# SIMULATING TRANSIT EMISSIONS

## *UNDER VARIOUS SCENARIOS AFFECTING OPERATIONS: A CORRIDOR-LEVEL ANALYSIS*


**Ahsan Alam**
**Ehab Diab**
**Ahmed El-Geneidy**
**Marianne Hatzopoulou***
*marianne.hatzopoulou@mcgill.ca


McGill | RAM Transportation Research at McGill | CIRRELT | TRAQ Transportation and Air Quality research

## INTRODUCTION

Public transit is considered as an alternative to the private vehicle for its per passenger **lower carbon** footprint.

To make transit more attractive, transit providers adopt various service improvement strategies.

As reduction of travel time and improvement of passenger satisfaction are the main concerns, the impacts of those stratetegies on **green house gas (GHG)** emissions are often overlooked.

It is important to **quantify** the effects of bus service improvement strategies on **GHG emissions** in order to evaluate whether emissions and service improvements are in-line or whether trade-offs are unavoidable.

This study performs **a corridor level** analyses to investigate the isolated and combined effects of different strategies on total and per-passenger basis

## STUDY CORRIDOR

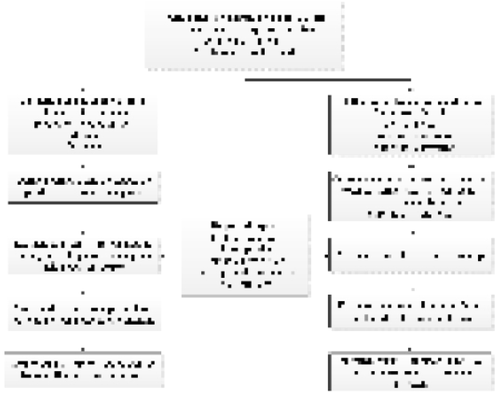
Boulevard Saint Michel is a busy transit corridor located in the east side of Montreal, Canada.

Two buses concurrently run on this corridor: the regular route (67) and the express route (467).

The local transit service provider, Société de Transport de Montréal (STM), implemented a series of transit service imporvement strategies which are:

- The implementation of a **smart card system** called 'OPUS' in April, 2008.
- The implementation of **a limited-stop** bus service (Route 467) running parallel to the regular bus service (Route 67) in March, 2009.
- The implementation of a **reserved bus lane** during peak hours in August, 2009.
- Implementation of a number of **articulated buses** to serve Route 467 in February, 2010.

## METHODOLOGY



- The study **estimates emissions** for each bus and compare emissions across express bus, reserved bus lane, and smart card strategies.
- It also performs regression analysis to understand how **running and dwelling emissions** are affected with different strategies and variables.

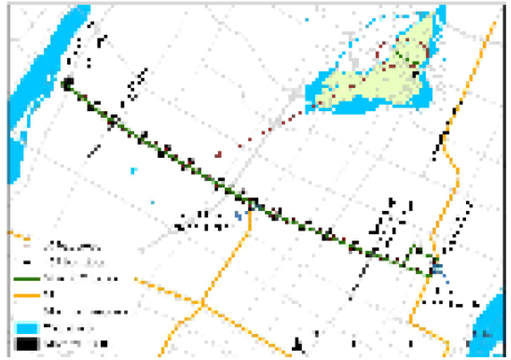


Figure 2: The Study Corridor of Saint Mitchel

## TRIP CHARACTERISTICS

A slightly shorter sub-segment of the corridor extending between Boulevard Saint Joseph and Rue Fleury is analyzed whose length is 4.68 miles.

In the morning peak the southbound (SB) buses and in the afternoon peak the northbound (NB) buses get reserved bus lane facilities.

Northbound morning trips have lowest travel time and southbound afternoon trips have highest travel time.

People take express bus more when they are travelling along the congested direction using the reserved bus lane.

All buses are articulated

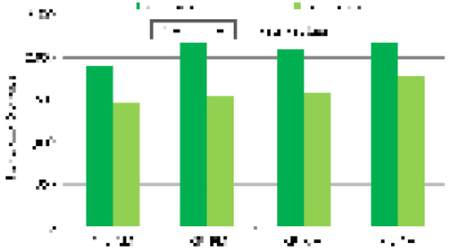


Figure 3: Trip Travel Time in Different Time Periods and Directions

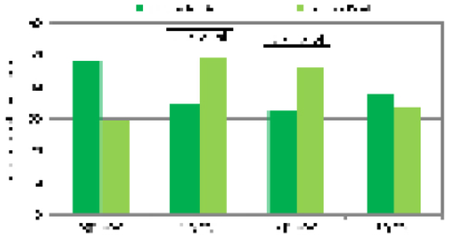


Figure 4: Passenger Ridership in Different Time Periods and Directions

## EMISSIONS RESULTS

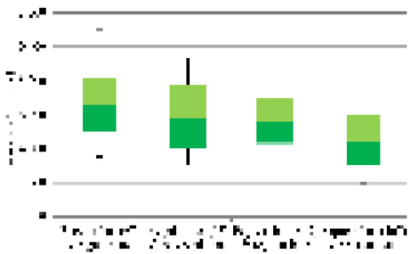


Figure 5: Segment Level Total Emissions

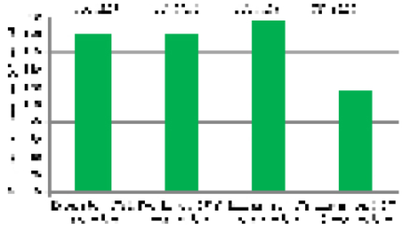


Figure 6: Segment Level Per Passenger Emissions

## REGRESSION ANALYSIS

**1 Segment Total Emissions**

| Variable | Coefficient | T-stat | Std. Error |
|---|---|---|---|
| Constant | **1393.06** | **2.55** | **546.37** |
| Length of the link | **1537.65** | **7.97** | **192.81** |
| Southbound trip | 136.87 | 0.60 | 229.39 |
| PM peak | **683.47** | **2.96** | **231.15** |
| Express bus service | **-885.62** | **-3.78** | **234.06** |
| Reserved lane in operation | **-794.75** | **-3.27** | **243.31** |
| No. of events | **222.21** | **1.92** | **115.54** |
| Total passenger activity | **9.15** | **3.91** | **2.34** |
| *N* | 149.00 | | |
| $R^2$ | 0.48 | | |

**Bold** indicate statistical significance

**2 Dwell Emissions Model**

| Variable | Coefficients | T-stat | Std. Error |
|---|---|---|---|
| Constant | **20.440** | **8.37** | **2.44** |
| Southbound trip | 1.935 | 1.16 | 1.66 |
| PM peak | -1.263 | -0.76 | 1.66 |
| Smart card user | **4.815** | **31.94** | **0.15** |
| Magnetic swipe card user | **4.608** | **3.99** | **1.15** |
| Cash user | **12.469** | **6.63** | **1.88** |
| No fare user | **7.777** | **5.64** | **1.38** |
| Express bus service | **4.134** | **2.29** | **1.80** |
| Alighting through Door 1 | **3.029** | **5.59** | **0.54** |
| Alighting through Door 2 | **1.244** | **3.09** | **0.40** |
| Alighting through Door 3 | 0.416 | 1.12 | 0.37 |
| Total passenger activity square | -0.001 | -1.67 | 0.00 |
| No. of onboard passengers | -0.065 | -1.46 | 0.04 |
| *N* | 1391.00 | | |
| $R^2$ | 0.63 | | |

**Bold** indicate statistical significance

## CONCLUSION

- Express bus service (R467) reduces total emissions by 15.31% compared to regular route (R67).
- Reserved bus lane reduces 10.21% of emissions in R67 and 18.72% of emissions in R467 compared to non-reserved lane condition.
- Express bus service with reserved lane achieves the largest emissions reduction.
- As the service is improved (i.e. expresss route, reserved bus lane), variability in total emissions decrease.
- The benefits of service improvemnt strategies could be different when emissions are considered on a per passenger basis.
- As the total passenger activity increases bus emissions increases initialy, but when the the passenger activity becomes too much bus emissions start to decrease.
- Passenger alighting through door 1 generates more emissions compared to doors 2 and 3.
- Use of smart card can reduce 61.3% of dwell emissions compared to fare payment by cash.