Incorporating various travel segments in demand modelling and planning

by

Sundar Damodaran, Ph.D., P.Eng.
Ontario Ministry of Transportation

Paper prepared for presentation

at the Best Practices in Urban Transportation Planning Session

of the 2010 Annual Conference of the
Transportation Association of Canada
Halifax, Nova Scotia

ABSTRACT

Background
Urban travel demand forecasting models are an essential planning tool in planning and policy development. These models range in level of detail and comprehensiveness, depending on various factors including the availability of good quality data on travel and traffic in the area of interest. Household travel surveys form the major source of information on local travel patterns and trip making characteristics, and provide inputs into model development. While these surveys provide a rich database on households, persons and trips made by them, they are seldom complete. There is a large array of travel segments that are not typically captured by these surveys, for example, trips made by persons who live in group quarters (e.g., campus residences) and trips made by non-residents visiting or travelling through the region.

In addition, there are a number of trips made by various vehicle types that are not adequately addressed in urban travel models, such as emergency response, garbage collection, and private transit vehicles, etc.

Study Details
The purpose of this research is to explore various travel and traffic segments, with a view to identifying how they are accounted for in modeling and planning applications, using the Greater Toronto and Hamilton Area (GTHA) as a case study. Two main data sources in the GTA, i.e., the Transportation Tomorrow Survey (TTS) and Cordon Count Data are analyzed, within the context of travel demand models in use in the GTA, to provide insights.

The main finding from research will be to develop an understanding of the size of these segments of travel that are traditionally unaccounted in urban models. This knowledge will be useful when applying demand forecasts from such models to aid planning, policy development and evaluations.

Background

Urban travel demand forecasting models are an essential planning tool in planning and policy development. These models range in level of detail and comprehensiveness, depending on data availability and various other factors including the availability of good quality data on travel and traffic in the area of interest. Household travel surveys form the major source of information on local travel patterns and trip making characteristics, and provide inputs into model development. While these surveys provide a rich database on households, persons and trips made by them, they are seldom complete. There is a large array of travel segments that are not typically captured by these surveys, for example, trips made by persons who live in group quarters (e.g., campus residences) and trips made by non-residents visiting or travelling through the region.

This paper explores various travel and traffic segments, with a view to identifying how they are accounted for in modeling and planning applications, using the Greater Toronto and Hamilton Area (GTHA) as a case study.

Demand Forecasting Models and Planning

Most urban models deal primarily with passenger trips by most common modes of travel, i.e. auto and public transit. Depending upon the urban area, the number of modes available could include a wide range of alternatives. Application of travel demand forecasting models for planning purpose also ranges widely depending on the size of urban area and the planning process. For example, in the case of major metropolitan areas like Toronto or Montreal, where the public transit system is quite rich and comprehensive, which includes buses, streetcar/trams, rapid transit modes (light-rail, heavy-rail, or bus-rapid-transit, people-mover, etc.), and commuter rail. Table 1 below shows the list of different modes that cater to passenger and freight transportation, grouped by type.

Table 1 - Modes of Transport - Passenger & Freight

Detail	Non-Motorised	Motorised	
	Private / Semi-Private/Public		Public
Passenger	Walk, Bicycle	Auto, Motorcycle, Taxi, Rental car, Private school bus, Vanpool/carpool	Bus, streetcar/tram, rapid transit (LRT, BRT, MRT, etc.), commuter rail
	Courier, Private, Owner-operated firms		For-hire & Common carriers
Freight / Commercial	Bicycle	Motorcycle, small vans/pick-ups, medium & heavy trucks	Medium & heavy trucks, air, rail, marine, etc.
Others*		small vans, medium & heavy trucks	
* - includes emergency-response, garbage collection, etc.			

A survey conducted in 2008 as part of a study on Best Practice on long-term urban planning studies (TAC, 2008) compiled data on travel demand models used by various planning agencies. It found that while 100% of municipalities modelled auto driver mode, the percentage of agencies that modelled other modes was lower at around 50% for transit, 40% for trucks, 30% for walk & bicycle, and about 12% for others (including school bus, motorcycle and taxi). The rationale for not including all the modes in their forecasting models may depend upon various factors including local conditions, the size of such segments in travel market, and data availability. The above study revealed that the number of modes covered in forecasting varied with the population size of the region; large metropolitan regions tend to include a larger variety of modes, including trucks.

Table 1 above categorized the travel segment by mode of travel. Another way to categorize travel segments would be to consider the person who makes trips, the purpose for which the trips are made, and finally where the trips are being made. Table 2 shows one such method. Passenger travel in urban areas comprises trips made by residents of that urban area for various activities (that generate the need for travel) listed in the table. In addition to that, there are trips made by visitors to the city who also make trips within the urban area. Visitors could also be classified by the purpose for which they visit the city, i.e., for business/work-related, tourism, visiting friends and relatives, etc. Similarly, on a given day, some residents of the urban area also take an out-of-town trip for one of three above listed purposes in another city. Part of these trips are made within the urban region, i.e., the first (or the last) leg of the trip between home and the airport or a bus/train terminal.

Table 2 - Travel Segments

Journey Purpose	Resident		Non-Resident/Visitor	
	Urban	Inter-City	Urban	Inter-City
Commute (between home & work/school)	*	N/A	N/A	N/A
Work-related/business	*	§	§	§
Personal business	*	§	§	§
Recreational / Entertainment / Social	*	§	§	§

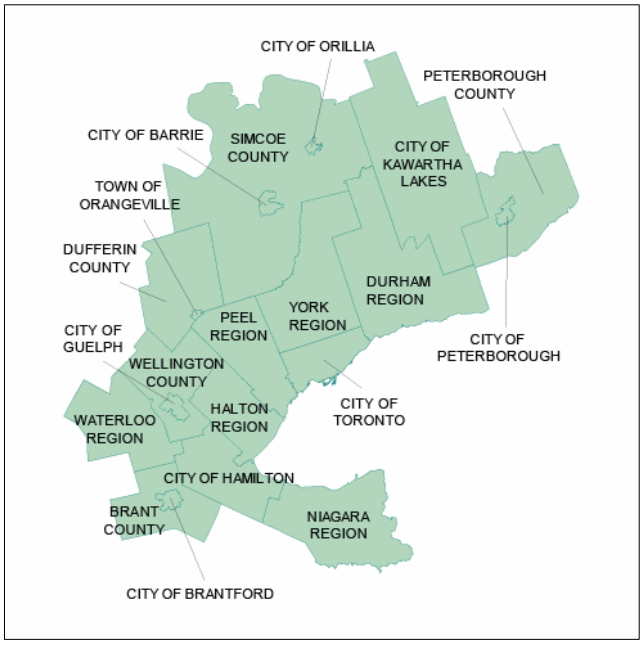
* usually modelled
§ usually not-modelled

As indicated in the table, most urban travel demand prediction/forecasting models do not cover all of these travel segments. Similarly on the freight / goods movement side, there are truck trips made within the region or city by local firms and there are truck trips made to/from/through the region by truckers from outside the region.

Case Study of the Greater Toronto & Hamilton Area (GTHA)

The GTHA, comprising six upper-level municipalities (Cities of Toronto and Hamilton and the Regional Municipalities of Durham, York, Peel and Halton), is home to approximately 50% of population in Ontario. The primary source of data on travel by residents of this region is the Transportation Tomorrow Survey (TTS), which has been conducted every five years since 1986. The survey covered 5% of households in the larger conurbation of the area (see Figure 1 below for the areas covered by the survey). Conducted over the telephone, this survey captured data on trips made by each member of the household who is 11 years and above, along with various other personal and household characteristics.

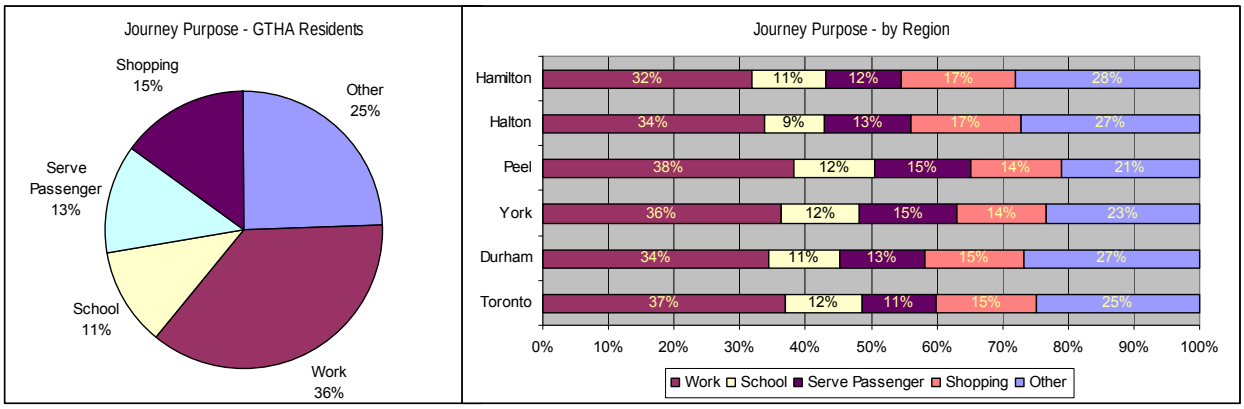
Figure 1 – TTS Coverage Area



Journey Purpose

The TTS recorded person's journey purpose in terms of activity at origin and destination, for example, going from home to work, from work to shopping, etc. Figure 2 shows the breakdown of all trips made during a typical weekday in 2006. This classification has been done using trip purpose at the destination, excluding those with "returning home" as the destination purpose. It is worth noting that these "returning-home" trips account approximately 42% of all trips made in the day, and the breakdown of their "origin" purpose is identical to those shown here.

Figure 2 – Journey Purpose – 2006 TTS



Work and school trips represent the largest component at 47% of trips, and trips made for other personal purpose and serving another person (usually in a private car) account for 38%, larger than work trips. It is worth noting that these two classifications of journey purposes provide no information on what activity actually gave rise to the need for travel. For example, "other" may include any one of the following sub-groups along with further sub-classification; social (visiting friends/relatives, place-of-workshop, etc.), recreational (take part in a game, sport, event, etc.), entertainment (visit a pub, club, restaurant, sporting event, playhouse, movie, theatre, etc.), and personal business (visit bank, clinic, hospital, etc.). The category "serve passenger" may refer to driving a passenger who may be pursuing any of these activities, or one of the three (work, school, shopping) purposes. In addition, the person may be driven to the place of activity or to an intermediate transportation terminal/hub from where the person follows his/her own route on the transit for the rest of the journey.

Such lack of information can pose a big challenge while developing behavioural models that relate trip-making characteristics with the land use. Adding these levels of detail to segmentation while collecting travel related data from surveys will help better understand the trip-making behaviour of residents. This would help improve segmentation of travel markets within travel demand forecasting models, which in turn will improve model robustness and policy sensitivity by creating a link between land use / urban development and transportation.

Mode of Travel

Table 3 shows the breakdown of trips by the mode used. Besides major motorised modes (auto and public transit) and active transportation modes, which are usually accounted in urban travel demand models, there are three other groups shown in the table. Note that the school bus includes both the school buses provided by school boards as well as those privately contracted by parents for their children's transportation to/from school. The latter is applicable for private schools and students who opt to attend schools outside of their normal school district boundaries. In 2006, the survey recorded approximately 208,000 person trips that were made by school bus in a typical weekday.

Less than 1% of trips reported by residents were by taxi (about 60,000). The "other" category (about 20,000 trips) includes different other transport companies such as VIA Rail, Greyhound, and others, as well as motorcycle (about 3,000). These estimates are likely to be low as the sample for the TTS was only drawn from households in private homes, excluding those living in group quarters that include senior homes, student residences on campus, and rooming houses.

Table 3 – Mode of Travel – 2006 TTS

	Work/School trips					
Region	Major Modes	Walk/Cycle	School Bus	Taxi	Other	Total trips
Toronto	85.5%	13.0%	1.0%	0.3%	0.1%	1,211
Durham	85.3%	9.8%	4.8%	0.1%	0.0%	283
York	87.2%	7.5%	5.1%	0.1%	0.0%	464
Peel	86.8%	8.4%	4.5%	0.1%	0.1%	612
Halton	86.5%	8.6%	4.7%	0.2%	0.0%	216
Hamilton	82.2%	12.0%	5.4%	0.2%	0.1%	233
GTHA	85.8%	10.6%	3.3%	0.2%	0.1%	3,019
Non-Work/School trips						
Toronto	91.9%	6.5%	0.4%	1.0%	0.2%	3,575
Durham	93.9%	4.2%	1.5%	0.3%	0.1%	938
York	94.5%	3.4%	1.8%	0.2%	0.1%	1,389
Peel	93.8%	4.0%	1.7%	0.3%	0.1%	1,728
Halton	94.8%	3.4%	1.4%	0.3%	0.1%	773
Hamilton	93.1%	4.6%	1.6%	0.6%	0.2%	822
GTHA	93.2%	4.9%	1.2%	0.6%	0.1%	9,226

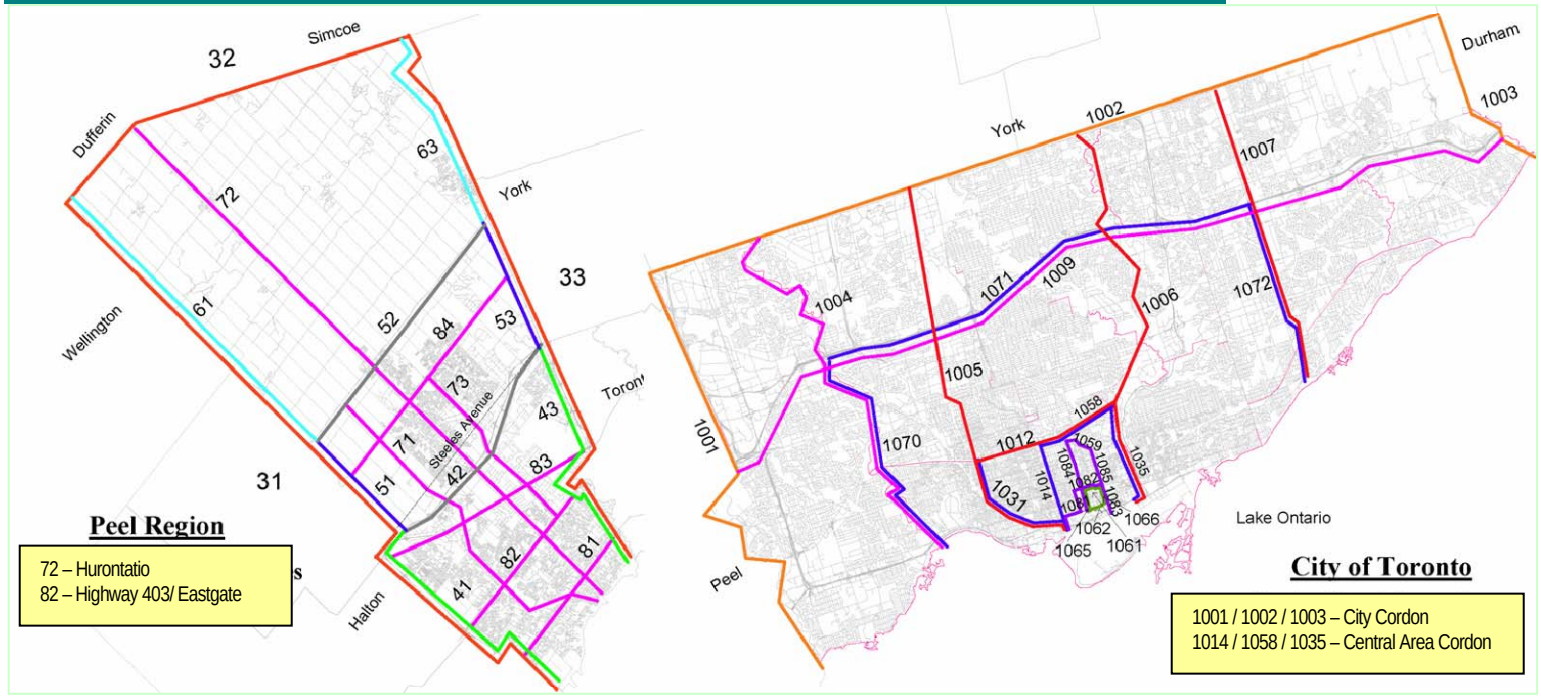
* Includes Auto (as driver or passenger) and public transit

Traffic Count Data

The Cordon Count Program is a joint initiative between the Ontario Ministry of Transportation and regional /upper level municipalities in the Greater Toronto Area. Classified vehicle counts are done manually at count stations located on screenlines or cordons throughout the GTA. What is unique about this program is that it captures "person counts", by classifying vehicles based on passenger occupancy. Table 4 shows a sample screenline summary for a few screenlines/cordons in the City of Toronto and the Region of Peel (see the figure below the table for the location of screenlines). The most important observation from the table is the number of trips by various modes that are not fully captured by the household travel survey, i.e., taxi and other buses. The two cordons in the City of Toronto alone registered approximately taxi 67,000 trips crossing the screenlines, whereas the TTS had only recorded about 60,000 trips for the entire GTHA. Although some of the trips recorded at the screenline may have crossed more than one screenline on a given trip, the sample from the cordon count data clearly shows an indication of the total number of trips made by taxis, considering both resident and non-resident trips.

Table 4 - 2006 Cordon Count Data - Trips by Mode & Modal Share

Person Trips (000's) – Both direction – All Day*										
			Municipal Transit		Regional Transit					
Cordon/Screenline	Auto	Taxi	Bus/ Street Car	Subway	GO Bus	GO Rail	Other Bus	School Bus	Bike	Total
Toronto - City Cordon	2,184	24	39	-	19	121	81	26	1	2,494
Toronto - Central Area	822	43	112	576	5	138	20	13	12	1,740
Peel - Hurontario St	970	4	26	-	5	65	7	18	2	1,098
Peel–Hwy 403/ Eastgate	480	2	15	-	3	10	2	7	1	521
	Modal Share– Both direction – All Day*									
Toronto - City Cordon	88%	1%	2%	0%	1%	5%	3%	1%	0%	100%
Toronto - Central Area Cordon	47%	2%	6%	33%	0%	8%	1%	1%	1%	100%
Peel - Hurontario St	88%	0%	2%	0%	1%	6%	1%	2%	0%	100%
Peel - Highway 403/Eastgate	92%	0%	3%	0%	1%	2%	0%	1%	0%	100%
* - From 6:00 am to 8:00 pm for Toronto and 5:30 am – 8:30 pm for Peel										



The cordon count data also shows the number of inter-city and other bus trips; at the City Cordon, the number of trips by these other buses is much higher (at about 81,000), than the GO Bus trips (about 19,000).

Lastly, the school bus is another mode that is not fully captured in the TTS. The survey only collected trips made by persons of age 11 and above. The nature of school bus service is very much determined by the School Boards, which define the school district boundaries and rules associated with the service. Table 3 shows that the City of Toronto has the lowest school bus share among the regions in the GTHA. It is worth noting that much of school bus trips are likely to be intra-regional, except in the case of school boards that serve more than one region and school bus service operated for private schools.

Travel Demand Models in the GTHA

Several planning agencies in the GTHA responsible for transportation and land use planning have developed travel demand forecasting models to serve their planning and study needs. They range in level of detail and area covered, based on the planning agencies' jurisdiction and focus. Most models are based on the traditional four-step urban transportation modelling approach, with variation in what travel segments are modelled and the way in which they are modelled. Table 5 below presents a comparison of some of the models in use in the GTHA.

Table 5 - Comparison of a few Urban Models in GTHA

Detail	Greater Golden Horseshoe Model	GTA Travel Demand Modelling System, Version .2.0	York Region Transportation Model	GTA PM Peak Model/Halton Region Sub-model
Agency	Ontario Ministry of Transportation	City of Toronto	Region of York	Region of Halton
Time Period	AM (6-9) and PM (3:30-6:30) peak	AM Peak (6-9)	AM Peak (6-9)	PM Peak (3-6)
Area of Coverage	GTHA & surrounding 10 Counties/Regions	GTHA	GTHA	GTHA
Travel segments modelled				
Modes (Passenger)	Auto (Driver & Passenger)	Auto (Driver & Passenger)	Auto (Driver & Passenger)	Auto (Driver & Passenger)
	Transit (5 sub-modes)	Transit (4 sub-modes)	Transit (4 sub-modes)	Transit (2 sub-modes)
	[Transit allway, Subway park-n-ride, GO Rail Park-n-ride, GO Rail walk/local transit access, GO Bus]	[Transit allway, Subway park-n-ride, GO Rail Park-n-ride, GO Rail walk/local transit access]	[Transit allway, Subway park-n-ride, GO Rail Park-n-ride, GO Rail walk/local transit access]	[GO Rail & non-GO Rail]
	Walk & Bicycle	Walk/other	Walk/Cycle (not-assigned)	Walk & Bicycle (not-assigned)
	School Bus (not assigned)	School Bus (not-assigned)		
Modes (Commercial Vehicles)	Three classes (Light, Medium & Heavy) trucks	Nil	Nil	Nil
Journey Purpose	Home-based-work	Home-to-Work	Home-to-work	From Work
	Home-based-school	Home-to-School	Home-to-school	From Non-work Origins
	Home-based-shopping	Non-work/school	Home-to-other	
	Home-based-other		Other-to-Other	
	Non-home-based			
Special trips / Non-Resident trips	External trips from surrounding regions/counties and International border-crossing	External auto trips from surrounding regions and counties	External auto trips from surrounding regions and counties	External auto trips from surrounding regions and counties
	Trips to/from the Airport			

From the features of each models, the Greater Golden Horseshoe (GGH) Model which covers the greater conurbation of the region is by far the most comprehensive in terms of not only the geographic coverage, but also in terms of coverage of various travel segments. At the other end is the most simplified of the regional models, i.e., the P.M. peak-only model of the Region of Halton. In addition to these, the Regions of Durham and Peel and the City of Hamilton each has its own model[1]. It should be noted that none of these models address travel segments such as trips by non-residents and trips by certain modes like taxi, private transit and certain public transport operators. The GGH Model accounts for some of the non-resident trips, for example, those arriving at / departing from the Pearson International Airport, but does not fully address trips made by visitors.

Special Purpose Vehicles

Finally, there is a segment of traffic and travel that is seldom considered in any regional travel demand forecasting models comprising fleet vehicles that serve special purpose. These include emergency response vehicles (police, ambulance, fire trucks, etc.), as well as vehicles related to repair and maintenance of utility and services, construction, road-side assistance, etc. Some of these types of vehicle trips can be accounted through a commercial vehicle / goods movement component of the model. However, the practice in urban travel demand models - at least among those in use in the GTHA – is to traditionally treat passenger demand independent of commercial vehicle demand. The GGH Model is the first model in the area to move towards integrating modelling of passenger and commercial vehicle demand into the same platform. One way to incorporate all elements of travel demand segments into a modelling framework is to a) identify all the potential market segments from analysis of available data, and b) to identify gaps in data collection and filling the gaps through augmenting and/or modifying the data collection.

Conclusion

In summary, recognizing all the different market segments of travel is of key importance when it comes to travel demand modelling and forecasting. Travel demand modelling and forecasting is an area that is continually evolving and advancing, aided by advancements in computing and modelling softwares. At the same time, availability and richness of traffic data is also improving continuously, due to various ITS initiatives and technologies. The latter provides an opportunity to fill the data gaps, and at the same time refine and improve modelling tools to better reflect the travel markets. There is a need to develop innovative techniques and methods to address these special sectors within the modelling framework. This will improve the results of travel demand forecasting models and in turn lead to better planning applications.

[1] The models of the Region of Peel and the City Hamilton are similar in features to the York Region's model, while Durham has recently developed a model that covers a.m. and p.m. peak periods.

References

Transportation Association of Canada (2008), *Best Practice for the Technical Delivery of Long-Term Planning Studies in Canada,* Ottawa

Data Management Group, *http://www.dmg.utoronto.ca/transportationtomorrowsurvey/index.html*, University of Toronto

Data Management Group, Greater Toronto Area Cordon Count Program 2006, University of Toronto.