The Ohio Department of Transportation Office of Research & Development Executive Summary Report

Statistical Validation of Speeds and Travel Times Provided by a Data Services Vendor

Start Date: October 2008

Duration: 16 Months

Completion Date: January 2010

Report Date: January 2010

State Job Number: 134416

Report Number:
FHWA/OH-2010/2

Funding: $95,497.80

Principal Investigators:
William H. Schneider IV, Ph.D., P.E.

ODOT Contacts:

Technical:
George Saylor, P.E. and
Marian Thompson, P.E.
Office of Traffic Engineering

Administrative:
Monique R. Evans, P.E.
Office of Research and Development

For copies of this final report go to http://www.dot.state.oh.us/divplan/research *or call 614-644-8173.*

Ohio Department of Transportation
Office of Research & Development
1980 West Broad Street
Columbus, OH 43223

Problem

The provision of real-time traffic and travel time information is becoming increasingly important in urban areas as well as in freight-significant intercity corridors. However, the high cost to install and maintain roadway-based traffic sensors has prevented widespread availability of real-time traffic information in these areas. A market for real-time traffic information is emerging in the United States, and several private companies are gathering and distributing traffic information independently of public sector transportation agencies. In fact, several of these private companies have begun marketing their traffic information to public sector agencies like state departments of transportation (DOTs).

The problem is that some private companies are still developing and/or refining their traffic monitoring technology, whether it is Global Positioning Systems (GPS), probe vehicles or cell phones methods, while at the same time trying to sell the technology as a mature product. For example, several evaluations of cell phone-based traffic monitoring in the past five years have provided poor results. Based on these findings, it is critical that the quality of private sector travel time data be adequately evaluated in fee-for-service contracts with state DOTs.

Objectives

There are four research objectives, which must be met in order to insure that project PS-09-05 "*Statistical Validation of Speeds and Travel Times Provided by a Data Services Vendor*" will be considered a success as described in the request for proposal. These four objectives include:

- Objective One - Conduct a GPS floating car methodology data collection along 103 centerline miles in Dayton, Ohio,
- Objective Two - Evaluate the accuracy of travel time data from a service provider,
- Objective Three - Provide recommendations for travel time data service evaluation procedures to be used in contract provisions and/or future evaluations, and
- Objective Four - Summarize the final results.

Description

Over the five data collection trips, data are collected from three main sources used to record vehicle speeds. The first source is spot speeds, the second source is a traditional approach using floating car probe data and the third source is a newly developed technique using Bluetooth device matches. These three methods for estimating traffic flow, more specifically vehicle speed over a segment of roadway, are used to estimate the actual travel time required by a driver to travel between the beginning and ending mile point of the 36 travel time segments located in Dayton, Ohio. To ensure accuracy of the estimated travel times, it is paramount that the system used with these estimations is audited for accuracy. In this study, the conclusions are presented concerning the following research areas:

- Comparison between spot speed readings and sensor speeds,
- Evaluation of Bluetooth and floating car methods, and
- The comparisons of ODOT travel times and speeds with field reference data.

Conclusions & Recommendations

Research Area One

The first conclusion is based on the comparison between spot speed readings and sensor speeds. In most cases, spot speed comparisons are made during data collection runs. In the data collection associated with the spot speeds, the research team uses laser guns, which sample across all lanes of traffic in random order for a period of 25 minutes. The collected speeds are then averaged on a per minute basis and compared with the ODOT reported speeds based on the device id. The results from the field show on average 75% of the one-minute intervals are within the ODOT required four mile per hour range.

Research Area Two

The second research area compares the performance of floating car probe data with a relatively new technique using Bluetooth device matches. The ultimate goal is to obtain highly correlated average speeds between both methods. In this study, field data are collected on three high volume access-controlled interstate highways, I-70, I-75 and I-675, an urban arterial US-35, and two state highways SR-4 and SR-49.

The first finding is developed for periods when vehicles are operating under free-flow conditions. When the vehicles are travelling under free-flow conditions, the Bluetooth devices may have a tendency to record slightly faster speeds in comparison to the floating car data. The main explanation for this is the drivers of the floating cars are instructed to maintain “normal” speeds close to the posted speed limit, while there are no limitations placed on the Bluetooth data.

A second finding shows there are significantly higher numbers of data points for the Bluetooth devices in comparison to the floating car data. The increased number of points may not be of great significance under free-flow conditions, but is extremely effective in describing periods of high variability. The higher number of points also provides a greater confidence in estimating the actual speed along a segment of highway. The third finding of significance is the impact of the segment length. In the case of the floating car data, the travel time length is not a limiting factor. The drivers are instructed to begin and end their individual runs at fixed points. The Bluetooth devices are not independent of segment length. As the segment length increases, the number of potential Bluetooth matches decreases. In order to improve the efficiency and capabilities of the Bluetooth devices, it is recommended to either increase the number of travel time segments, lowering the

length between end points, or additional Bluetooth readers should be included throughout the studied segments.

Research Area Three

The third set of conclusions are based on the statistical evaluation of the reported ODOT travel time algorithms and the field reference data provided by the floating car and the Bluetooth method. In this evaluation, findings are evaluated for both the average travel times and speeds during the entire data collection, as well as the individual sample comparisons. There are six evaluations: free-flow conditions, congestion, data resolution using Bluetooth methods, the underreporting of travel times especially on arterial highways, the influence of rounding travel times to the nearest minute on short segment lengths and unexplained differences in reported travel times.

The first evaluation of the ODOT travel time algorithm is developed under free-flow conditions. During this study between 53% and 62% of the samples are collected during free-flow conditions. In these cases, the overall findings between the reference data and the ODOT travel time algorithm show slightly faster travel times and speeds for the reference data when compared with the ODOT travel times. Even though there are some differences between the methods, the overall results and conclusions show a nice correlation between the two methods. One potential recommendation is to define the capped speeds based on segment links in-lieu of spot locations.

The second evaluation of the ODOT travel time algorithm is developed for periods of congestion. In general, the overall trend in terms of longer travel times and slower speeds is consistent between the ODOT travel time algorithm and the reference data. In most cases, the ODOT travel time algorithm under congestion over estimates the actual speeds, which in turn lowers the corresponding travel time per segment. The difference between the ODOT travel time algorithm and the reference data is generally between one to three minutes per segment. This estimation is reasonable under the high variability associated with congestion.

The third evaluation of the ODOT travel time algorithm is the impact of data resolution between the Bluetooth and the floating car methods. In this set of results, especially for the high volume access-controlled interstate highways, there are substantially more Bluetooth values than floating car data. The improved resolution is particularly significant during periods of variability, and the use of Bluetooth data is highly recommended.

The fourth evaluation of the ODOT travel time algorithm is the underreporting of travel times on arterial highways. In this set of results, the overall trends are the same between the reference data and the ODOT travel time algorithm. The main difference is the consistent underestimation of travel times using the ODOT travel time algorithm. One potential recommendation of this study for these results is the re-calibration of the ODOT travel time algorithm.

The fifth evaluation of the ODOT travel time algorithm is the impact of rounding the travel times to the nearest minute. The rounding of the travel times is one of the variables used to calculate the average speed across a travel time segment over time. Although from a motorist point of view there probably is no noticeable difference, there is a significant impact on the estimation of speeds. The rounding of the travel times, especially on shorter travel time segments, under free flow conditions produces a significant change in the average vehicle speeds. One potential recommendation is the development of a calculation procedure for the minimum route travel times to avoid high equivalent speeds.

The sixth evaluation between the ODOT travel time algorithm and the reference data is based on unexplained differences in reported travel times. In these cases, there are no clear reasons why the travel times and speeds are significantly different. The first general recommendation is further analysis is required of the fixed-point sensor data and the posted travel times. A second recommendation is the review of archived travel times to reveal how often these extreme fluctuations occur in low-volume traffic

conditions. A final recommendation is based on a cursory analysis of rainfall data and fixed-point sensor data.

Summary of Research Areas

In conclusion, the use of Bluetooth data along with floating car data provide an effective methodology used in referencing travel times and speeds over a travel time segment. In terms of evaluation, the research team recommends the comparison of both travel times and speeds using the mean absolute difference and the mean bias difference, as well as visual observations between the ODOT travel time estimates and the reference data. In general, the overall results at the system-wide level seem reasonable.

Implementation Potential

To ensure the future success of this research, the research team will continue to work closely with the technical liaisons to address any questions that arise in the future.