Transit System Resilience

The rising impact of climate change has pushed the government of Canada to have several targets in place to reduce emissions. The transportation sector is currently a critical contributor to emissions, accounting for ~24% of total Canadian emissions in 2015 (Government of Canada, 2017). To promote sustainable transportation options, among other initiatives, the Canadian government is investing in public transportation. This is clearly seen through Alberta's $1.53 billion commitment to the Calgary Green Line, its $600 million to the Southeast Valley Line Light Rail Transit in Edmonton (Government of Canada, 2017), and Trudeau's recent re-announcement of over $3 billion towards the Broadway subway and Surrey rail transit projects in British Columbia (CBC News, 2018).

With regard to reduced carbon emissions, a life cycle assessment of transportation infrastructure must be undertaken to quantify the emissions associated with several factors, including construction, operation, and ridership (Saxe, Miller, & Guthrie, 2017). This is to say that, among other quantitative measures, though investment in public transit is a step in the right direction, public transit requires a certain threshold of commuters for it to reduce emissions. In low ridership scenarios, it is often more environmentally friendly for the same commuters to all use single occupancy gasoline automobiles instead. Therefore, it is critical to ensure that adequate ridership is achieved and maintained. However, many factors influence commuters' transportation mode choice. Reliability is one of the key considerations in this regard. Unforeseen transit disruptions, and their resulting delays, negatively impact public transit service, commuter satisfaction, and ridership in the long term.

While there is a strong body of established research in automobile and highway resiliency, the University of Toronto (UofT) has been the leading source of recent research into transit system resilience, of which there is currently considerably less research. Previous research at the UofT has taken a few different approaches to studying this topic. One was to model the mode choice of commuters in light of historical (revealed-preference) and hypothetical (selected-preference) unplanned disruptions (Lin, Srikukenthiran, Miller, & Shalaby, 2017). Another study focussed on the impact that subway disruptions had on the local surface public transit performance, notably streetcars and buses (Diab & Shalaby, 2018). Lastly, using 2013 incident data from the Toronto Transit Commission (TTC), the impact of non-causal factors was investigated in further detail (Louie, Shalaby, & Habib, 2017). The conclusion of this last study contained recommendations for future research that the following proposed research is based upon and aims to address.

The objective of my M.A.Sc. research at the UofT is to develop a model for the real-time prediction of unplanned rail incident duration. More specifically, after an unplanned rail incident occurs, whether from a power failure, mechanical breakdown, medical emergency, or security breach, the model would predict how long the incident would persist. The UofT has recently developed an off-line model for this, but it currently relies on many independent variables and takes considerable time to process. This proposed research aims to refine the previous model into one that is computationally fast and relies on fewer independent variables. The potential use of artificial intelligence and machine learning methods will help in this regard. The accurate prediction of incident duration is valuable to both the TTC's management and immediate responders. Such information could also be communicated to commuters, as incident delay predictions will help them make informed trip decisions.

While the occurrence of disruptions to rail transit systems is inevitable, the communication of provisional delay duration information to affected commuters is expected to mitigate the impact of disruptions and thereby reduce the long-term decrease in ridership (Louie, Shalaby, & Habib, 2017). This proposed research seeks to do just that by accurately modelling the duration of rail-incidents in a timely manner. While this information is immediately useful to the TTC and its affected commuters, it is also important in the national context by increasing ridership. It will therefore aid in realizing the full potential of the government's multi-billion-dollar transportation investments against climate change.

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