NOVA Bikeways and Trails Plan

Technical Analysis – Latent Demand for Bicycle Travel

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In March 2002, the consulting team conducted a bicycle travel demand analysis for the NOVA Bikeways and Trails Plan. The analysis was conducted on proposed regional bikeways, specifically measuring "latent" travel demand – or the relative amount of bicycling that would occur if riding conditions were comfortable. This involved identifying bicycle trip generators – parks, schools, high employment areas, park-and-ride lots, transit stations, shopping areas, and other high volume destinations. The analysis also included population densities. A map showing the results of this analysis should be available on the project website in the summer of 2002. This memorandum explains the basic theories of bicycle travel demand analysis, focusing on the Latent Demand method that was employed for this study.

The Latent Demand method provides a picture of potential demand throughout a transportation network. By contrast, traditional four step travel demand models don't generally model non-motorized modes for a variety of reasons among them the prohibitive cost of model calibration.[1]

In order to perform a travel demand analysis for the bicycle mode, a methodology must be employed that recognizes the unique impediments to that mode. Unlike automobile travel, bicycle travel often does not occur due to a number of impediments, one of which is relatively poor accommodation of bicyclists within the existing transportation network. Consequently, existing bicycle counts generally do not indicate the level of potential bicycle trip activity on a roadway

[1] For a more detailed discussion of the inability of traditional models to estimate non-motorized travel demand see the Federal Highway Administration's *Guidebook on Methods to Estimate Non-Motorized Travel* (Washington DC: Federal Highway Administration, 1999). It can be accessed at http://www.bicyclinginfo.org/rd/planning.htm#guide. Refer to Section 2.4 – Factors Specifically Influencing Bicycle and Pedestrian Travel.

network. Therefore, alternative or surrogate measures of assessing bicycle trip activity are needed.

Methods of Assessing Bicycle Trip Activity

There are three primary methods of assessing bicycle trip activity. The first method is documenting *revealed demand*. This is accomplished by simply counting the existing number of people bicycling on the roadways or off-road pathways. A second method is to identify, map, and *evaluate key bicycle generators or attractors*. In practice, this method tends to focus on major bicycle trip attractors. The third method is to assess the *latent demand* throughout the study area. Assessing latent demand considers both existing activity and pent-up bicycle demand. It also enables planners and engineers to anticipate and plan for future bicycle travel needs. The following paragraphs briefly describe each of these three methods, their advantages and disadvantages.

Revealed demand

This method consists of compiling counts of existing bicycles on the roadways. Its usefulness is limited to areas that already have an extensive bicycle network that provides an overall high-quality bicycling environment. This method is <u>not</u> usable for the vast majority of U.S. metro area transportation networks, due to their generally poor bicycle accommodation.

Evaluation of Key Bicycle Trip Generators and/or Attractors

Until recently, this method has been the most common method of estimating bicycle travel demand. However, it has two major problems: the limited number of *key* bicycle attractors it considers, and the fact that it generally focuses only on attractors – therefore only one end of the bicycle trip is considered.

The first problem with this method is that it tends to focus on *key* bicycle trip attractors such as schools, parks, and neighborhood retail centers, and thus only a fraction of the existing and potential bicycle trip attractors are represented. In

fact, virtually every residence, every business, and every social and service establishment in a study area is a *key* bicycle trip generator or attractor. Thus this method, in practice, fails to account for that fact.

The method's second shortcoming is directly related to the first. Since the method focuses on *key* attractors, only one end of the bicycle trip – the destination, is quantified. This is a problem because the method does not account for the production (or supply) of trips available to that attractor. For example, a particular park may have many amenities, and hence exhibit a high trip attraction rate, but if it is in a rather remote area (i.e., the surrounding population density is very low) the actual bicycle trip activity (or interchange) between the attractor (park) and generator (population) would be low. Consequently, the method does not account for the bicycle trip interchange reality that exists *among* generators and attractors throughout the study area.

Latent Demand

The method that quantifies both ends of the bicycling trip as well as considers *all key* generators and attractors in a study area for both existing and potential trips is the *Latent Demand Method*. The *Latent Demand Method* is a logical extension of the second method, and it is rapidly becoming the method of choice for metropolitan areas throughout the United States. Numerous U.S. metro areas are using this method to estimate the potential of roadway corridors to serve bicycle and/or pedestrian trip activity.

The *Latent Demand Method* is essentially a simplified gravity model, based upon a theory similar to that used in the prevailing four step Urban Transportation Planning System-based travel demand models throughout the United States. The following sections outline its theory and technical application in a Geographic Information System (GIS) transportation planning environment.

The Latent Demand Method

Travel patterns in a metropolitan area are well described by Newton's law of universal gravitation as applied to trip interchanges. This relationship essentially reflects that the number of trips, regardless of travel mode, between two areas is *directly* related to the number of trip productions (e.g. population residences) in one area and the number of trip attractions (e.g., workplaces, shopping opportunities, schools, etc.) in the other (destination) area. The relationship also shows that impedances (e.g., travel distance and/or time between the areas, conditions of the travel environment, etc.) play a significant role in *reducing* the amount of trips made between those areas.

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Bicycling activity patterns can be described by a similar relationship. However, unlike those for the automobile travel mode, the impedances to the bicycling mode play a greater role. For example, the distance between trip origins and destinations affects bicycling more dramatically than it does for automobile travel. Additionally, the condition of the bicycling environment affects whether a bicycling trip is made and how far, and what route, a person is willing to travel. Furthermore, depending on the purpose of the bicycle trip, the carrying, or "payload" capacity plays a role in not only the bicycle travel distances but also whether or not a bicycling trip is even made.[2]

Impedances are different for different trip purposes. For example, people are typically willing to bicycle a greater distance to work than they are to simply pick up a convenience item at a neighborhood store. This phenomenon is reflected in national survey data, as depicted for three trip purposes in Figure 1. Essentially, the trip making probability varies according to the distance between origins and destinations, and it also depends on the purpose of the trip.

[2] Seasonal and environmental factors also affect travel distances, but in an analysis of roadways within the same metro area, they are not a factor unless they vary *within* the region.

The *Latent Demand Method* accounts for the above outlined characteristics of bicycle travel in an area. While it is not a full and rigorous four-step travel demand model, it includes the trip interchange relationship in a gravity model trip distribution analysis but is conducted with a corridor focus. It models trips according to the four general utilitarian trip purposes identified in the National Personal Transportation Survey (NPTS) shown in Figure 2. The *Latent Demand Method* is an analysis of the entire region, using a corridor-based, geographic information system (GIS) algorithm to quantify relative potential bicycle trip activity.

The *Latent Demand Method* is an effective analysis tool for assessing bicycle travel demand. It can:

- include all *key* trip generators and attractors;
- quantifies the potential trip interchange between *key* generators and attractors;
- recognize that different trip types account for differing shares of the total trips
- estimate the trip making probability of each trip type as a function of distance; and
- be employed to assess the latent demand for any roadway or off-road trail network.

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As previously outlined the impedances to bicycling as a transportation mode play a large role in the probability of a bicycle trip occurring. One of the significant impedances, the effect of motor vehicle traffic, is assumed not to exist for the purpose of calculating non-linked, or *latent* trips. This assumption is based on the premise that if motor vehicle traffic was not present, the "latent" bicycle trips would become "revealed" trips.

Latent bicycle travel activity is directly related to the frequency, magnitude, and proximity of trip generators and attractors to a roadway segment. The *Latent Demand Method* process takes these "snapshots" of the potential trip activity for

all key attractors and generators throughout the study area and essentially assembles them into a composite. Figure 3 shows the basic mathematical expression of this GIS-based region-wide model.

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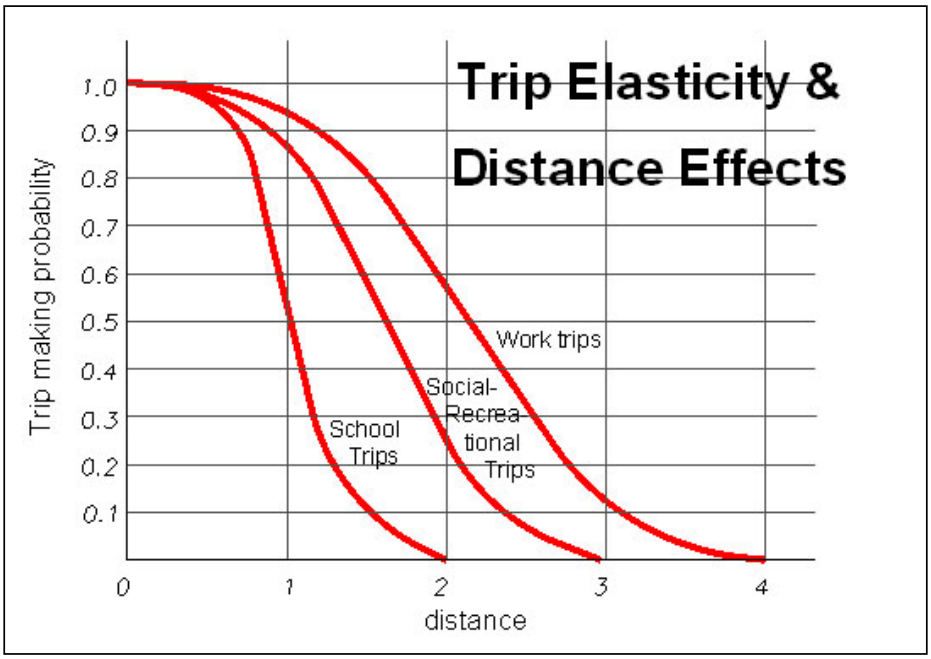

FIGURE 1 Typical Trip Making Probability (impedance effects) due to distance

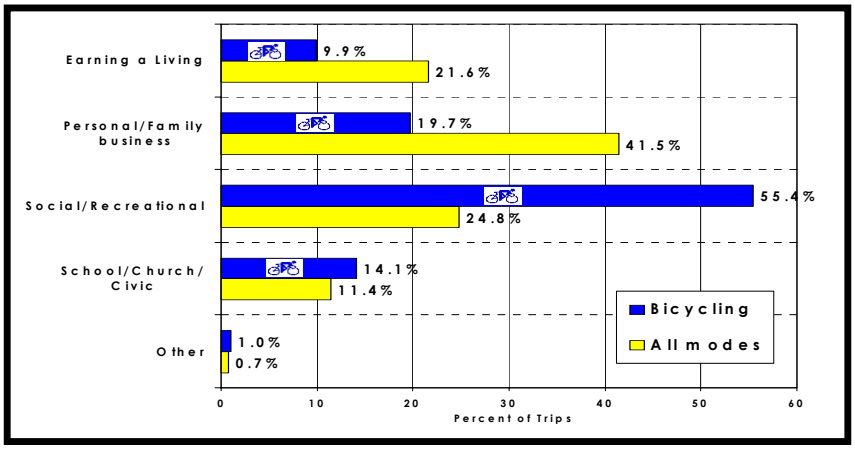

FIGURE 2 Bicycling by Trip Purpose

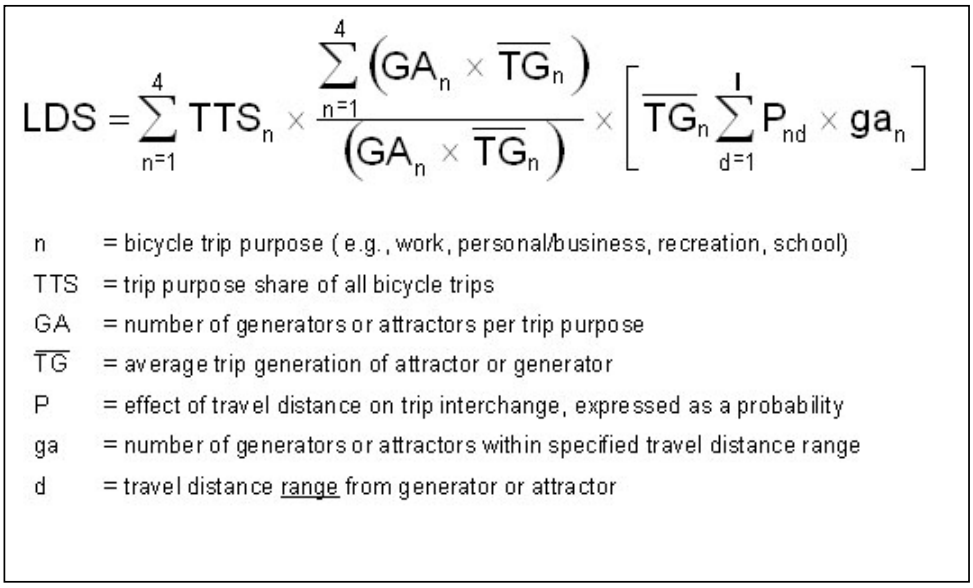

FIGURE 3 The Basic Latent Demand Assessment Algorithm