

Urban Density and Transit Viability: A Case Study

By

*Sundar Damodaran, Ph.D. P.Eng.
Transport Planner & Consultant; and
Affiliate, IBI Group, Toronto*

INTRODUCTION:

Most of the public transit operations in North American cities are operated under a subsidy, with the fare-box recovery ratio ranging from 40 to 80 per cent. While there are many factors that contribute to this situation, two factors may be considered most important. First, the high car ownership level coupled with the low operating cost of private vehicle when compared with the transit fare for a similar trip. As a result, transit companies get into the vicious circle of losing ridership and fare increases.

The second factor is the urban make-up, which includes urban density and design features. It has been well documented how the neighborhood and street lay out plans, especially in the suburban sub-divisions have been transit unfriendly and thus increasing auto dependence. This has given rise to the awareness of transit oriented development in the last decade.

The other factor addressed in this paper is the transit industry structure. In most jurisdictions in North America, transit service is almost entirely provided by public companies, which is not the case in many cities, especially in Asia.

All these factors are studied through a case study of the transit industry in two Cities, viz., Singapore and Toronto. Comparative analysis was undertaken to evaluate if any one of

these factors may be considered the single-most important factor influencing the success of transit.

TORONTO:

The City of Toronto with a population of 2.45 million (2001 Census), is the fourth largest¹ City in North America, by population. The Census Metropolitan Area (CMA) of Toronto that includes the urban areas in the surrounding regions has a population of over 5 million. For the purpose of this study, only the part of Toronto CMA that includes the Municipalities that surround the City of Toronto have been considered. Table 1 shows the selected area and the population and population density for that area².

Table 1. Greater Toronto Statistics

<i>City</i>	<i>Population</i>	<i>Dwelling Units</i>	<i>Land Area (Sq.km)</i>	<i>Density (pop/sq.km)</i>
Toronto	2,481,494	965,554	629.9	3939.4
Mississauga	612,925	198,235	288.4	2125.1
Brampton	325,428	98,753	266.5	1221.0
Vaughan	182,022	54,359	273.5	665.5
Richmond Hill	132,030	41,966	100.9	1308.7
Markham	208,615	61,618	212.5	981.9
Oakville	144,738	50,000	138.5	1045.0
Total	4,087,252	1,470,485	1,910.2	2139.7
CMA Total	4,682,897	1,671,087	5,902.7	793.3

Transit service in the GTA is provided by respective local Municipal governments, with the exception of inter-regional bus and commuter rail service provided by the Government of Ontario through the GO Transit. Table 2 shows a summary of transit companies that serve the above listed areas, along with the average daily transit trips for each of them.

¹ After New York, Los Angeles, and Chicago.

² Source: 2001 Census, Statistics Canada

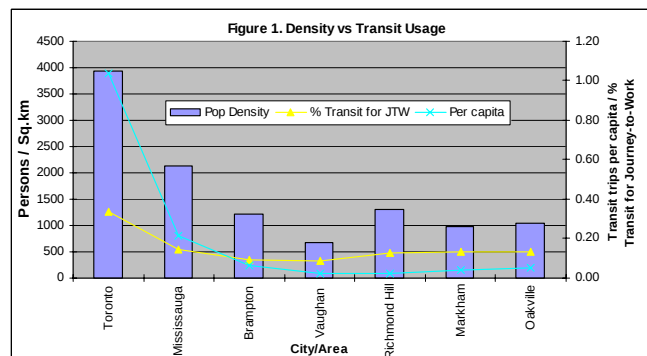
Table 2: Transit Operators in the Toronto Area

City	Transit Operator	Daily Boardings (2001)*	Per capita
Toronto	TTC	2,568,386	1.04
Mississauga	Mississauga Transit	132,287	0.22
Brampton	Brampton Transit	21,692	0.07
Vaughan		4,388	0.02
Richmond Hill	York Region Transit	3,347	0.03
Markham		8,499	0.04
Oakville	Oakville Transit	7,707	0.05
Total		2,746,306	0.67

* - 2001 weekday ridership reported in "TTS2001 Data Validation" DMG, Joint Program in Transportation, Civil Engineering, University of Toronto, 2003

The table above shows the severe imbalance in transit usage, illustrated by transit trips per capita, between the City of Toronto and the suburban cities. It is interesting that although the population density in Mississauga is only about half of Toronto's, the transit ridership per capita in Mississauga is less than one fourth of Toronto's.

Figure 1 below shows the relationship between population density and transit usage across these cities in the study area.



Note: Source of "% Transit for Journey-to-Work" is from Census 2001, Statistics Canada.

It should be noted that the per capita transit ridership reported here do not include trips taken by residents on the GO Transit, which serves commuters from suburban cities into the City of Toronto. This explains the discrepancy between transit share for work trips and overall transit trips per capita in some cities.

SINGAPORE:

Singapore is a City State in the southern tip of Malaysian Peninsula. It has a population of about 4.24 million (2004) residents, of which some 0.8 million constitute foreign workers/students and their dependents. Singapore economy is rated one of the most competitive in the World³, with a per capita GDP of U.S.\$29,000 in 2004.

Transit service in Singapore is provided by two multi-modal (bus, rapid transit, and taxi) transit operators, both private companies. Singapore Mass Rapid Transit (SMRT), one of the two private companies is partly owned by the Singapore Government. Although originally wholly owned by the Government, it has been divested gradually over the last several years. The other company SBS Transit was originally a bus operator which became a multi-modal operator in 2003 when it started operating the newly completed NorthEast Line (NEL), a driverless mass rapid transit⁴ system.

Table 3 shows some key statistics for the two transit operators in Singapore.

³ See World Economic Forum, "Global Competitiveness Report" 2004.

⁴ This 20 km line is entirely underground, with 16 stations. Being driverless, this is claimed to be the first fully automatic heavy rail transit (HRT) in the world.

Table 3: Summary of Transit Operators in Singapore

Detail	SMRT	SBST	Total
Rapid Transit (km)	97.2	30.7	127.9
Bus Routes	74	192	266
Bus Fleet	800	2400	3,200
Average Daily Ridership(000)	1,734	2,198	3,932
Population Served (000)			4,240
Ridership per capita			1.08
% Transit for Journey-to-Work			61%

Sources:

<http://www.lta.gov.sg/>

<http://www.smrt.com.sg/>

<http://www.sbstransit.com.sg/>

<http://www.singstat.gov.sg/keystats/c2000/transport.pdf>

It is interesting to note that the average daily transit ridership per capita in Singapore is only marginally higher than in the City of Toronto, whereas the transit modal share for journey to work in Singapore is so much higher than in Toronto. While transit modal share is from the Census 2000 at which time the modal share would have been higher than in 2004/05, there are probably various other factors contributing to this. The demographic make of the population and trip making characteristics of Singaporeans are probable factors.

CAR OWNERSHIP & OPERATING COSTS

Car ownership level is an important factor that affects transit ridership. North American cities in general have a very high car ownership level. Based on the 2001 Transportation Tomorrow Survey (TTS), vehicle ownership in the cities in the Greater Toronto Area (GTA) ranges from approximately 1 car per 2 persons (this being within the City of Toronto) to 1 car per 1.25 persons (in Durham). On contrast, the car ownership level in Singapore has been around 1 per 9 persons⁵.

In addition to restraint on the vehicle population, Singapore had adopted a policy of high upfront taxes that result in very high cost of owning a car. Although fuel prices are

⁵ The Government in Singapore has a control on the growth of car ownership level through a Vehicle Quota System that limits the year to year growth in cars.

relatively inexpensive compared to European countries, the high cost of owning a car was meant to be a deterrent to car dependence and usage. This however, has resulted in those owning a car making use of it to the fullest extent, thereby pushing the annual km driven/car to about 20,000 which may be too high considering the size of the country.

Cost of operating a vehicle in Singapore has also been increased by the Electronic Road Pricing that cordons the CBD with a per-entry charge in the range of approximately S\$3.00.

Canadian Automobile Association estimates the car ownership and operating costs based on an average small car⁶ to be about 12.8 ¢/km for fuel, tyres, and maintenance. If the annual fixed cost of owning is converted to a variable cost per km, assuming 18,000 km driven per year, then the cost increases to 51.5 ¢/km. Even at this rate, a trip over a 10 km distance would cost the user just about \$5, while the cost of transit single-ride fare in the GTA is around \$2.50. However, most car users do not perceive the fixed cost, as well as various other external costs such as air pollution caused, public health, subsidy by Government for road building and maintenance, etc. Thus, at approximately 13¢/km, even a solo driver will consider the transit fare of \$2.50 (or about \$1.70 at discounted 10-ride ticket fare) too high to consider switching, except if he/she has to pay a huge parking fee out-of-pocket.

The variable cost of operating a car in Singapore is not much different from the Canadian rates. The fixed cost of ownership is the one that makes a difference. Transit fare however, is more competitive in Singapore. The fare system in Singapore is based on fare-stages which is equivalent to fare-by-distance. An average bus/MRT trip ride costs \$0.65/\$0.94⁷ in Singapore, which typically is likely to be around 7 or 8 km long, given the distances involved in Singapore. For a similar trip by car, even at about 20¢/km for variable cost, the transit fare would

⁶ Using a 2005 Cavalier Z-24 (see CAA, *Driving Costs, 2005 Edition*).

⁷ See The Report of the Committee on the Fare Review Mechanism, February 2005, Singapore Government Parliamentary Committee.

be very competitive. On top of that, one pays the road pricing charge is one drives into the CBD.

In summary, the car ownership is high and car operating costs are low in the GTA, but transit may be seen as too expensive which could be a determinant factor for low transit usage.

URBAN MAKE-UP

With a total land area of 690 sq.km, the population density in Singapore is 6144.9 persons per sq.km, some 50% higher than the City of Toronto's. Table 4 shows a comparison of certain key demographic and household characteristics between Toronto and Singapore. Given the density of suburban municipalities in the Toronto CMA is so much lower, this comparison is restricted to the City of Toronto proper.

Table 4: Demographic and Housing Comparison

Details	Toronto*	Singapore**
Number of households (000's)	965.6	923.3
Population (000's)	2481.9	3263.2
Household size	2.6	3.5
% Dwelling Types		
Private (Single/Duplex/Townhouse)	74.0	5.1
Condominium & Private Apartments	26.0	6.0
Public Housing (Flats)	N/A	88.0
Others		0.9

Notes:

* - In the case of Toronto, only buildings more than 5-storey are classified as apartments/flat; the rest are grouped under the first category

** - Data for resident population, i.e., citizens and permanent residents, excluding foreign students&workers

Sources:

2001 Census, Statistics Canada:

<http://www12.statcan.ca/english/census01/home/index.cfm>

2000 Census, Department of Statistics, Singapore

<http://www.singstat.gov.sg/papers/c2000/adr-housing.pdf>

More than 90% of households in Singapore live in high-rise apartments, as compared to a meagre 26% in Toronto. It just

shows that the high-density urban landscape provide the necessary mass to make transit an attractive alternative to private mode of travel. From the urban design perspective, the reliance on high-rise high density housing developments in Singapore has made possible sufficient land being allocated for open-space, park, and other community uses, thus augmenting the liveability of the City. At the same time, the mass provided by this high-density urban landscape has made possible the provision of an accessible, frequent, and quality transit system that is also economically viable for the private operators.

INDUSTRY STRUCTURE

Are the two factors described thus far sufficient conditions that would make public transit viable? Experience in many Asian cities that also feature high density, low car ownership levels, and high vehicle operating costs has shown that these factors are essential, but not necessarily sufficient. Probably the most important factor is the way in which the transit industry is organised and regulated.

As mentioned earlier, the transit operators in Singapore are both private companies. The Government funds all capital expenditure on Rapid Transit System expansion, including the first set of rolling stock required to serve the expansion. The lines are then leased to private operators who are expected to cover all operating costs from fare-box and other revenues from advertising and commercial leases at stations, plus set aside enough funds to be able to replace the asset at the end of the lease period (usually 30 years)⁸.

For the bus operations, the Government provides funding for certain infrastructures such as Interchanges and Bus Stops. Again, the operators are expected to be dependent on the revenue for operation and fleet augmentation. Bus operations are regulated by an independent council set up by the Government (Public Transport Council), in the areas of service entry/exit, standards, and fares. Service standards are set through performance measures in timeliness, crowding, and customer

⁸ See "White Paper: A World Class Land Transport System" Jan 1996, Land Transport Authority, Singapore

satisfaction. Although fares are not set by the PTC, the operators have to apply and obtain approval for any increase in fares. Criteria used in fare increase regulation include operators' return-on-total-asset and fare affordability⁹. Affordability of transit fares is measured by the percent expenditure on transport by the lowest second quintile (40th percentile) income group.

As compared to this model in which the transit services are operated by private operators, with support from Government for major infrastructure, and a regulatory body to ensure commuters' interests are protected, transit industry in Toronto is entirely owned and operated as a monopoly by the local government. While capital expenditures for expansion of subways and bus fleet augmentation are *partly* funded by the Provincial Government, its investment in public transit infrastructure in the recent past has been dismal compared to Singapore¹⁰.

On operating costs and revenue, a comparison is made between Toronto's TTC and the two operators in Singapore. This comparison is based on the Annual Report of the three companies for the year 2004. Table 5 below shows the comparison.

⁹ Public Transport Council, Annual Report 2004/2005, Singapore

¹⁰ For the period from 1997 to 2003, the Government spent S\$4.6 billion on the 20-km/16 station fully underground North East Line alone. In comparison, the only major transit expansion in Toronto was the Sheppard Subway, a 6km/5 station line at a cost of C\$0.9 billion.

Table 5: Comparison of Transit Financials

Details	TTC		SMRT		SBST	
	C\$(000's)	%	S\$(000's)	%	S\$(000's)	%
Revenue						
Fare-box revenue	685,425	93%	667,344	96%	538,211	98%
Other revenue	53,449	7%	28,771	4%	10,104	2%
Total	738,874	100%	696,115	100%	548,315	100%
Expense						
Wages	735,151	62%	256,424	41%	267,008	47%
Depreciation	212,286	18%	154,221	25%	47,064	8%
Fuel/Power/Utilities	79,845	7%	49,383	8%	54,638	10%
Material/Service/Supplies	116,726	10%	63,299	10%	72,503	13%
Others	43,446	4%	105,108	17%	129,502	23%
Amortization / Special ¹	-195,844		-31,655		-47,257	
Total	991,610	100%	596,780	100%	523,458	100%
Net operating surplus	-252,736		99,335		24,857	

Note: ¹ - Payment received for assisting in commissioning North East Line

Sources: Annual Reports of TTC (2004), SMRT (2005), and SBST(2003)

The table shows that revenue from fare-box for the two operators in Singapore, combined far exceeds that of TTC's. This is a reflection of high transit ridership in Singapore, despite a low average fare/trip. On the cost side, the wages as a proportion of total operating expenses for TTC outweighs that of SMRT and SBST. While wages and salaries may in general be high in North American Cities, it may be due to these transit companies being run by the local government sector. Other sector costs such as fuel and power, maintenance, etc., are comparable between the three operators. It is ironical that despite wages making up less than 50 percent of total operating costs, Singapore adopted the driver-less system for their latest line; perhaps, that is something that TTC should consider.

For TTC, the high direct operating cost (approximately \$1.2 billion, if the amortization of capital contribution is discounted) is partly due to urban density. More compact development leads to shorter runs for transit services which will result in energy and other savings.

The fare level is probably another cause of this situation. As mentioned before, the fare level on public transport has to compensate for some of the disutility that commuters bear, in terms of walking and waiting time. But, transit companies usually end up increasing the fare to offset revenue loss and in that process making transit more unattractive.

CONCLUSION:

This paper compared the transit operations in the Toronto area with those in Singapore, with a view to identifying factors that determine financial viability of transit. The study was limited to exploring three factors, viz., urban density, auto ownership level, and industry structure.

It showed that urban density is an important factor in ensuring that the transit market is sufficiently large. Car ownership and high car operating costs are essential support mechanisms. But, more importantly the industry structure could play a vital role as well.

Presence of two multimodal operators in Singapore could have created a sense of competition between the two companies. Compared to that, public monopoly operators in Toronto may be hindering innovation that otherwise could have made transit service delivery more cost effective. On the other hand, the government and its agencies could also be instrumental in guaranteeing a healthy transit industry, through various policies and supports in place, as in the case of Singapore.