Using Automatic Vehicle Location Data to Measure the Impact of Traffic Congestion on Bus Routes

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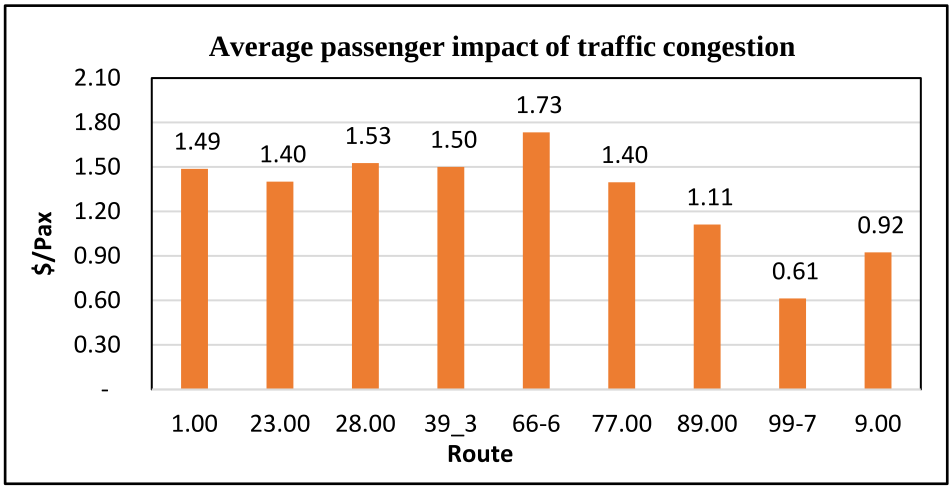
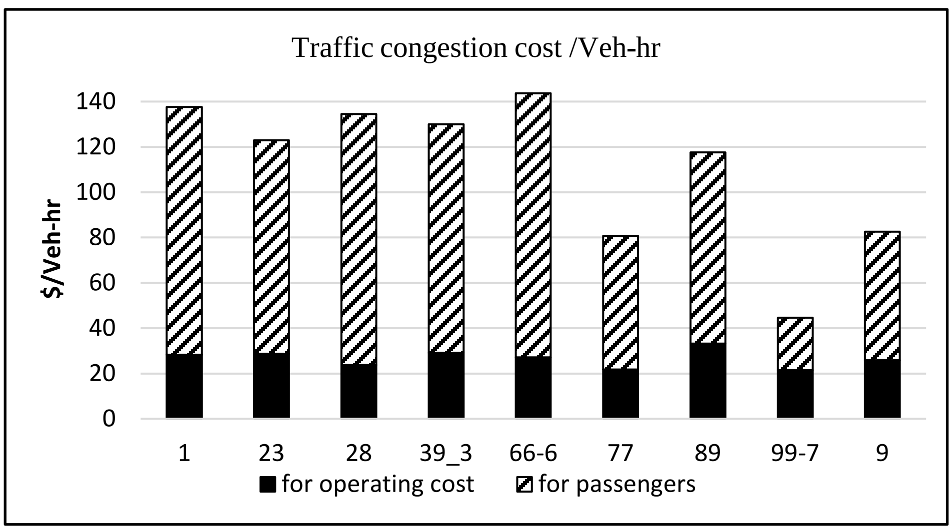
Letting buses operate in mixed traffic is the least costly way to accommodate transit, but that exposes transit to traffic congestion which causes delay and service unreliability. Understanding the real cost that traffic congestion imposes on both passengers and operating agencies is critical for the efficient and equitable management of road space. For transit operators, congestion results in longer running times and increased recovery time. To passengers, traffic congestion increases riding time and, because of how congestion increases unreliability, waiting time and potential travel time (buffer time). This study aimed to develop a systematic methodology to estimate those costs for Boston-area bus routes using Automated Vehicle Location (AVL) data and automated passenger counting (APC) data.

Using data from a low-traffic period as a baseline, incremental running time in each period can be calculated. However, some of the incremental running time is due to the greater passenger volumes that typically accompany higher traffic periods. Passenger counts and a regression model for dwell time, estimated from detailed ride check data, were used to estimate the passenger volume effect on running time so that running time impact from traffic congestion could be identified.

Observed running time variability is a combination of variability due to random passenger arrivals, variability in the schedule, inherent variability in running time, variability due to imperfect operating control, and variability due to traffic congestion. Methods were developed to model the first four components so that incremental variability due to traffic congestion could be identified for each period, again using a low traffic period as a baseline. From this incremental variability, one can calculate the additional recovery time needed as well as increases in passenger waiting time and potential travel time (buffer time), which is the difference between budgeted travel time and actual travel time.

The methodology was tested on nine different bus routes operated by the MBTA, including both high and low frequency routes. The data sources are AVL announcement records, AVL time point data, and APC route-level data. The main results are shown in the figures below. Summing over all the periods of a week, the average impact of traffic congestion on operating cost is $20.4 per vehicle hour, and the average impact to passengers is $1.30 per passenger; naturally, these impacts are far greater during peak periods.





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