The Use of Adaptive Assignment in Travel Demand Models; Focusing on the Application of Adaptive Assignment to the Highway-to-Highway Model in Anchorage, AK

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Abstract

This paper describes an alternative approach and process for travel demand modeling on projects in the design decision and engineering phases. Adaptive assignment is a tool which uses time period count data to re-estimate origin-destination matrices. The adaptive assignment process results in a much better match of modeled volumes with available count data, and enhances the underlying base model calibration. Adaptive assignment is a flexible tool which can result in a better and more resolved calibration for multiple time periods and vehicle classes.

Adaptive assignment has been applied to the Highway to Highway (H2H) model in Anchorage, Alaska. The H2H model is a focused version of the Anchorage Municipality Area Transportation Solutions regional model. The H2H model uses the adaptive assignment process, and was developed for an engineering study which would connect two major freeways. This paper focuses on a comparison of forecasting procedures for traffic analysis using traditional model demands and adaptive assignment model volumes.

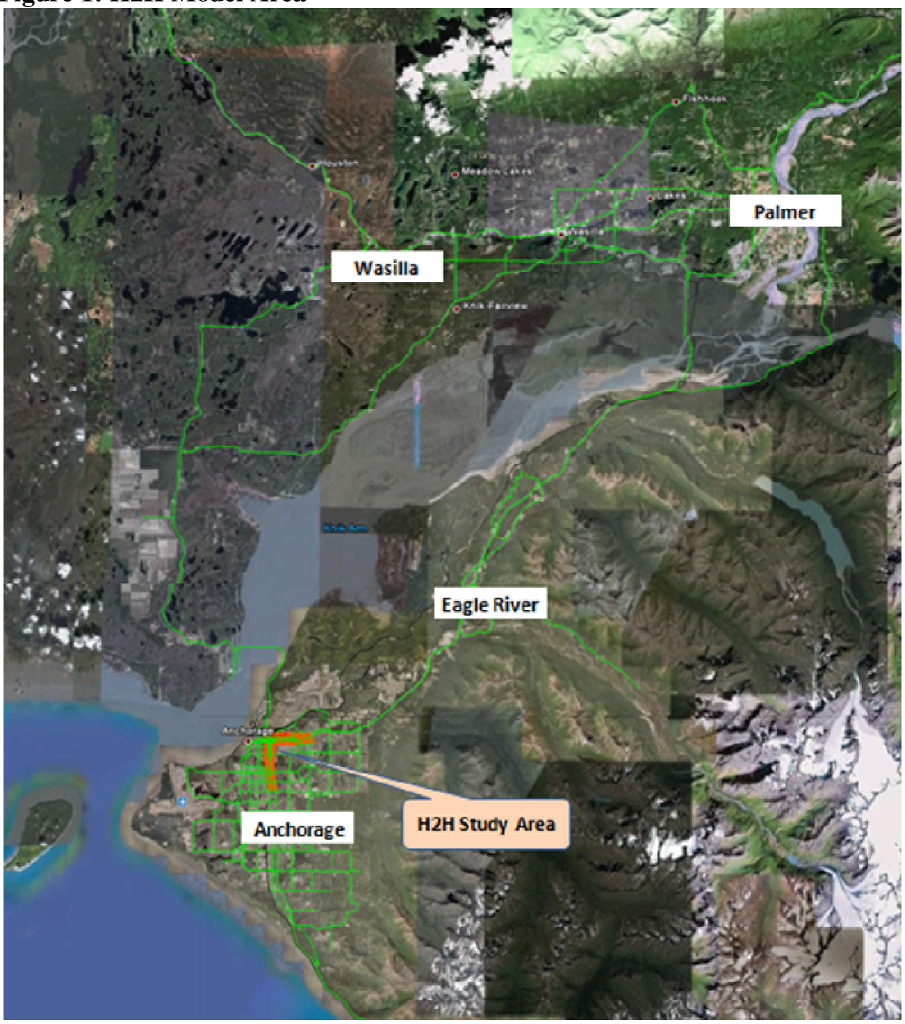
The application of adaptive assignment to the H2H model resulted in calibrated travel demand model volumes which closely replicated existing travel patterns for multiple time periods and modes.

Introduction

The Anchorage, Alaska metropolitan area has a sophisticated multi-modal travel demand model which is maintained by Anchorage Metropolitan Area Transportation Solutions (AMATS). The AMATS model is a traditional four step travel demand model, and incorporates highway, transit, and non-motorized modes, time-of-day trip estimation, feedback of congestion impacts to trip distribution, land use and demographic submodels to take account of urban form and population characteristic data, and an extensive set of analysis and reporting post-processors. The AMATS travel demand model has been used for many local planning projects, and was most recently refined for the Anchorage Bowl 2025 Long-Range Transportation Plan: With 2027 Revisions[1], and validated to the base year 2007. The AMATS model encompasses the entire AMATS area, including the Anchorage Bowl and Chugiak-Eagle River.

The Highway to Highway (H2H) project is a regional study focusing on the connection of the Seward and Glenn Highways. In support of the H2H project, the AMATS travel model was expanded and modified to better address regional traffic issues, and to improve upon the underlying base calibration. The use of an "adaptive assignment" technique was used to calibrate the project model within the larger region, and primarily along the study corridor. The H2H focus model was developed to take full advantage of the capabilities of the AMATS model. Figure 1 shows the extent of the enhanced AMATS model, and the location of the H2H project.

Figure 1: H2H Model Area



Travel Demand Model

The platform for the AMATS travel demand model is the TransCAD software, version 4.7. The H2H project model enhancements include extending the network to include the Matanuska-Susitna Borough, a refinement of the zone structure within the H2H study area, development of an extensive count database, the application of adaptive assignment for existing model calibration, and future model growth factoring. This report will focus on the count database, application of adaptive assignment, and future model growth factoring.

Count Database

The adaptive assignment process is highly dependent on the count database to get the best calibration possible. The extensive count collection and database development for the H2H project included collecting peak period counts within the entire region on freeways, arterials, and collectors. For the H2H project, there were 437 AM and PM peak period directional counts which were used for model calibration.

Adaptive Assignment

Adaptive assignment is a mathematical model based on maximum likelihood that is used to adjust a table of origin-destination trips to best match a set of input link volumes. In short, adaptive assignment attempts to produce a modified table that best matches known conditions.

The adaptive assignment process is designed to provide the necessary focus on details, and refining forecasting while maintaining sensitive to potential regional traffic influences. The adaptive assignment estimation process was conducted by time periods (AM peak period, PM peak period, and off-peak period) and by vehicle modes (auto and truck). NEPA travel forecasting guidance mentions alternative approaches to using raw forecasted volumes from regional travel models, and specifically mentions using adjustment factors derived using observed traffic counts.

> *"In the case of a regional travel model, it may not be advisable to directly use the raw forecasted volumes from a planning model and apply them in the context of a NEPA study." … "When adjusting traffic volumes produced with a regional model, the modeler develops adjustment factors using base year volumes and observed traffic counts and applies those adjustment factors to the future traffic volumes estimated from a model."*[2]

Future Model Growth Factoring

The adaptive assignment process also includes a **growth factoring** model that estimates future travel patterns based on combining a base year (2007) trip table with estimated future growth. In this way, the calibrated trip patterns developed through the adaptive assignment process are used directly in forecasting future traffic volumes. This type of factoring is an industry-standard practice and is commonly used in project and corridor studies.

Base Model Calibration

The AMATS travel model was previously validated only to match weekday daily travel forecasts. In comparison, the base model calibration for the H2H model was performed by comparing the ground field counts to the assigned volumes for links within the region by time of day (AM peak period, PM peak period, off-peak period, and total daily) travel. The adaptive assignment process was used for the H2H model to supplement more traditional model calibration methods to achieve better correspondence with existing traffic counts, particularly for specific time periods.

A travel demand model calibration process begins with comparing predicted base model volumes and observed traffic counts. The closer the correlation of counts to volumes the closer the calibration is to existing conditions. Figures 2 and 3 show the counts versus volumes for the AMATS travel demand model and the H2H project model. These figures give a visual of how much closer the H2H model predicts traffic volumes when compared to the AMATS model.

Figure 2: AMATS Travel Model Daily Existing Counts vs. Model Volumes

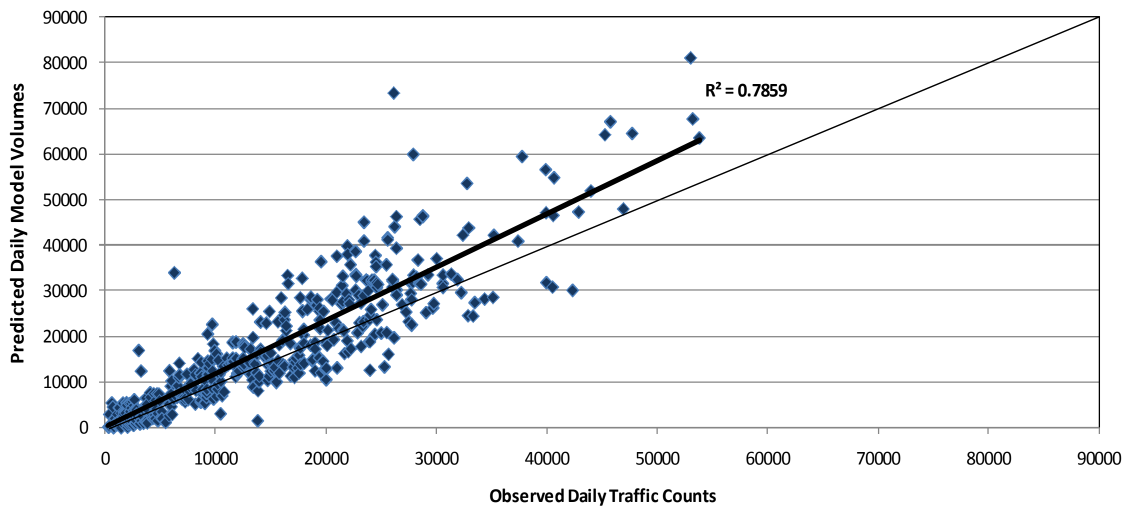
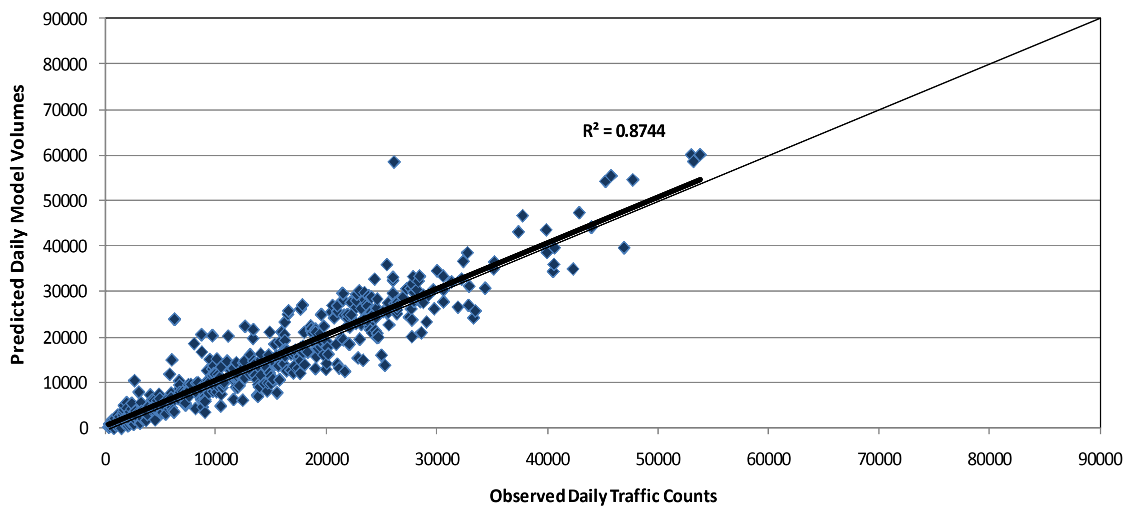


Figure 3: H2H Project Model Daily Existing Counts vs. Model Volumes



The AMATS travel demand model and the H2H project model calibration were compared using three different methods: Federal Highway Administration (FHWA) facility class targets, coefficient of determination (R-squared) value, and United States Department of Transportation (USDOT) Travel Model Improvement Plan (TMIP) root mean squared error (RMSE) values.

FHWA Calibration Criteria

One way to assess the calibration of a travel demand model is to compare how closely the model predicts volumes by facility type when compared to observed counts. The

FHWA has defined targets for daily volumes, and Table 1 shows how closely the AMATS model and the H2H project model meet these targets[3].

The AMATS model calibration does not meet these targets for freeways, major arterials, or minor arterials, although it does meet the criteria for collectors. The H2H model calibration meets these targets for all facility types, and much closer than the AMATS model calibration. The comparison between the AMATS model and the H2H model shows that the adaptive assignment process used in the H2H model creates much closer relation of model volumes to observed counts, and the H2H model more closely meets t he facility type criteria developed by the FHWA.

TABLE 1
FHWA Facility Type Criteria and Model Performance

Facility Type	FHWA Targets	AMATS Model Performance	AMATS Model Target Met?	H2H Model Performance	H2H Model Target Met?
Freeway	+/- 7%	+44%	No	+3%	Yes
Major Arterial	+/- 10%	+11%	No	+3%	Yes
Minor Arterial	+/- 15%	+16%	No	+3%	Yes
Collector	+/- 25%	+4%	Yes	+5%	Yes

Coefficient of Determination Calculation

The coefficient of determination (also called R-squared) value is often used for assessing regional travel demand models, which measures the strength of the linear relation between counts and volumes. An R-squared value close to 1.0 means that the model is considered statistically good at predicting travel, meaning that the model has a strong correlation between observed traffic counts and model volumes. The USDOT[4] has stated that the R-squared value should be 0.88 or higher for the daily time period, which is referred to as a "standard" for travel model validation.

The R-squared value for the AMATS model is .7859 and the R-squared value for the H2H project model is 0.8744. Therefore, the H2H model better matches the observed counts than the AMATS model, and is also very close to the recommended daily R-squared value.

RMSE Criteria

Another method for checking the reasonableness of the calibration is the RMSE, as defined by the Model Validation and Reasonableness Checking Manual, Second Edition. The mean squared error (MSE) value is the squared distance vertically between the count and the volume. The smaller the MSE, the closer the volumes are fitting to the counts. The RMSE is the square root of the MSE, and is the distance on average, of a data point from the fitted line measured along a vertical line. For model calibration purposes, the percent RMSE was calculated using the following equation:

$$\%\text{RMSE} = 100 * \frac{\sqrt{\frac{\sum_j((\text{Model}_j - \text{Count}_j)^2)}{(\text{Number of Counts} - 1)}}}{(\frac{\sum_j \text{Count}_j}{\text{Number of Counts}})}$$

There are no specific %RMSE targets, but several states do have their own guidelines that have been used in practice. The Montana Department of Transportation suggests less than 30%[5], the State of Tennessee suggests less than 30%[6], the Iowa Department of Transportation recommends less than 30%[7], and the Community Planning Organization of Southwest Idaho recommends an overall RMSE [8]less than 40%.

The %RMSE values for the AMATS model and the H2H project model are 48.3% and 27.4%. The %RMSE predicted by the H2H project model is lower than the AMATS travel model, and shows that the H2H project model has a closer calibration of predicted model volumes to observed traffic counts.

Adaptive Assignment Benefits

The primary benefit to using adaptive assignment is a quicker calibration of the base year travel demand model to time periods and modes. The time required for a traditional model calibration and validation often takes months; approximately 3 months for the AMATS model. The time required to calibrate and validate the H2H project model, including developing the extensive count database, took almost 2 months.

Another benefit to using the adaptive assignment process is that it better replicates existing travel patterns than the traditional model calibration process, and provides a solid foundation and forecasting methodology.

Conclusion

The major advantage of adaptive assignment over more traditional approaches is the ability to refine estimates of traffic based on specific categories and trip types. In the case of the H2H model, input traffic counts were stratified into time-of-day and auto-only trips to improve validation of these categories.

The use of adaptive assignment in the H2H project model shows that the adaptive assignment process is a viable and effective alternative to traditional forecasting processes and procedures in the development of subarea travel demand models for corridor studies. This approach is particularly effective for schedule-driven projects by reducing time needed for base year model calibration. The usefulness of the adaptive assignment process can be maximized with the support of a strong regional travel demand modeling framework.

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[2] FHWA. *Interim Guidance on the Application of Travel and Land Use Forecasting in NEPA.* March 2010. Page 23, Section 2.4.5.

[3] FHWA, *Calibration and Adjustment of System Planning Models*, 1990; Michigan Department of Transportation (MDOT), *Urban Model Calibration Targets*, June 10, 1993

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