Ontario's Multimodal Province-Wide Model: Validation, Challenges and Data Gaps

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Paper prepared for presentation at the 'Innovations in Transportation Systems Modelling' session of the 2023 TAC Conference & Exhibition, Ottawa, ON

Abstract

The Ontario Ministry of Transportation (MTO) uses an integrated, multimodal passenger and freight forecasting model for the province in long-range planning and to support various applications such as corridor-level highway planning and design, highway project prioritization and modal studies. This model – termed Transport and Regional Economic Simulation of Ontario, TRESO – is a multimodal macroscopic model, used to forecast person and freight transportation demand throughout the province of Ontario.

This model connects five key components, namely: a macroeconomic model that is spatially disaggregated, person travel models dealing with urban as well as inter-urban/long-distance travel by residents and visitors, freight models that deal with commodity flows by main modes of rail, marine, intermodal and truck flows on the road, and the underlying "supply-side" common element of the transportation network.

The focus of this paper is "model validation", which is a process through which model outputs for the base year are compared with observed data to gauge how well a model represents the reality. This paper discusses the details of validation of different components of the TRESO model, data used to perform such validation, while pointing out the data gaps. Validation efforts focus on the following key areas:

- modeled road network volumes versus traffic count
- use of GPS data to compare network performance
- long-distance rail passenger demand compared to rail ridership data
- urban transit travel demand compared to transit ridership data for major urban areas of Ontario

The paper concludes with key observations from the analysis, key challenges, and potential areas of improvements in future model re-calibration and validation exercises.

1 Introduction

Transport and Regional Economic Simulation of Ontario (TRESO) is a macroscopic travel demand model developed by the Ministry of Transportation, Ontario (MTO). The model is used to forecast multimodal – passenger and freight – traffic throughout the province. The model represents a typical Fall weekday. In the current version of TRESO the base year is 2016 from which forecasts are made for horizon years like 2041 and 2051. Primary applications of the model include, among others, supporting development of long-range transportation plans and evaluating infrastructure projects. TRESO is comprised of the following model components. Further details on the model architecture and various model components are discussed by Damodaran (2017).

- *Macroeconomic model* that forecasts population, employment, and GDP
- *Resident person-travel model* is an activity-based model of regular day-to-day passenger travel (a simplified adoption of the Greater Golden Horseshoe Model, GGHM)
- *Long-distance passenger model* simulates occasional long-distance travel, such as business or leisure trips
- *Freight models* that simulate commodity flows, long-distance truck trips and urban truck tours, and
- *Network model* that allocates hourly auto and truck trips on the road network and long-distance person trips on the passenger rail network

Validation is a process through which model outputs for the base year are compared with observed data to gauge how well a model represents the reality. This paper discusses validation efforts of TRESO in terms of four aspects:

- Traffic volume: model vs traffic count
- Travel time: model vs GPS travel time
- Long-distance passenger rail: model vs VIA rail ridership
- Urban transit: model vs Canadian Urban Transit Association (CUTA) ridership

2 Traffic volume

The road network forms the backbone of the TRESO model, given that private modes such as passenger autos and commercial vehicles/trucks make up the largest share of overall transport demand. With that, the most revelant aspect of model validation is by analyzing how well modeled volume on the road network compares with observed traffic count data. For TRESO validation, count data were from three sources:

- MTO Traffic Volume Information System (TVIS), 2016
- MTO Data Collection Site (DCS) counts as part of the MTO Commercial Vehicle Survey

- Cordon count data for the GGH, that come from MTO and local municipal collaboration, that were used for GGH Model (GGHM) validation (hence referred to as GGHM Counts).

Comparison of modeled versus observed traffic volume on a selection of road segments can be summarized statistically by root mean square error (RMSE), calculated as:

$$RMSE = \sqrt{\frac{\sum_i (O_i - S_i)^2}{n}}$$

Where, O_i and S_i are observed and simulated/modeled volume, respectively for road segment i and n is the number of road segments. The value of RMSE is scale-dependent, so it is typically normalized by the average of observed counts $\bar{O}$ and expressed in terms of percent RMSE (PRMSE):

$$PRMSE = \frac{RMSE}{\bar{O}} * 100$$

Additionally, graphical representation of modeled and observed volumes provides a more granular picture. NCHRP Report 765 suggests that there are upper and lower limits to model error i.e., the difference between modeled and observed volume. The report provides a maximum desirable deviation (MDE) for a specific highway widening project (Figure 1). Project-specific model forecasts should be below the MDE. However, traffic counts are not always reliable. So the report also provides a minimum bound called an approximate error in a count (AEC) and model forecasts should be ideally around the regions between the two bounds. The MDE is recommended for project-specific forecasts and it may be too aspirational for a large-scale models like state-wide models in the US or a provincial model such as TRESO. However, plotting modeled and observed volumes with the two bounds provide a visual reference of the overal distribution.

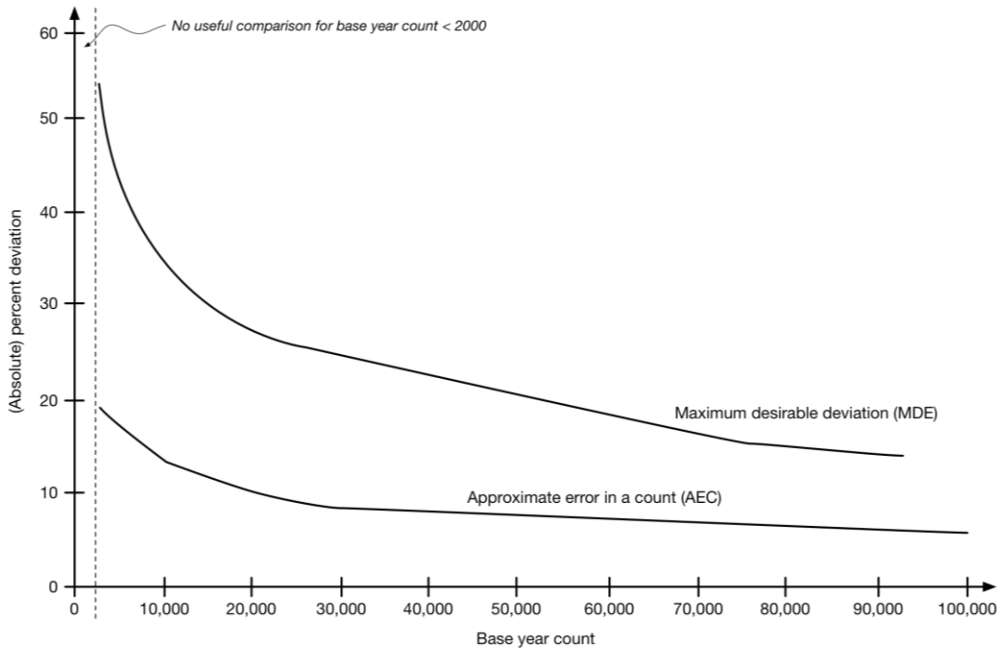
As part of TRESO validation, several such plots were generated for the three types of count data, two modes (auto and trucks) and seven Ontario regions (Figure 2):

- Greater Toronto and Hamilton Area (GTHA)
- GGH region external to GTHA (GGHx)
- North-east Ontario (NEO)
- North-west Ontario (NWO)
- South-east Ontario (SEO)
- South-west Ontario (SWO)
- Ottawa-Gatineau region covered by the TRANS model

Figure 3 illustrates such a diagram for GGH region outside of the GTHA (GGHx). A summary of these diagrams are provided in

Table 1 and Table 2. Percent RMSE does not indicate whether the model under/over-simulates volumes on the network, so Table 2 provides a qualitative summary of traffic count validation.

Figure 1: Maximum desirable error (MDE) and approximate error in a count (AEC)



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Source: Figure 4-13, NCHRP Report 765 (Smith et al., 2014), taken from WSP et al. (2021)

Figure 2 Ontario Regions in TRESO

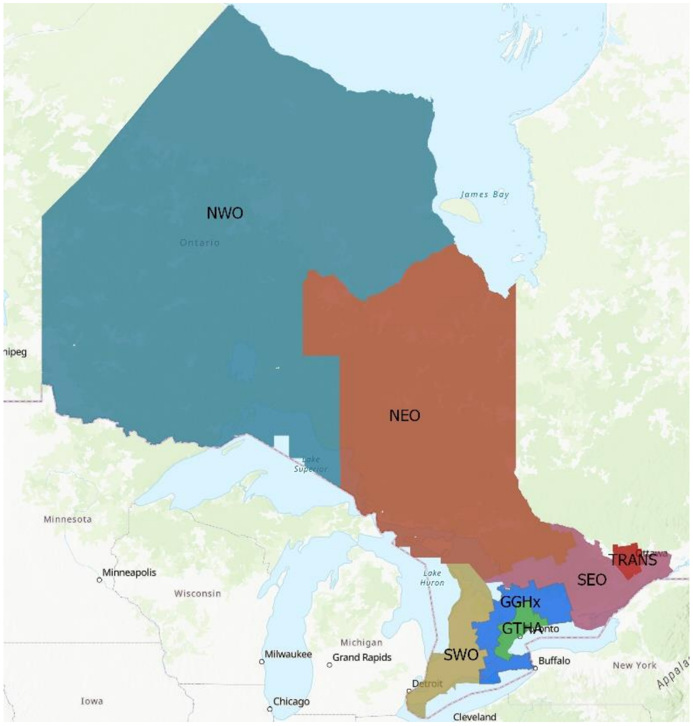
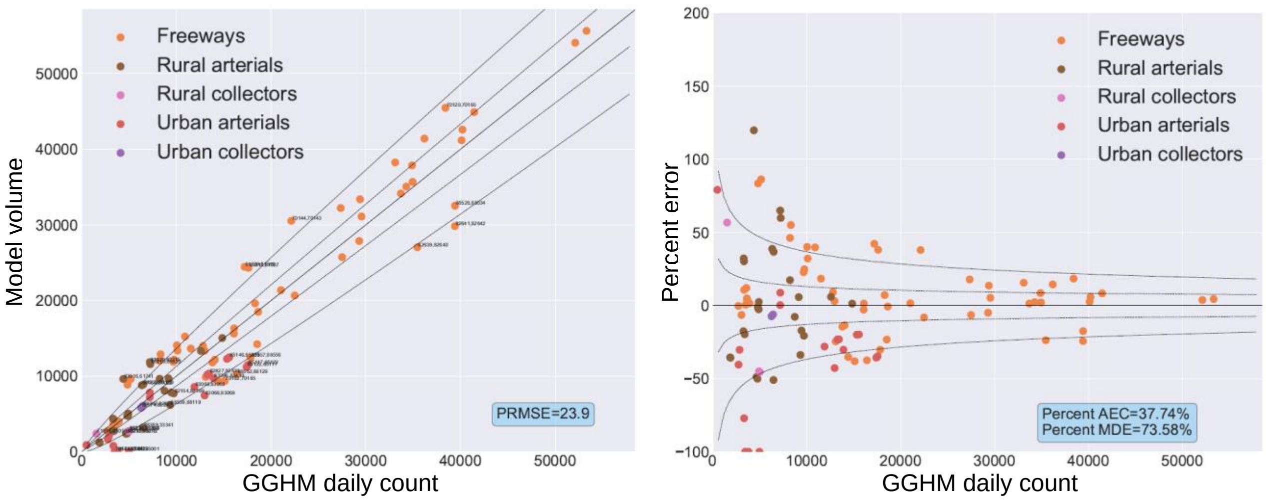


Figure 3: Road count validation of auto in GGH external region (GGHx)



Source: WSP (2021)

Table 1: Percent RMSE by region and data type

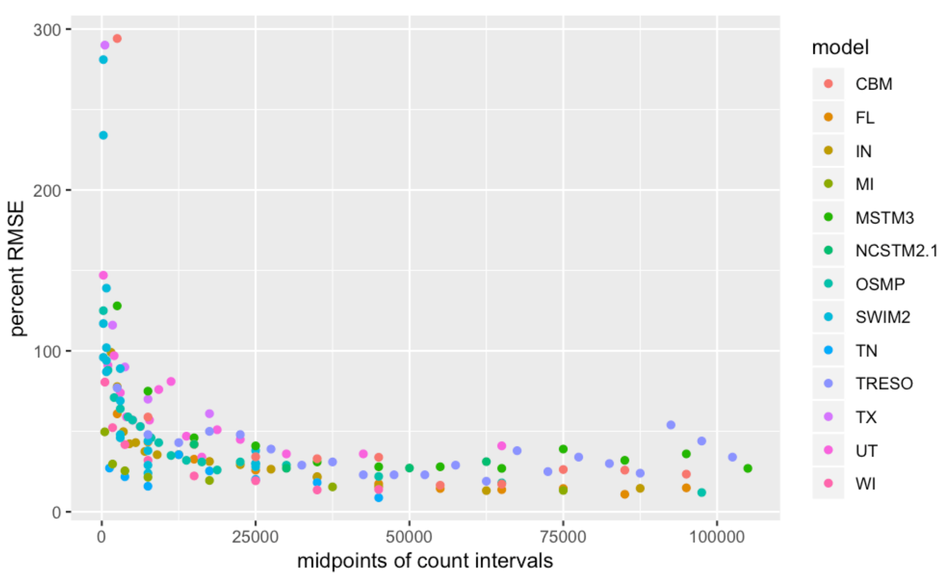
Region	TVIS		DCS		GGHM counts	
	Auto	Truck	Auto	Truck	Auto	Truck
GTHA	45.0	45.8	28.3	63.5	44.8	N/A
GGHx	35.1	45.6	31.5	140.0	23.9	N/A
NEO	71.4	67.2	54.4	51.0	N/A	N/A
NWO	N/A	78.5	58.0	61.2	N/A	N/A
SEO	28.0	29.8	43.1	40.0	N/A	N/A
SWO	39.0	47.4	24.4	45.2	N/A	N/A
TRANS	15.9	66.9	32.0	80.4	N/A	N/A

Source: WSP (2021)

Percent RMSE, broken down by region and count data type (

Table 1) suggests significant variation of model performance in terms of predicting traffic volume on the road. This is due to a) variations of number of traffic count locations in different regions (see count samples in Table 2) and b) due to the geographical size of the province, which makes it is hard to achieve a consistent model accuracy in different parts of the province. Another important observation is that the model performs better in predicting auto volumes (median RMSE 35%) than truck volumes (median RMSE 56%). This is party due to insufficient truck count locations and data limitations to accurately model complex freight activities in the province. Nonetheless, TRESO does a decent job predicting traffic volumes overall when compared against various statewide models in the US that have percent RMSE roughly ranging from 20% to 40% (Figure 4).

Figure 4: Model vs count volume (in percent RMSE) of US statewide models and TRESO



Source: WSP et al. (2021)

In terms of over/under-prediction of traffic volumes, the model performance varies by data type (Table 2). In general, auto volume is underpredicted when TVIS and DCS counts are considered, but that is not the case when compared against the GGHM counts that have significantly higher sample size. Truck volume is generally overpredicted especially in the Ottawa-Gatineau region (TRANS model area). There seems to be no prediction bias in the south-east and south-west regions, however the sample size is too low in the south-west region to draw any definitive conclusion.

TRESO validation work on traffic volume, while substantial so far, can be further improved by a) including additional counts from various sources, such as municipal counts, and b) analyzing spatial distribution of count stations on the premise that count locations that are spread throughout the network is better than having majority of the counts on one or two highways.

Table 2: Over/under-prediction of daily volume by region and data type

Region	TVIS		DCS		GGHM count		Count sample
	Auto	Truck	Auto	Truck	Auto	Truck	
GTHA	Hwy ↓↓	Var ↑	Hwy ↓	Hwy ↑	✓	N/A	
GGHx	Hwy ↓	✓	✓	Hwy ↑↑	✓	N/A	DCS truck ↓
NEO	Hwy ↓	✓	Hwy ↓	✓	N/A	N/A	DCS, TVIS ↓↓
NWO	N/A	Art ↓	Var ↑	Art ↓	N/A	N/A	DCS, TVIS ↓↓
SEO	✓	✓	✓	✓	N/A	N/A	DCS truck ↓
SWO	✓	Hwy ↑	✓	✓	N/A	N/A	DCS, TVIS ↓↓
TRANS	✓	Hwy ↑↑	Hwy ↓	Hwy ↑↑	N/A	N/A	DCS, TVIS ↓↓

↑↑ = High overprediction, ↑ = Overprediction, ↓↓ = High underprediction, ↓ = Underprediction,
✓ = No prediction bias, Hwy = Freeways, Art = Arterials, Var = Variation

Source: WSP (2021)

3 Travel time

In TRESO the road traffic assignment is done with EMME Space-Time Traffic Assignment (STTA). STTA is a form of temporal dynamic traffic assignment that is based on a static user equilibrium approach for each time period, where demand is loaded on the network by departure time periods. The implementation of STTA within the??, which in TRESO model uses 24 hourly time slices, providing hourly predicted volumes on every road segment in the model network. For a province-wide model like TRESO, STTA is more appropriate than a standard Second Order Linear Approximation (SOLA) assignment for a single peak period because of the large geographic scale of the model where trips may range from 30-minute urban travel to several hours of inter-city travel. Through STTA hourly demands are assigned to the road network and hourly travel times are estimated.

The modelled travel time of TRESO is validated against a set of reference travel times. Travel times are calculated using the average speed data provided by HERE

Technologies (HERE's Traffic Analytics). HERE aggregates individual vehicle speeds hourly and travel times are computed for each link and hour:

$$Reference\ Travel\ Time = \frac{Length}{\left(\sum_{i=1}^{n_{vehicles}} Speed_{vehicle_i}\right)/n_{vehicle}}$$

The TRESO models an average Fall weekday in 2016. For this paper, the earliest travel time data from HERE are available for September-November 2017. The travel time data of these three months are first averaged hourly, and then only the data of 65 weekdays are averaged per link.

The TRESO and HERE networks have significant topological differences which do not allow for a link-by-link travel time validation between the two networks. A visual comparison is also not straightforward since the lengths of the links are usually different. Therefore, the Travel Time Index (TTI) is calculated as the value of travel time divided by free flow travel time per link. The map TRESO and HERE networks with TTI values are illustrated for visual comparison in Figure 5.

The travel time validation is completed for two peak hours: AM (8 am – 9 am) and PM (5 pm – 6 pm). Visual comparison from Figure 5 shows that TTI estimated from the TRESO model has a similar pattern to the ones from the HERE data. The red links represent congestion with a TTI value greater than 2.5, while the green links represent the free flow traffic with a TTI value less than 1.1. The free flow speed used for calculating free flow travel time are obtained from posted speed limits. However, the free flow speeds are slightly higher than posted speed limits up to 10%. To account for this difference, the upper band cut-off of the first TTI category, free flow traffic flow, is set as 1.1 instead of 1. Unsurprisingly, the model displays a smoother distribution of TTI than the observed patterns in the HERE data.

Figure 5: Travel Time Index (TTI) on freeways: modeled vs observed (HERE data)

Modeled AM (8am-9am)

Observed AM (8am-9am)

Modeled PM (5pm-6pm)

Observed PM (5pm-6pm)

For travel time validation, a corridor-based approach is implemented because a link-by-link comparison is not feasible due to differences in link length. For this purpose, 14 freeway corridors are selected based on their congestion level in either AM or PM peak hours. Figure 6 shows the selected corridors, two of which are in Ottawa and the remaining are in the Greater Toronto Area.

All selected corridors are located on 400-series freeways. They are coded in the TRESO network to contain the same Volume Delay Function (VDF) that takes the following tangential form:

$$VDF = \begin{cases} Length \times \left(\frac{Speed_{Free-Flow}}{60}\right)^{-1} \times (1 + \lambda^6) & where\ \lambda \leq 1 \\ Length \times \left(\frac{Speed_{Free-Flow}}{60}\right)^{-1} \times (1.5 \times \lambda + 0.5) & otherwise \end{cases}$$

Where, λ is volume-capacity ratio, formulated as:

$$\lambda = \frac{Volume_{total}}{N_{lanes} \times Capacity_{lane}}$$

Figure 6: Selected corridors for travel time analysis

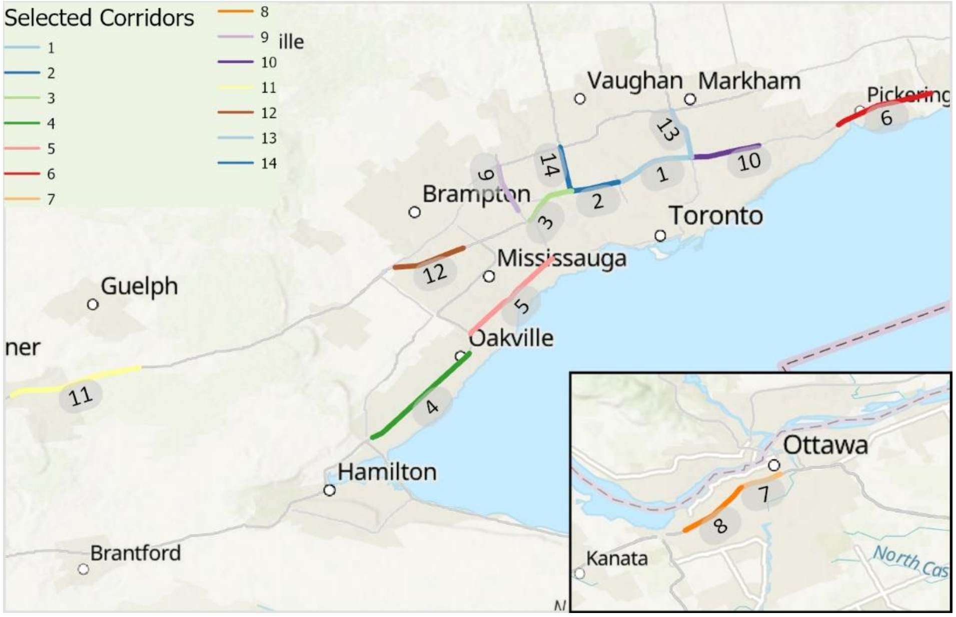


Table 3 presents corridor travel times in AM and PM peak hour by direction. The two directions of each corridor are categorized into congested direction and the opposite direction. The congested direction has a higher congestion level in the AM or PM peak hours and are identified based on the total travel time of the reference data. The opposite direction simply means the opposite side of the freeway from the more congested side. This classification is made to aggregate and visualize direction with similar traffic condition in Table 3 and Figure 7.

A notable observation from Table 3 is that there are very little differences between modeled travel times in congested and the opposite sides of the selected corridors. This is evident from overall differences of travel times by direction measured by the mean absolute percent error (MAPE). There considerable differences in travel times in congested and less-congested directions in the observed data as evident from AM and PM MAPE of 32% and 35%, respectively. In contrast, the model predicts similar travel times in both directions as evident from AM and PM MAPE of 9% and 8%, respectively. The MAPE values by direction are not shown in Table 3 for simplicity.

$$MAPE = \frac{|Modeled - Observed|}{Observed} \times 100$$

Figure 7 illustrates the modelled (TRESO) vs observed (HERE) travel time of selected corridors by direction. When the congested direction of the corridors is considered (chart in the left), the points of the AM peak are somewhat evenly scattered around the identity (45°) line. The total modeled and observed travel times for this category are almost exactly the same, 151.1 and 150.6 minutes, respectively (Table 3). On the same graph, the data points of the PM peak suggest that the model underestimates congestion for most corridors. The total modeled and observed travel time for this category are 143.2 minutes and 190.8 minutes, respectively.

Table 3: Average AM and PM peak hour travel time on selected highway corridors

Corr-idor no.	**HWY**	**Length (km)**	**Congested direction**						**Opposite direction**			
			AM travel time (min)			PM travel time (min)			AM travel time (min)		PM travel time (min)	
			Dir	Mod	Obs	Dir	Mod	Obs	Mod	Obs	Mod	Obs
1	401	10.3	WB	11.2	10.8	EB	10.1	15.1	11.8	9.3	11.3	12.5
2	401	5.9	WB	7.3	6.4	EB	6.7	11.1	7	4.6	7	7.1
3	401	7.7	EB	10	15.7	WB	9.8	8.2	8.8	7.4	8.4	14.4
4	403	18.7	EB	19.5	16.4	WB	20.4	24.5	19.9	13.4	18.9	14.5
5	QEW	16.2	EB	20.9	17	WB	20.5	17.9	18.1	13.6	17.7	20.6
6	401	12.7	WB	11.7	8.6	EB	10.7	16.2	10.4	7.3	9.4	7.5
7	417	3.8	EB	4.2	2.4	WB	4.2	9.4	4.1	2.5	4.2	4
8	417	7.3	EB	9.2	10.6	WB	9.2	13.5	8.9	4.4	9	7.6
9	427	8	SB	5.9	7.7	NB	5.3	15.4	5.6	5.7	5.6	4.9
10	401	8.6	WB	10.1	13.5	EB	8	6.8	8.5	5	8	6.6
11	401	16.7	EB	14.4	10.4	WB	14.3	20.4	14.1	13.9	13.9	10.6
12	401	9.2	EB	9.6	12.8	WB	9.3	11	9	7.3	9.3	9.3
13	404	8.6	SB	10.2	10.3	NB	8.4	11.5	8	7.2	7.2	12.5
14	400	7.6	SB	7	8.1	NB	6.2	9.8	5.4	4.5	5.1	8.1
Total	**-**	**141.1**	**-**	**151.1**	**150.6**	**-**	**143.2**	**190.8**	**139.4**	**106.1**	**134.9**	**140.3**
MAPE	**-**	**-**	**-**	**24%**		**-**	**31%**		**37%**		**21%**	

HWY: Highway
Dir: Direction
Mod: Modelled (TRESO)
Obs: Observed (HERE)

Comparing the less congested direction of freeway corridors (chart in the right), the points of the PM peak are generally located around the identity line. The total modeled and observed travel time for this category are 134.9 and 140.3 minutes, respectively. However, for the AM peak, the model overestimates congestion for most corridors. The total modeled and observed travel time for this category are 139.4 and 106.1 minutes, respectively.

There are two likely reasons for the model to overestimate AM congestion for the less direction. First, the model does not predict directionality of congested travel times very well. As a result, travel times in congested and less congested directions are quite similar. Second and more importantly, the traffic profile of modeled volume is concentrated with a higher peak during AM compared to more spread-out PM peak (

Figure 8). This profile results from start hour of trips which is not explicitly modeled in TRESO, rather it is based on exogeneous distribution of start hour from observed data, namely the household travel survey. Further investigation is needed to investigate the departure time profile for different demand segments, ie., urban vs intercity travel, and passenger vs comercial vehicles, to validate the start hour distribution used in TRESO.

Figure 7: Modelled vs observed travel time for congested and uncongested directions

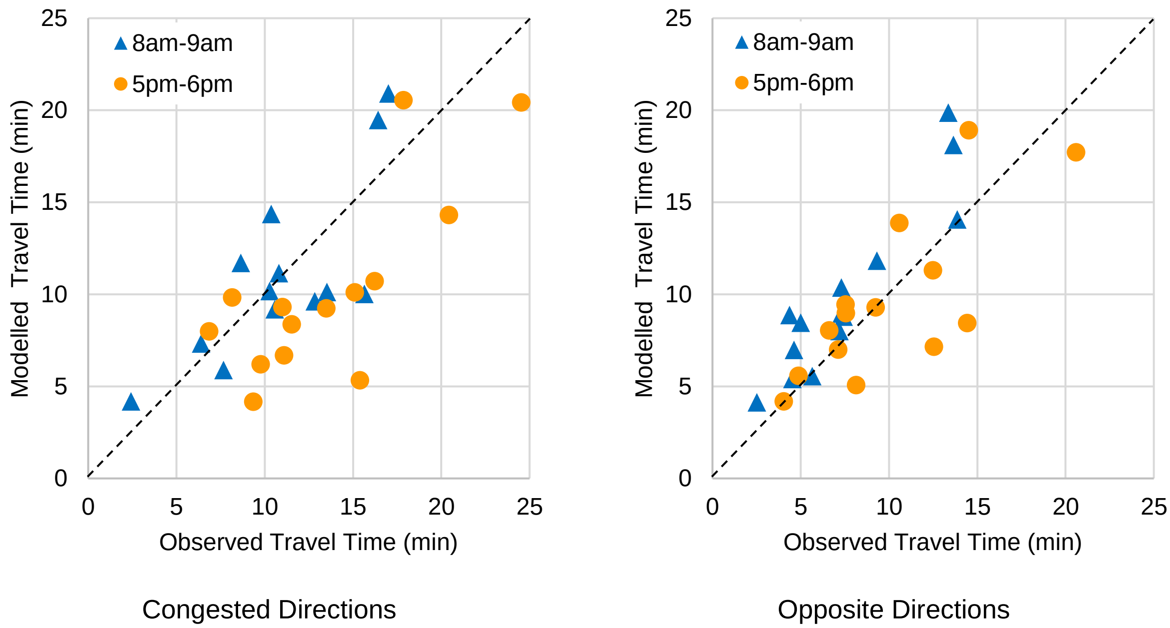
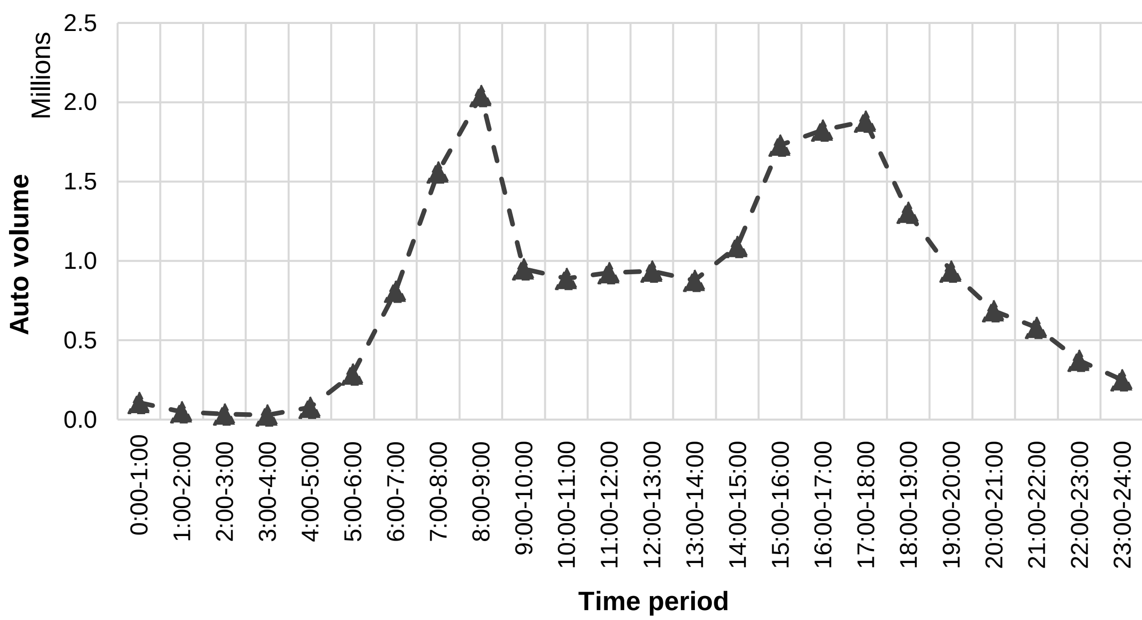


Figure 8: TRESO hourly profile of auto, 2016



4 Long-distance passenger rail

A key feature of a province-wide model like TRESO is its ability to capture long-distance travel, in addition to intra-urban travel in all urban regions of the province. The long-distance passenger model (LDPM) accounts for intercity travel by two primary modes of travel, auto and rail. The rail passenger demand predicted by the model is validated by comparing assigned passenger volume on the rail network with VIA rail ridership data. This is achieved by assigning LDPM rail demand to the VIA network within TRESO. The transit assignment implemented in TRESO specifies VIA and other rail, notably GO rail in the GGH as a “must-use” mode while local transit, walking, or auxiliary auto modes are used as access or egress modes to/from the stations.

TRESO rail assignment predicts the ridership for a typical day (weekday or weekend) in the Fall season. Prior to running the rail assignment, minor checks were completed in the TRESO VIA network to ensure all stations were coded with accurate station labels for comparison with VIA data. Individual transit lines for the VIA network were inspected and any coding errors were fixed to reflect accurate transit routes and attributes. Stations and transit segments located in the province of Ontario were given priority while performing these checks.

For validation, VIA station-level boarding and alighting data for the months of September, October and November 2015 are summed and divided by total number of days to calculate an average Fall-day ridership. The station-to-station data from VIA show trips by line and not by actual origin-destination. For example, there are no trips between South-west Ontario and Eastern Ontario (e.g., London-Ottawa) because there are no direct trains between the two regions and passengers need to change train at the Union station in Toronto. As such, only boarding/alighting data are used for validation.

Table 5 presents station-level VIA rail boarding and alighting summarized by region. The model underpredicts the overall ridership in Ontario by 22%. The underprediction is the higher in the GGH region and lower in Ottawa (TRANS model region). In contrast, the model overpredicts boarding and alighting in the South-east region.

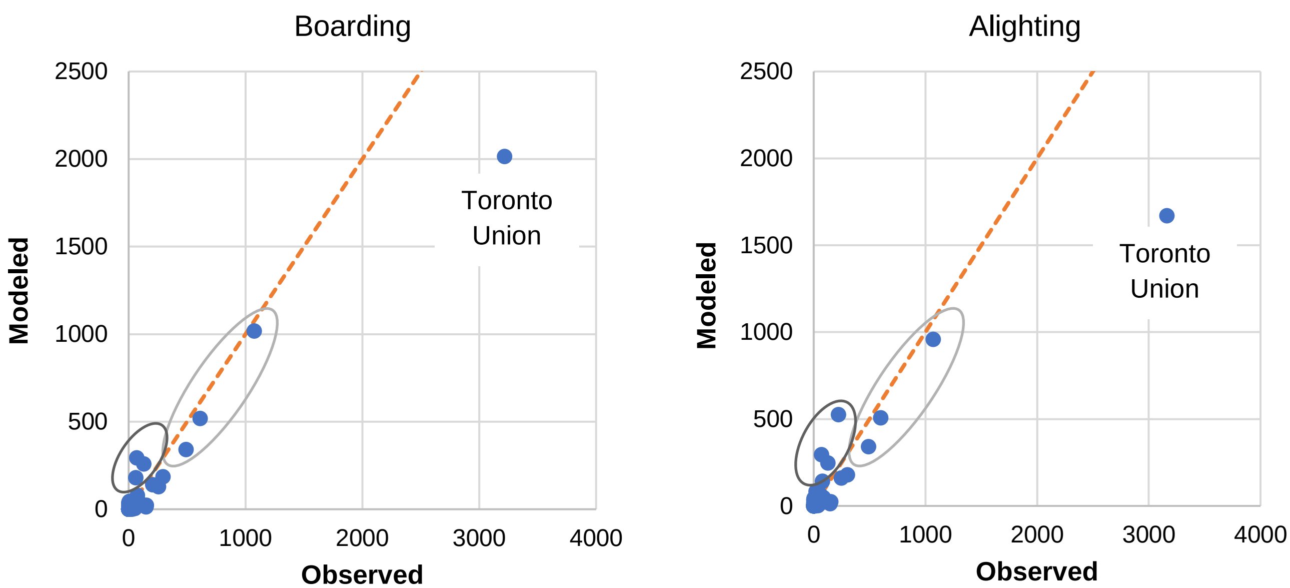
Figure 9 break downs boarding and alighting by station. Ideally, the points in the scatterplot should cluster around a 45° line. The major outlier in the chart is Toronto Union station for which the model heavily underpredicts both boarding (by 37%) and alighting (by 47%). Additionally, the model underpredicts boarding and alighting across other major stations (dark grey ellipse) and overpredicts on several minor stations (light grey ellipse).

The main reason TRESO underpredicts boarding/alighting is because the model simulates disproportionately large number of trips within the GTHA. The number of intra-GTHA trips from the model is over 2,500 (33%) while the VIA data only reported 184 trips (3%) starting and ending within the GTHA. Unsurprisingly, TRESO allocates most of these trips on to the GO rail, which is why the model under-simulates boarding and alighting in Toronto Union VIA station. There is also a likley issue in the trip destination choice of LDPM that over-simulates shorter trips, thereby under-simulating boarding/alighting in the regions outside of the GTHA.

Table 4: Daily long-distance rail boarding and alighting by region

Region	Boarding			Alighting		
	Modeled	Observed	Percent difference	Modeled	Observed	Percent difference
GTHA	2352	3505	-33%	2423	3494	-31%
GGHx	376	478	-21%	321	501	-36%
TRANS	1146	1332	-14%	1119	1318	-15%
SWO	900	1127	-20%	887	1130	-22%
SEO	888	840	6%	915	843	9%
NEO	43	18	139%	43	20	115%
NWO	20	6	233%	20	6	233%
Total	5725	7306	-22%	5728	7312	-22%

Figure 9: Daily long-distance rail boarding and alighting by VIA station

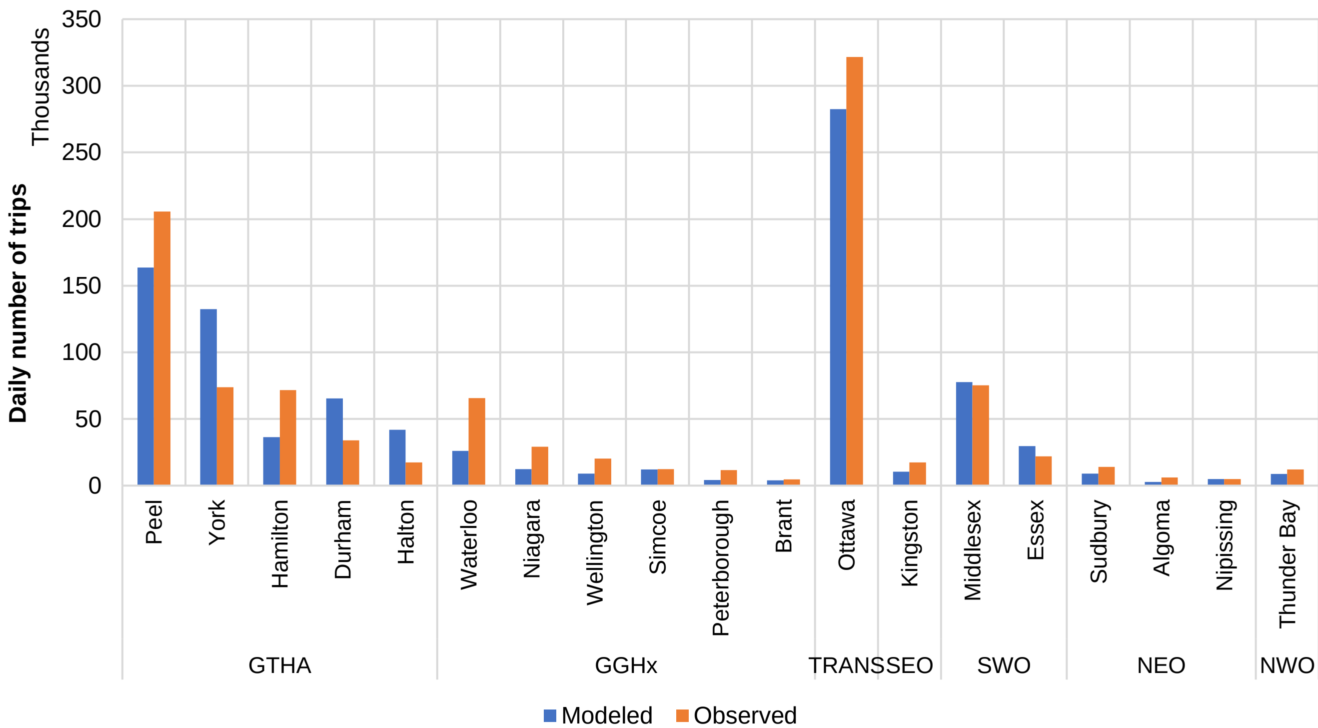


5 Urban transit

Urban transit trips are regular day-to-day trips taken on any transit mode and are represented by the *resident person-travel model* component within TRESO. Transit ridership data came from Canadian Urban Transit Association (CUTA). Annual ridership is divided by 300 to convert to a weekday average, since local transit ridership is lower on weekends and holidays.

On aggregate, the model underpredicts local transit trips throughout the province by approximately 800,000 trips or by 28%. Figure 10 compares modeled and observed transit ridership for census divisions (CDs) with 5000 or more observed ridership. Toronto is not shown here because the disproportionately large magniture of Toronto ridership masks smaller CDs in the province. The model underpredicts transit ridership in most CDs, apart from a few exceptions like York, Halton and Durham. The underprediction is substantial in Toronto (not shown in the chart) – by over 700,000 trips or 41% of all Toronto trips. The mismatch in Toronto's local ridership does not present a major problem in terms of model application, because the urban model GGHM is better suited for studies within the GGH region. However, the model performance needs to be improved in regions outside of the GGH by calibrating the resident person-travel model component to reflect local transit ridership more accurately.

Figure 10: Weekday transit ridership (showing CDs with 5000 or more daily ridership)



6 Data gaps and challenges

The development and validation efforts of TRESO identified some challenges and important data gaps. One of the biggest challenges is the geographic scale of the province of Ontario. To accurately represent the heterogeneity in travel behavior in various parts of the province, multiple travel diary surveys are required and then modeled in a manner that does not substantially add to the computational cost. The current version of TRESO assumes that resident person travel follows the patterns reported in the Transportation Tomorrow Survey (TTS) that has a large, diverse sample.

However, the same travel assumptions may not hold across the province, especially in small towns and rural communities.

A more noticeable data gap is present in the case of long-distance travel. The key data source for the estimation of the long-distance passenger model (LDPM) is the Survey of Residents of Canada (TSRC). Within Ontario the model predicts overall rail demand reasonably close to the TSRC, the percent difference being 7% (detail comparison of data is not shown in this work for the sake of brevity). So, the overprediction of intra-GTHA trips, as discussed earlier, is most likely the result of travel preferences reported in the TSRC. The resulting travel patterns predicted by the model differ from VIA rail data as demonstrated earlier. While VIA data is more accurate with regard to observed ridership on the VIA, the TSRC survey does not preclude the commuter rail mode, ie., the GO Rail, thereby leading to ambiguity. There is a clear need for higher quality long-distance passenger travel diary surveys that capture the modes better, as well as rely on more granular geographies. In terms of data sources for model validation, there are no observed data on inter-community bus (ICB) travel to perform validation of TRESO predicted ICB demand.

The most common and extensive part of any model validation is comparison of assigned road volume with traffic count. As discussed earlier, the number of traffic count locations are insufficient throughout the province to conduct a rigorous validation on modeled volume. The traffic count sample is particularly limited for trucks, as some of the count data do not include classified counts. This validation effort does not investigate spatial representation of traffic counts i.e., several counts on one road versus counts distributed throughout the network, which will be done in a future work.

7 Conclusion

Several important observations can be made from the TRESO validation work presented in this paper.

First, TRESO does reasonably well of predicting traffic volumes on the road network when compared with various counts data. However, the prediction error, indicated by percent RMSE, varies in different parts of the province because it is not realistic to achieve a consistent accuracy across a vast geography like Ontario, but more importantly, due to different count samples in different regions. Nonetheless, the percent RMSE of TRESO seems to be in line with various state-wide models in the US.

Second, the model does quite well in predicting freeway congestion and AM and PM peak hours as evident from travel time index (TTI) maps and an analysis of a selection of corridors on the 400-series freeways. The model struggles to represent directionality of congestion in the sense that it predicts similar congestion in the two directions of selected corridors, while the observed GPS data indicates relatively higher variability of congestion by direction an AM and PM peak hours. Because of this and due to higher AM peaking in the model, the model overpredicts AM congestion in the less congested direction of freeways.

Third, long-distance rail trips are underpredicted by the model when compared with VIA rail data. Toronto Union station is heavily underpredicted. The issue is likely how destination location choice is predicted by the model as evident by disproportionally higher number of trips generated within the GTHA.

Fourth, local transit ridership is generally underpredicted by the model. The underprediction is particularly high for Toronto. This may not be a major issue in terms of TRESO applications for long-range planning purposes, since the GGH Model can be used for the GGH region. However, the mode choice needs to be calibrated to better represent local transit ridership outside of the GGH region.

Overall, as a first operational version, TRESO does well to represent various types of travel in the province. Several data challenges, especially on the traffic count sample, long-distance travel diary, and representative travel diaries in small communities hinder more accurate model development and validation efforts. However, novel applications of new sources of data like GPS travel time data, as demonstrated in this paper, can address some of challenges in model validation. Finally, it should be noted that despite the challenges and limitations associated with validation, the model remains a useful tool for forecasting and scenario testing for long-range planning, evaluation, and other applications. For region-wide planning studies, the model outputs are compared with other data to test reasonableness of model results for the study region. If some aspects of model results show significant shortcomings, then alternative data (e.g., AADT, VIA rail ridership) are used to complement model results. As to small-scale subarea analysis, the subarea results are typically calibrated to obtain a better match with local traffic counts.

Future work to enhance TRESO validation includes incorporating updated traffic count data and inclusion of more freeway and urban corridors for travel time validation. In terms of model improvements, accuracy in traffic volumes and urban transit will be improved in the next version of TRESO, while efforts are underway within MTO to improve the accuracy of long-distance rail outputs.

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