Development of Bus-Stop Time Models in Dense Urban Areas: A Case Study in Washington, DC

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Bus transit reliability depends on several factors, including the route of travel, traffic conditions, time of day, and conditions at the bus stops along the route. The number of passengers alighting or boarding, fare payment method, and the location of the bus stop also affect the overall reliability of bus transit service. Total Bus Stop Time (TBST) is an important measurable factor that could be used for improving the design of more reliable bus transit schedules. The study developed and optimized Dwell Time (DT) and TBST models for bus stops located at intersections and at mid-blocks.

Study Methods

The DT and TBST models were developed using nonlinear optimization methods. The study involved data collection at sixty bus stops, thirty of which were located at intersections, while the remaining bus stops were at mid-blocks. The data were obtained for the morning, midday, and evening peak hours from January through September 2014. Data on the following variables were obtained at each bus stop: bus stop type, number of passengers alighting or boarding, DT, TBST, number of lanes on approach to the bus stop, presence of parking, and bus pad length. The data were analyzed, and all statistical inferences were conducted based on 95% confidence level. Finally, a nonlinear programming process was used to optimize the objective function.

Findings

Both DT and TBST differ based on the bus stop location type.

The mean TBST and DT at intersections were generally higher at the bus stops at intersections than at those located at mid-blocks. This could be attributed to the potential influence of intersection interactions, including traffic, signal operations, pedestrian crossings, congestion, parking maneuvers, and other factors. The overall mean DT was determined to be 29 seconds, while the mean TBST was approximately 48 seconds at the bus stops at intersections. For mid-block bus stops, the overall mean DT and TBST were 21 and 35 seconds, respectively.

TBST and DT models were determined to be statistically significant.

Regression models by bus stop location-type yielded statistically significant regression models within the margin of error (5% level of significance), with high R2 and adjusted R2 values for DT and TBST (73%-95% and 67%-99%, respectively). The results of the analysis of variance (ANOVA) tests also showed statistically significant F-statistics ($p < 0.05$). For all the DT models, the number of passengers alighting and boarding significantly contributed to the model based on the significance of their coefficients. In the case of the TBST models, only DT contributed significantly to the model at a 5% level of significance, in addition to statistically significant regression coefficients (from the t-tests, with $p< 0.05$).

Policy Recommendations

The authors state that the concept of total bus stop time prediction will provide bus transit decision-makers additional metrics to enable them to improve bus schedule planning and overall reliability. In addition, due to potential changes in traffic patterns and land uses near bus stops, these models should be updated and validated on a 3–5-year cycle.

About the Authors

Dr. Arhin is an assistant professor of the Department of Civil and Environmental Engineering of Howard University, the director of the Howard University Transportation Research and Traffic Safety Data Center (HUTRC), and the director of this transit research project, conducted under the Mineta National Transit Research Consortium. Dr. Noel is a professor of the Department of Civil and Environmental Engineering of Howard University. He served as the executive director of the Howard University Traffic Safety and Transportation Data Center and for this study. They both are registered Professional Engineers.

To Learn More

For more details about the study, download the full report at ***transweb.sjsu.edu/project/1239.html***

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