Understanding the impacts of a combination of service improvement strategies on bus running time and passenger's perception

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ABSTRACT

This article aims to evaluate the impacts of implementing a combination of strategies, designed to improve the bus transit service, on running time and passenger satisfaction.

These strategies include using smart card fare collection, introducing limited-stop bus service, implementing reserved bus lanes, using articulated buses, and implementing transit signal priority (TSP).

This study uses stop-level data collected from the Société de transport de Montréal (STM)'s automatic vehicle location (AVL) and automatic passenger count (APC) systems, in Montréal, Canada.

The combination of these strategies has lead to a 10.5% decline in running time along the limited stop service compared to the regular service. The regular route running time has increased by 1% on average compared to the initial time period.

Riders are generally satisfied with the service improvements. They tend to overestimate the savings associated with the implementation of this combination of strategies.

INTRODUCTION

Boulevard Saint-Michel is a heavily used bus corridor located to the east of Montréal's central business district, in the province of Québec, Canada. STM has implemented a series of measures along the corridor. Figure 1 is a timeline showing these measures, which includes:

- On April 2nd, 2008, the implementation of a smart card system called 'OPUS' .
- On March 30th, 2009, the STM implemented a limited-stop bus service (Route 467) running parallel to the regular bus service (Route 67) along the corridor.
- On August 3rd, 2009, the STM began to operate a reserved bus lane during peak hours in order to improve the service.
- On February 1st, 2010, the STM assigned a number of articulated buses to serve Route 467.
- On September 1st, 2010, the STM equipped a few of these articulated buses with transit signal priority (TSP) systems which operates across all signalized intersections along the corridor.

METHODOLOGY

After the data cleaning process, two datasets were constructed. The first includes records from January to April 2007 and 2011, which contains 6,478 trips. The second dataset contains 60,973 complete trips between January 1st, 2007 and April 21st, 2011. Figure 2 shows Route 467 and 67 as well as the analyzed segment along the routes. Then, we generated the following:

- Two running time models to capture and isolate the effects of the improvement strategies made by STM.
- The first model is a general model that captures the overall impact of all changes made by STM during the study period.
- The second model contains dummy variables to control for the implementation of the studied strategies.
- Using the second model coefficients, a sensitivity analysis that enables a better understanding of the synergies impacts of each change in the operational environment, has done.

The second part of the analysis compares the actual running time changes to riders' perceptions. A short field survey was carried out by the research team in June 2011 among 354 users at stops serving both routes 67 and 467.

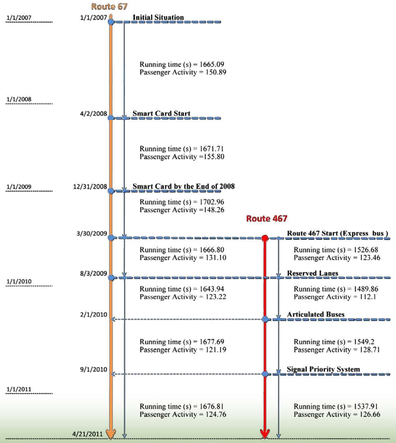

Figure 1: Time line of changes in bus service along Route Saint Michel

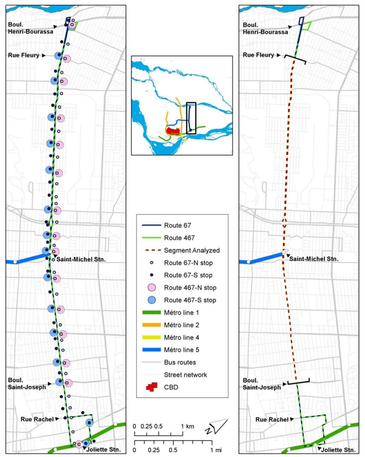

Figure 2: Study routes and the analyzed segment

ANALYSIS

Table 2 presents summary statistics for Route 67 and 467. Two linear regression models are developed using running time in seconds as the dependent variable. Table 3 presents the results of these models.Table 4 presents the estimated running times and the percentage of change compared to Route 67 initial situation.

Table 2: Descriptive Statistics for start period and 2011 period

	Route 67				Route 467			
	Start (from January to April 2007)		Year 2011 (from January to April 2011)		Start (from May to July 2009)		Year 2011 (from January to April 2011)	
	Mean	Std. Dev.	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Running Time (s)	1662.2	170.9	1688.3	198.9	1526.7	129.4	1535.2	185.2
Passenger activity	155.1	63.0	131.9	54.4	123.5	48.4	137.4	67.6
Actual stops made	24.6	3.1	22.3	3.4	12.7	0.7	12.5	0.9
Delay at the start (s)	38.2	89.5	56.3	114.6	56.2	105.3	64.7	131.3
Delay at the end (s)	32.9	145.2	149.7	192.8	-100.5	154.1	81.52	189.2
Max. passenger load	43.5	15.4	37.4	13.1	39.1	13.8	44.5	20.8
Average speed (km/h)	14.8		14.5		16.1		16.0	
Number	2538		2548		348		2001	

Table 3: Running time Models

	2007 data (from January to April) and 2011 data (from January to April)		All data (from January 2007 to April 2011)	
	Coefficients	T	Coefficients	t
Constant	1425.73***	92.86	1395.80***	266.07
Maximum Passenger Load	-0.40*	-2.03	-0.75***	-10.00
Actual stops made	5.03***	7.36	5.21***	21.38
Total passenger activity	1.39***	24.31	1.56***	71.86
Articulated passenger activity			-0.21***	-7.78
Precip	0.79**	2.54	0.52***	6.60
Snow	1.81***	9.57	1.07***	13.95
R467	-134.32***	-15.75	-123.75***	-35.57
N	-89.79***	-29.16	-60.22***	-56.58
Delay at the start (s)	-0.22***	-15.95	-0.17***	-35.11
AM Peak	-47.03***	-10.79	-33.59***	-21.65
PM Peak	49.54***	11.61	60.14***	38.93
Night	-100.47***	-20.99	-99.94***	-62.21
Midnight	-219.16***	-30.63	-212.50***	-87.35
Y2011	56.21***	14.10		
Smart card start			5.83***	3.15
Smart card by the end of 2008			46.81***	24.79
Reserved lane			-35.26***	-20.08
After articulated buses date			26.80***	14.68
Articulated buses			43.62***	10.24
After TSP date			-4.76**	-2.64
TSP			-13.56***	-4.37
N	6,478		60,973	
R2	0.62		0.59	

*** Significant at 99.9% ** Significant at 99% * Significant at 95%

Table 4: Estimated Running time in seconds and the percentage of change* comparing to Route 67 initial situations

Route 467

Scenario	Initial Situation	Reserved lanes	Articulated Buses	TSP
North AM Peak	1440(-11.5%)		1486(-8.7%)	1467(-9.8%)
North PM Peak	1534(-10.8%)	1498(-12.9%)	1544(-10.2%)	1526(-11.3%)
South AM Peak	1500(-11.1%)	1465(-13.2%)	1511(-10.5%)	1492(-11.5%)
South PM Peak	1588(-10.8%)		1634(-8.2%)	1616(-9.3%)

Route 67

Scenario	Initial situation	OPUS	After the limited-stop service	Reserved lanes	After Articulated date	After TSP date
North AM Peak	1627	1677(3.1%)	1632(0.3%)		1665 (2.4%)	1661 (2.1%)
North PM Peak	1720	1770(2.9%)	1725(0.3%)	1690 (-1.7%)	1724 (0.2%)	1719 (-0.1%)
South AM Peak	1687	1737(3.0%)	1692(0.3%)	1657 (-1.8%)	1694 (0.4%)	1686 (-0.1%)
South PM Peak	1781	1831(2.8%)	1787(0.4%)		1819 (2.2%)	1815 (1.9%)

*Change is indicated between brackets

SURVEY ANALYSIS

A survey was carried out in June 2011 among 354 users of routes 67 and 467. Passengers were asked which route do they used most often and how often they used it. They were also asked to evaluate and compare their travel time now to the period when they started using either route. Table 5 presents a summary of the survey findings.

The survey also asked the riders to identify the bus stops that they use for boarding and alighting as well as the time when they started using either route. This information was compared for every rider with the average travel time changes using archived AVL data.

Then, a difference in means t-test was used to compare perceptions to the actual travel time changes. Figure 2 shows the users paired difference (in minutes) according to the route used.

Table 5: Survey findings summary

	Travel time		
Perception	Route 467	Route 67	Route 67 &467
Decrease in time	49.2%	54.8%	55.2%
Increase in time	7.1%	9.6%	7.5%
No change	43.7%	35.6%	37.3%
Number of observations	183	109	67
% of the sample	51.7%	29.4%	18.9%
confidence interval*	7.2%	8.5%	9.2%

*The confidence interval (also called margin of error) at the 95% confidence level

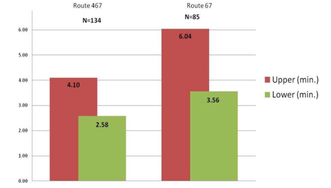

Figure 2: Users paired differences using means t-test

CONCLUSION

After the implementation of the studied measures, the analysis indicates that the limited-stop bus service (Route 467) provides a faster service by 10.5% on average, while the regular route (Route 67) is slower by 1% on average compared to the initial situation.

The introduction of smart card system and the use of articulated buses had a larger negative (increasing running time) impact than the positive ones (decreasing running time) associated with the implementation of exclusive lane, faster passenger activity along articulated buses, and TSP.

For articulated buses, boardings are limited to the front door due to the fare collection procedures. Therefore, moving fare collection off the articulated buses offers the greatest potential to use all doors in order to maximize their benefits, particularly at high passenger activity stops like metro stations, such as Saint-Michel Metro stop.

For reserved lanes and TSP, Montreal has a no turn on red policy which affects the cue of cars in front of the bus, though this can be partially addressed by locating stops on the far side. It is important to note that a negative spillover effect was present due to the presence of articulated buses in the corridor which caused delays for other buses.

Therefore, mixing between articulated buses and regular ones is not recommended in order to avoid such an effect in the future. Meanwhile, TSP equipped buses had a positive impact on non-TSP equipped buses leading to time savings for these buses.

The second objective of this article was to quantify to what extent users have perceived STM's implemented strategies and their effects on their travel time. Generally, users perceived a decrease in their travel time. While there was no actual saving in buses running time,

Users over estimated their travel time savings within a range of 2.5 to 6.0 minutes. This generally indicates that passengers have a positive attitude towards the improvements in service and over estimate them.

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