Monitoring Toronto's King Street Transit Pilot

A Case Study of ITS Applications

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Introduction and Scope

This paper describes the ITS technologies currently being used to monitor Toronto's King St Transit pilot. A description of the project is first provided, with an emphasis on the importance of the corridor for transit. The technologies employed for transportation network monitoring are then described. Following this, the impacts of the project are discussed and contextualized. Finally, my relationship to the project through my time at the City of Toronto is presented.

King Street Contextualized

Toronto is unique among North American cities in that during the mid 20th century, the city did not dismantle its streetcar network in favour of busses. As the years went by, vehicle traffic in the city grew and the streetcars, which mostly operate in mixed traffic, became increasingly unreliable. Of all the streetcar routes, those running on King street were particularly problematic. The King streetcar operates through the most central part of Toronto and, consequently, is the busiest surface transit route in the city. Over 70,000 passengers take the streetcar on a typical weekday and, when compared to the 20,000 cars that travel in the same space, the importance of the streetcar becomes clear (City of Toronto, 2017). A reliable operating policy is required for a transit line of this magnitude and operating the streetcar in mixed traffic is no longer sustainable due to the growth taking place in Toronto's downtown.

Recognizing the unsustainable status quo, the City of Toronto launched the King St Transit Pilot in 2017. This program makes various changes to King St for motorists, transit riders, cyclists, and pedestrians with the goal of increasing speed and reliability of transit service. The most significant of these changes is restricting through and left-turn movements at most intersections, as shown in Figure 1 below.

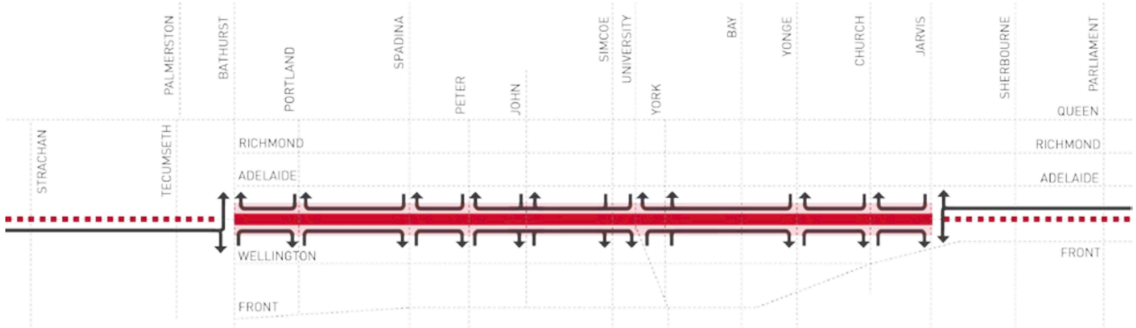

Figure 1: Changes to Traffic Restrictions on King St (City of Toronto, 2017)

Motorists are forced to turn right off of King at most major intersections. By restricting through movements, King St becomes a much less attractive option for motorists and so traffic volumes volume on this corridor should drop. Consequently, the reduced auto traffic allows transit vehicles to pass through with significantly less delay.

Transit service is also impacted. Most stops are moved to the far side of each intersection. A barrier is placed to allow for passengers to stand on the curbside lane rather than waiting on the curb itself. This design speeds up boarding time and improves safety by removing the potential for conflict with vehicles that are now forced to turn right due to the new regulations.

Cyclists and pedestrians also gain a number of safety and quality-of-life improvements. Though dedicated cycle lanes are not provided, the reduced auto volume results in an improved experience because of a lower chance of conflict with autos. Public spaces are added to the curb lane to improve the pedestrian experience. Seating and recreational spaces are placed on the curb lane at focal points along King street, making the public realm more attractive for tourists and residents alike.

Using ITS to Monitor King Street

Toronto's City Council voted overwhelmingly to implement the transit pilot. Part of the proposal was an extensive monitoring program that uses a number of different ITS technologies to evaluate the transportation network performance along King and on parallel corridors. The city is particularly interested in the effects of the pilot on automobile traffic. Consequently, passive data collection technologies have been installed to monitor traffic travel time and volumes. A description of the technologies used follows.

Travel times are collected using an array of Bluetooth sensors provided by Blip Systems. This method of travel time data collection is considered the gold standard as it is highly accurate and captures both the mean and variance in travel time (Bruce, 2013). With the high rate of smartphone users and hands-free talk enabled vehicles, most vehicles have at least one Bluetooth antenna within them. As a vehicle passes through the sensing range of one of these detectors, its unique, anonymous identifier is recorded with a corresponding timestamp. As the vehicle moves through the network, it will be detected at further sensors and the travel time between sensors can be inferred. By placing Bluetooth sensors at major intersections of Toronto's street grid, travel times across the network can be accurately measured. In the case of the King St Pilot, Bluetooth sensors were installed at all major intersections, creating the network shown in Figure 2. Travel times were monitored on these segments so that the impact of Pilot on adjacent corridors can be determined.

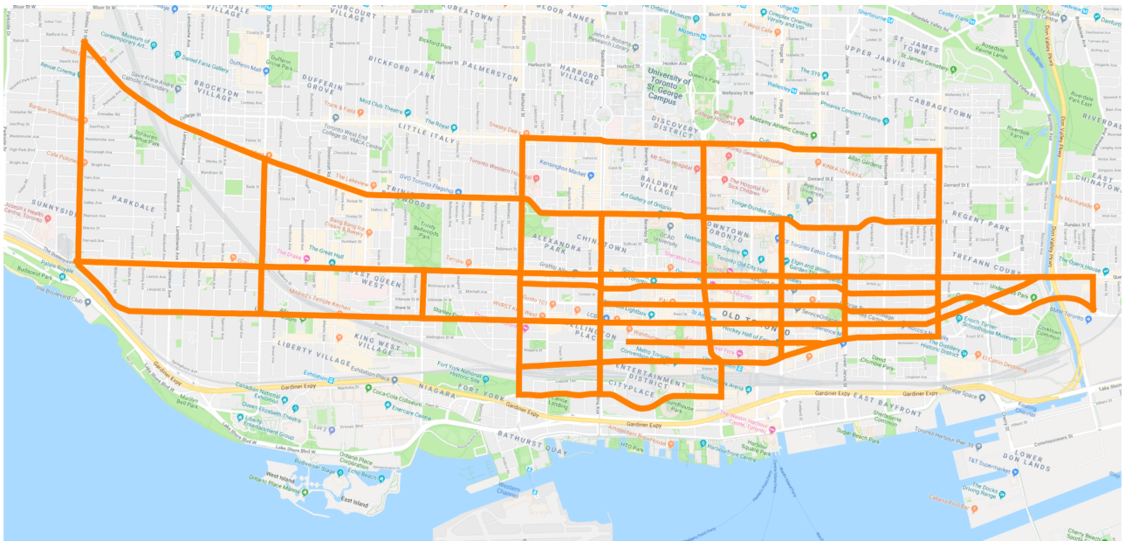

Figure 2: Downtown Toronto Bluetooth Sensor Coverage

The Bluetooth sensors are excellent for determining travel times but fall short in accurately measuring traffic volumes. To supplement the Bluetooth sensor array, the City installed traffic monitoring cameras at 31 major intersections in the area surrounding the pilot corridor. The combination of a wide-angle lens and machine learning software developed by Miovision allows for the collection of highly granular pedestrian, cycle, and traffic turning counts at each major intersection (City of Toronto, 2017). Moreover, traffic is separated into passenger vehicles, transit, and freight vehicles which provides insight on how each of these modes behaves. When compared with the traditional method of counting traffic, induction loops and manual turning movement counts, the camera-based method is more accurate in counting multiple modes and can be operated 24/7 since it is a completely automated tool.

Overwhelming Support and Success

The original Pilot Project was passed by City Council in July 2017 with overwhelming support: 38 in favour, 1 against, and 6 absent (City of Toronto, 2017). Councillors recognized the significance of King St for transit users and agreed that the status quo was unsustainable. The project was deliberately launched as a low-budget pilot with few physical interventions. Most changes were modifications in signage, and all changes in road infrastructure are revertible. This was done deliberately, so that if the monitoring program of the one-year trial period yielded negative results, the program could be cancelled.

Transit and active mode users saw a number of measured benefits during the duration of the pilot (City of Toronto, 2019). Daily transit ridership increased 17%, and in the evening peak was up 44%. This was attributed to the more reliable travel times on the King streetcar - the slowest days with the pilot implemented were comparable to the average day prior to the pilot. Pedestrian volumes remained largely unchanged when compared to the already high baseline. Those surveyed generally stated they enjoyed spending time on King more than prior to the pilot. King has also transformed to a more attractive option for cyclists, overtaking Queen and becoming the second most popular corridor in Toronto.

All of these benefits were realized with little impact to drivers. Traffic volumes were reduced on King by more than 80%. The remaining volume comes from local traffic that has little impact on streetcar operations. The through traffic was diverted to parallel streets, which saw an average increase in volume of approximately 5%. Travel times along parallel streets saw a marginal increase initially, but then reduced to pre-pilot levels as motorists changed their behaviour.

Understanding the numerous benefits and limited draw backs, on 19 April 2019 the City decided to permanently install the pilot as the King Street Transit Priority Corridor (City of Toronto, 2019).

Personal Connection and Reflection

During my undergraduate internship on the City of Toronto's Big Data Innovation Team (BDI), I had first hand exposure to the technologies mentioned in this report. BDI spearheaded the data collection and analysis program for this project and my term on the team overlapped with the start of the pilot. A number of the analyses I performed used the same Bluetooth sensors implemented to monitor King St. These analyses confirmed the accuracy of the technology and motivated the expansion of the City's sensor network. I was involved in deciding where new infrastructure should be installed and on the format through which the collected data would be distributed to the public.

Conclusion

This innovative project shows how ITS technologies can be used to effect measurable improvements in the lived experience of urban residents. Pilot projects like the one on King allow cities to test innovative urban designs at minimal risks. Toronto's methods are particularly strong because multiple data sources are consulted when making conclusions on the results of the pilot. This project is an excellent example for other cities looking for low-risk methods for improving their transportation networks.

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