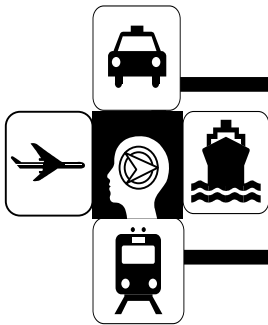


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IMPACT OF CONGESTION ON BUS OPERATIONS AND COSTS

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INTRODUCTION

Traffic Congestion interferes with the operations of bus service and imposes additional costs to the transit agency that provides the service.

As traffic volumes or congestion increase, traffic speeds decrease, as established in traffic engineering formulas and curves that show speed as a function of the traffic volume to capacity ratio. This results in additional time being required to travel a fixed distance. Congestion also decreases bus speeds and increases the travel time for buses. The basic approach of this study involved developing a regression model that estimates bus travel time rate (in minutes per mile) as a function of the travel time rate for traffic.

RESEARCH APPROACH

The data for calibrating the model were from two local New Jersey Transit bus routes operating in Northern New Jersey, Routes 59 and 62. The data were collected by study team members riding the buses and following the routes in cars as well as from automatic passenger counting (APC) equipment on eight buses. The APC equipment records passenger activity and also exact time and location using the global positioning system. The unit of analysis was one bus trip on a route segment, a one-way section of the route between two time points. For each bus trip, data on time the bus reached each bus stop, the number of passengers boarding, and the number of passengers getting off were collected.

The travel times for general traffic were determined by following the bus route by car during the same periods of the day (although not at the same time or day as the bus data were collected). Additional data on the route, such as the number of traffic signals in the route segment, were also recorded. After cleaning the data, there were 690 cases or 690 bus trips on 35 different route segments.

The data were used to develop regression models that estimated the bus travel time rate (in minutes per mile) as a function of the car travel time rate and other variables, such as boarding passengers, traffic signals, left turns. By using an estimate of car travel time rate under free flow conditions in the model and comparing the results with the current bus travel time rates, the increase in time due to congestion can be estimated.

FINDINGS

The best model of bus travel time rate was:

$$\text{BTT} = 0.52 + 0.73 \text{CTT} + 0.06 \text{Ons} + 0.31 \text{BS} \quad R^2 = 0.62$$

Where

BTT = Bus travel time rate (min/mile)

CTT = Car travel time rate (min/mile)

Ons = Passenger boardings per bus trip per mile

BS = Bus stop locations per mile

The travel time model was used to estimate the increment in bus vehicle hours due to the increase in traffic travel time over free flow time. This was done by estimating the bus travel time rate using the following values for the explanatory variables: car travel time rate under free flow conditions (2.22 min/mile), the average number of passenger boardings per bus per mile for each route segment (from the data set), and the number of bus stops per mile for each segment. The resulting bus travel time rate was compared to the bus travel time rate implied by the route schedule. The results for Route 59 indicated that 12 minutes of the one-way outbound scheduled time of 99 minutes is due to traffic congestion and 10 minutes of the one-way inbound scheduled time of 100 minutes is due to traffic congestion. This analysis was extended to all bus trips on Route 59 in the 6 AM to 6 PM period indicating a total increment of time per weekday due to congestion of 12 hours 53 minutes. When further extended to all non-holiday weekdays for one year, the congestion impact was 3156 vehicle hours for Route 59.

New Jersey Transit has determined that the cost of adding a vehicle hour of service is \$56.80. Using this figure, the cost per week day of congestion on Route 59 is \$732 and the 3156 vehicle hours per year due to congestion cost

New Jersey Transit about \$179,000 per year. This represents 4.3 percent of the total cost attributed to Route 59 in FY2002.

The concepts were then applied to all of the local bus routes in Northern New Jersey. The essence of this process is that the additional travel time per mile for a bus due to congestion is equal to 0.73 times the increment of general traffic time rate due to congestion. To determine the increment of general traffic time due to congestion on a broader basis, travel rate indices (TRIs) for the individual counties in New Jersey were used. TRIs are the ratio of actual travel time per mile to free flow travel time per mile. A New Jersey Institute of Technology study estimated TRIs for all New Jersey counties. Initially, the increases in bus travel time rate (in minutes per mile) and bus travel time (in hours) due to congestion were calculated from the indices for a sample of 39 bus routes in Northern New Jersey. The results for the 39 routes suggest that 93,600 vehicle hours of the total 1.2 million vehicle hours are due to congestion and the cost for the increase in vehicle hours alone is \$5.3 million or an increase in total costs of 5.7 percent. When this is further extrapolated to all New Jersey Transit bus routes in Northern New Jersey, the cost of congestion was estimated to be \$20.6 million for 2002.

The same New Jersey Institute of Technology study forecasted an increase in traffic levels of about five percent in the next five years. To calculate the impact of this increase on New Jersey Transit bus vehicle hours and costs, new TRIs were calculated for a five percent increase in volume to capacity ratios for the New Jersey counties. Using the new TRIs, the increment in vehicle hours and costs were calculated using the same 39 routes as above and extrapolated to the Northern New Jersey bus system, indicating that in five years time, New Jersey Transit will be paying \$30 million for 423,000 extra vehicle hours due to congestion.

CONCLUSION

The travel time model shows that there is strong relation between traffic speeds and bus speeds. As congestion adds an additional minute to the time that it takes general traffic to travel a mile, it will add almost 45 seconds to the time that it takes a bus to travel that same mile.

Applying this model to route 59 indicated that 10 to 12 percent of the scheduled time for the route was due to congestion. When extrapolated to the New Jersey Transit bus system, the model indicates that almost 350,000 bus hours per year are due to congestion, and, given forecasted increases in traffic, this will increase to 420,000 in the next five years. The cost to the agency of the additional bus hours due to congestion is \$20.6 million dollars per year currently, and this will increase to \$30 million (both figures in 2002 dollars).

The current and future impacts are summarized in the following table.

Summary of Current and Future Impact of Congestion on Vehicle Hours and Costs

	Current			Future	
	Current (FY2002)	Part due to congestion	Current w/o congestion	Congestion increment	Total
Vehicle hours	4,419,836	349,000	4,070,836	423,367	4,494,203
Operational variable expense (\$)	241,304,918	20,343,642	220,961,276	26,975,592	247,936,867
Total expense (\$)	361,758,967	20,343,642	341,415,325	26,975,325	368,390,916

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