August 25, 2021

Analyzing Impact of the COVID-19 Pandemic on GTHA Traffic Congestion Using Travel Speed Data

Executive Summary

Mostafa Kouchakzadeh, University of Toronto
Hasan Bayanouni, University of Toronto
Matthew J. Roorda, University of Toronto
Smart Freight Centre

http://www.smartfreightcentre.ca/

©Copyright held by authors
Acknowledgment

We thank Transport Canada, the Region of Peel and the Natural Science and Engineering Research Council of Canada for funding the research conducted in this report. Thank-you to the Smart Freight Centre (SFC) for facilitating access to Here data in Freight Data Warehouse (FDW), which forms the basis of this report. Access to data from Here Technologies was provided to the SFC as an in-kind contribution by Transport Canada.

About the Smart Freight Centre (SFC)

The Smart Freight Centre (SFC) is a centre of excellence for goods movement whose goal is to improve the economic vibrancy of business, environmental sustainability, and quality of life for residents of the Greater Toronto and Hamilton Area. The SFC provides innovative evidence-based research, decision support, advocacy, training, and monitoring in order to coordinate transportation infrastructure, land development, regulation, technology tools, and resources that improve goods movement activities.

Authors

- Mostafa Kouchakzadeh, MASc, University of Toronto
- Hasan Bayanouni, Postdoctoral Fellow, University of Toronto
- Matthew J. Roorda, Corresponding Author
  Professor, University of Toronto
  Dept. of Civil & Mineral Engineering,
  35 St. George Street,
  Toronto, Ontario, Canada, M5S 1A4
  (416) 978-5976 – matt.roorda@utoronto.ca
Analyzing Impact of the COVID-19 Pandemic on GTHA Traffic Congestion Using Travel Speed Data

1 Introduction
Traffic congestion imposes economic costs in urban areas [1]. The American Transportation Research Institute (ATRI) estimates that highway traffic congestion cost the trucking industry $63.4 billion in lost productivity over the course of one year in 2015 [2]. In the Toronto-Waterloo Corridor, $3 billion worth of goods are transported by truck every day, but congestion-related delays in this corridor alone cost $500 to $650 million per year [3]. For logistics service providers, congestion reduces the reliability of delivery schedules, reduces productivity and increases total logistics costs [4]. Congestion increases shipper costs because it delays their in-transit inventory and disrupts supply chains [5]. Congestion directly impacts the cost of delivery associated with labour and fuel costs due to longer truck operation hours. Congestion also impacts the size of business markets, business process scheduling, and the deployment of vehicles [4]. Therefore, supply chain and logistics planners and transportation system planners must have a thorough understanding of traffic congestion.

The COVID-19 pandemic has had major impacts on patterns of congestion. As the virus spread globally, the Canadian federal, provincial and municipal governments implemented measures to contain the virus by reducing in-person contact. Many workplaces shifted to a virtual format, schools were closed, and social gatherings were cancelled, leading to a reduced number of trips and alleviation of traffic congestion. This report analyzes freeway traffic congestion in the Greater Toronto Hamilton Area (GTHA) during the first two waves of the COVID-19 pandemic with focus on the following questions:

1. When and how much did freeway travel speeds rise during each of the first two waves of the COVID-19 pandemic?
2. Did governmental policy announcements align with reductions in traffic congestion?
3. Was there a meaningful difference in travel speed before and during each wave of the pandemic?
4. During reopening, did traffic congestion return to pre-pandemic levels?

These questions are important because supply chain and logistics planners plan to account for normal patterns of traffic congestion. COVID-19, especially at the beginning of the first wave, led to large reductions in traffic volume on normally congested roads. The second wave of the pandemic appears to have led to different responses than during the first wave. To fully understand responses during the pandemic, it is important to first document traffic congestion changes during government lockdown measures and reopening stages for each wave of the pandemic and assess the extent to which mobility rebounds to pre-pandemic conditions.

2 Method
This study uses travel speed data provided by HERE Technologies as a representation of traffic congestion. HERE uses probe data from a variety of vehicle types to assess average travel speeds
for passenger cars, trucks, and combined passenger car and truck traffic. For this analysis, combined passenger car and truck speeds were used due to the higher vehicle counts.

Travel speed has been examined to assess changes in traffic congestion before and after the first two waves of the COVID-19 pandemic. This analysis is focused on freeways in the GTHA, shown in Figure 1.

![Figure 1 - Freeways under analysis](image)

Our analysis focuses on weekday AM peak hour (7 AM - 8 AM) and the PM peak hour (4 PM to 5 PM). Congested freeway segments (bottlenecks) were selected based on the Travel Time Index (TTI) during AM and PM peak hours. TTI is the ratio of the observed travel time to the free-flow travel time [6]. Thirty-nine freeway segments were selected for which TTI was greater than two for at least 50 percent of the weekdays in the pre-pandemic time-frame (2019).

We divided our analysis into six periods to reflect the stages of the pandemic.

- Period 4 - Aug 1 to Oct 9, 2020. Third stage of reopening.
- Period 5 - Oct 10 to Dec 25, 2020. Onset of wave two. Toronto and Peel Region moved to modified stage 2 and then moved to Grey tier.
3 Results
Changes in travel speed are visualized for the first two waves of the pandemic. The question of whether governmental lockdown and reopening measures, such as the closure of schools and non-essential businesses, led to a reduction in traffic congestion has been investigated by incorporating the timeline of these measures into the visualizations. Figure 2 shows, as an example, eastbound AM peak hour freeway travel speeds on normally congested freeway segments. Figure 2 shows that speeds had increased dramatically by the time of the mandatory closure of non-essential businesses in mid-March 2020. Travel speed on parts of Highway 401, Gardiner Expressway and Highway 409 started to decrease again soon after the second stage of reopening in Toronto and Region of Peel. Other eastbound roads did not experience reduced speeds in the AM peak hour until stage 3 of reopening, while others did not return to congestion at all. By the time of the second Provincial lockdown on December 26, 2020, AM peak hour travel speeds had returned to almost free-flow conditions.

![Figure 2](image)

Figure 2 - Freeway segment travel speed AM peak hour (7 AM-8 AM) (EB)

Figure 2 is just a sample of our full analysis. Further visualizations and detailed analysis can be found in the technical report. Highlights of our assessment of bottleneck congestion through the first two waves of the pandemic are summarized more broadly by Period, below.

**Period 1 - Jan 1 to Mar 10, 2020. Pre-pandemic conditions**

Freeway bottlenecks experienced low travel speeds until March 2020, reflecting normal congestion patterns.
Period 2 - Mar 11 to Jun 11, 2020. Wave one Provincial lockdown

When WHO declared COVID-19 as a pandemic (March 11th, 2020) and the Government of Ontario decided to close public schools (March 12th, 2020), travel speed started to increase. By the time of the mandatory closure of non-essential businesses, travel speeds were at their peak. On some freeways such as Don Valley Parkway (DVP) and Gardiner Expressway, peak hour travel speed increased by almost 300 percent. Although the closure of public schools was an important reason for the alleviation of traffic congestion in the GTHA, the changes in travel speed before the mandatory closure of non-essential businesses show that many companies and workplaces were already prepared to shift to a remote work format.

Travel speeds on most bottlenecks remained high until the first stage of reopening in Ontario (May 19th, 2020). Traffic congestion on the Gardiner Expressway, Highway 401, DVP, and Highway 404 returned earlier than other freeways, especially during the PM peak hours. In the AM peak hour half of the bottlenecks did not experience a return of traffic congestion until the third stage of reopening in July 2020. PM peak hour traffic congestion had returned for two thirds of the bottlenecks by that time.

Period 3 - Jun 12 to Jul 31, 2020. Second stage of reopening

As Ontario started the second stage of reopening, travel speed started to decrease on the DVP both during AM peak hour and PM peak hour. However, changes in travel speed during the PM peak hour were greater than AM peak hour (PM peak hour speeds decreased by 7 km/hr more than the AM peak hour).

Except for Highway 401, from Highway 25 to Trafalgar Road, all other road segments of the freeway experienced increased traffic congestion after Ontario started the third stage of reopening. Similarly, the reduction in travel speed during the PM peak hour was greater than the AM peak hour (On average, travel speed decreased by 29 km/hr during PM peak hour and 18 km/hr during AM peak hour).

Highways 409, Queen Elizabeth Way (QEW), Highway 427, and Gardiner Expressway experienced a greater reduction in travel speed during the PM peak hour compared to the AM peak hour as Ontario started the reopening stages in June 2020.

Period 4 - Aug 1 to Oct 9, 2020. Third stage of reopening

Travel speed started to decrease on the majority of the bottlenecks after Ontario entered the third stage of reopening in late July 2020. However, except for parts of the Gardiner Expressway, Highway 400, and the DVP, travel speed was still significantly higher compared to 2019. Even after the Government of Ontario introduced new measures on October 10, 2020, traffic congestion on Gardiner Expressway from Bay Street to Bathurst Street was still similar to its pre-pandemic levels. Only after the second stay-at-home order was introduced did travel speed start to increase on this bottleneck.
Analyzing Impact of the COVID-19 Pandemic on GTHA Traffic Congestion Using Travel Speed Data

Period 5 - Oct 10 to Dec 25, 2020. Onset of wave two

Period 5 represents the onset of Wave 2 of the pandemic. Toronto and Peel Region moved to the modified stage 2 and then moved to Grey tier in this time period. A comparison of travel speeds in Period 5 to the same time frame one year earlier (2019, pre-pandemic) revealed that virtually every bottleneck showed significantly higher speeds compared to 2019. However, almost all the road segments had lower travel speed in Period 5 compared to the Period 3. This shows a lagging traffic impact, meaning that congestion was slow to return after the first wave (Period 3) and relatively slow to dissipate during the onset of the second wave (Period 5).

Period 6 - Dec 26, 2020 to Mar 8, 2021. Wave two Provincial lockdown

The heart of the second wave of the pandemic occurred after the second provincial lockdown on December 26, 2020. Comparison of first wave (Period 2) and second wave (Period 6) traffic congestion shows that 78% of the road segments had significantly lower travel speed in the second wave. Parts of the DVP, Highway 401, Highway 410, and the Gardiner Expressway experienced the highest reduction of travel speed when the second provincial lockdown was announced.

Travel Time Reliability During the First and Second Waves

Although travel speeds universally increased as the pandemic started, there were mixed results in reliability compared to 2019. In the first wave (Periods 2 to 4), in the AM peak hour, approximately 50 to 60 percent of the freeway bottlenecks experienced higher reliability (i.e. higher speeds and lower standard deviation) compared to 2019. However, in the PM peak hour, 60 to 80 percent of freeway bottlenecks had lower reliability (i.e. higher speeds but higher standard deviation) compared to 2019. In the second wave (Periods 5 and 6), over 50 percent of the freeway bottlenecks had a higher reliability compared to 2019, both in the AM and PM peak hours. The results are mixed, indicating that despite average reductions in congestion, it would not have been possible for freeway users to expect higher speeds with certainty.

The impact of the reopening on traffic congestion was different during the PM peak hour and AM peak hour. On almost all the road segments, travel speed reduction was higher during PM peak hour compared to AM peak hour. A probable reason that traffic congestion did not increase during AM peak hour is the continuation of remote working and education after the reopening stages.

4 Conclusions

Over the course of the first two waves of the COVID-19 pandemic, trucks have spent less time in traffic on freeway bottlenecks in the GTHA, including Highways 400, 401, 403, 404, 409, 410, 427, the DVP, QEW, and the Gardiner Expressway. These travel time savings occurred on some of the most congested and most heavily travelled truck routes in Canada, thus providing the trucking
industry with important relief to part of the supply chain in an otherwise very challenging operating environment.

Significant increases in travel speed occurred on almost all freeway bottlenecks after the early COVID-19 measures were put in place.

As wave one subsided and lockdown measures were eased, travel speeds started to decrease on many freeways. However, even after the third stage of reopening in Toronto and Peel Region, travel speed in 2020 was significantly higher than 2019. Most of the return of traffic congestion happened within the City of Toronto (Highway 401, the Gardiner Expressway, and DVP) as the reopening stages started in Ontario.

As the Government of Ontario introduced new measures due to the second wave of the pandemic, travel speed increased again until the end of the second wave.

The impact of the reopening on traffic congestion was different during the PM peak hour and AM peak hour. On almost all the road segments the return of congestion after the first wave was higher during the PM peak hour compared to the AM peak hour. A probable reason that traffic congestion did not increase during AM peak hour is the continuation of remote working and education even after the reopening stages.

Changes in travel speed on freeways may have become an incentive for companies to use more direct routes that were not cost-effective due to higher traffic volumes before the pandemic. Also, since traffic congestion returned in the PM peak hour sooner than AM peak hour, freight operators may have considered rescheduling trips to the AM. However, measures of reliability were mixed through the pandemic waves, indicating that despite average reductions in congestion, it would not have been possible for freeway users to expect higher speeds with certainty.

Future research will include analysis of truck GPS data to show changes in truck travel patterns before and during the pandemic, and to further assess impacts of COVID-19 on sub-sectors of the trucking industry.

5 References
