Hamilton
Public Works

Operating Costs Fact Sheet

February 2009

Rapid Transit
MOVING HAMILTON FORWARD

What are Operating and Maintenance Costs?

Modern light rail transit (LRT) vehicles, like all mechanized devices, have costs associated with their operation. These costs include the maintenance of the vehicle, tracks, stations and power infrastructure. They also include the costs to operate the vehicle, such as driver salaries and electric power supply. Many of these costs are similar to those incurred by other transit vehicles such as busses and heavy trains. Proper operating and maintenance is vital to ensuring a high level of reliability and to maximizing the operating life expectancy of the system. It also helps protect the city's investment by maintaining a positive image and high level of service.

Costing Issues

The majority of the capital costs for the proposed Hamilton Rapid Transit project will be funded by the province of Ontario's MoveOntario 2020 plan, administered by Metrolinx through the Regional Transportation Plan. Therefore, it is important to project realistic operating and maintenance costs for the system, since it represents the greatest on-going cost to the city. Some transit literature and research indicates that LRT systems are less expensive to operate then bus-based systems. Others have concluded that the opposite is true. It is important to be cautious as to how this comparison is made and what is being compared. For instance, basing the comparison on a per-vehicle factor, may bias the results because each LRT holds as many passengers as 2 - 4 busses (depending on the length of the train). Furthermore, one must ensure that the comparison is fair. As an example, if station maintenance is included in the LRT costs then it should also be included in the cost of BRT systems.

Examining Transit Data

One way to estimate operating and maintenance costs is to examine the data from other cities which operate both LRT and BRT. The United States National Transit Database (NTD) collects the capital, operating and maintenance costs for all transit operators in the country. Data for Portland, Oregon, Minneapolis, Minnesota, and other major North American cities which operate multiple modes of transit were analyzed (see table 1). The results were compiled as direct costs, cost per passenger mile traveled (PMT) and costs per unlinked passenger trip (UPT). Passenger Miles Traveled (PMT) is the cumulative sum of the distances traveled by each passenger; Unlinked Passenger Trips (UPT) is the total number of

passengers who board transit vehicles per mode. These measures allow a fair comparison to be made between different transit modes by making the data relative to the usage rate of each system.

Results

Table 1 illustrates that on average, the operating and maintenance costs for LRT systems throughout North America are significantly less than the costs to operate bus systems. The savings are as high as 60% (Houston, Texas); however, in some cases, bus costs were less than LRT costs (Pittsburgh). Results were not always similar between the PMT and UPT measures. For instance, in Pittsburgh, there was savings per passenger mile, but extra costs when the data was analyzed per unlinked passenger trip. In Pittsburgh, the low population may also have an effect, given the data, which indicates that populations of less than 300,000 may not efficiently support an LRT system due to low ridership.

Table 1: Operating and Maintenance Costs for Selected North American Cities by Passenger Miles Traveled and Unlinked Passenger Trips

City, State	Population	Per PMT		%Diff *	Per UPT		%Diff *
		BRT	LRT		BRT	LRT	
Denver, CO	588,349	$0.67	$0.34	**-49%**	$3.60	$2.17	**-40%**
Houston, TX	2,208,180	$0.55	$0.53	**-4%**	$3.18	$1.29	**-59%**
Minneapolis, MN	377,392	$0.72	$0.42	**-42%**	$3.20	$2.41	**-25%**
Pittsburgh, PA	311,218	$0.90	$1.23	**-37%**	$4.29	$6.00	40%
Portland, OR	550,396	$0.93	$0.39	**-58%**	$3.27	$2.04	**-38%**
San Diego, CA	1,266,731	$0.71	$0.27	**-62%**	$2.62	$1.59	**-39%**

*The % Difference indicates the difference between the LRT and BRT values. If the LRT value is less than the BRT value, then a negative percentage is shown.

Hamilton's population is similar to that of Portland's and Denver's, and therefore would be well suited for BRT or LRT. Also, many of the cities which demonstrated low LRT operating costs have complimentary planning policies that support transit oriented development. When comparing the operating costs for bus and LRT in the same corridor, it is clear that based on the NTD data, an LRT system could have reduced costs and lessened burden on taxes than a bus service. However, upon further analysis there may be reasons for this trend that clarify the outcomes, as demonstrated below.

Analysis

The evidence presented is inconclusive because the bus system, by its very nature, operates in corridors of low ridership to feed the major transit trunk lines. Bus Rapid Transit (BRT) and LRT systems are usually placed in areas with the highest potential for ridership. Since ridership is the variable which effects the cost per rider trip measure, costs measured per trip would favor LRT and BRT trunk lines. A better comparison would be to evaluate BRT and LRT in the same corridor. This cannot be done in practice, because a trunk line usually contains one mode or the other. However, one can do this theoretically by varying parameters and mathematically modeling a sample transit system.

Eric Bruun (2005) performed one such study published in the Transportation Research Record in 2005. His study estimated operating cost differences for BRT and LRT using a parametric cost model and National Transit Database (NTD) information. The study assumed train sizes of 28 m and bus sizes of 18 m. Marginal cost estimates were included to more accurately describe peak hour demand costs, when additional vehicles are required to meet demand. The study was completed for a medium sized city, based on Dallas Texas and using the data from all cities reporting in the NTD. It was also assumed that the cost to operate one light rail vehicle (LRV) per year is $1.4 million; the cost for one bus per year is $600 000; and the cost for one BRT is between $835,000 to $934,000 per vehicle per year, depending on the upgrades over a standard articulated vehicle the bus has. The assumed extra cost for BRT is a result of its train like operation such as dedicated right of way, possible variation in power supply from traditional busses, cost to maintain a fleet that differs from the standard and new emissions and drives technologies.

While it is clear that on a per-vehicle basis, LRT systems are the more expensive, the findings indicate that if the peak ridership demand of the system is 1556 passenger spaces (both seated and standing passengers) per hour or less, then BRT provides a better cost effectiveness than LRT. However, as peak demand (ridership) increases, the LRT system becomes significantly less costly to operate than a bus or BRT system (24% less expensive). BRT costs increase at a constant rate as ridership grows, since each bus needs an additional driver. However, LRT systems only increase in cost when a new driver is needed for an additional train, which is equivalent to 2 to 4 busses. LRT also becomes more attractive and less costly to operate than BRT, as service becomes more frequent and headways decrease, to provide increased capacity. Using the NTD data, as outlined in figure 1, the marginal cost increase for LRT is significantly less than busses or BRT. This gives LRT the advantage if off peak demand is expected to increase in the future, or if ridership is higher than projected.

This data analysis agrees with the previous findings that LRT is less expensive to operate in most cities because it operates in areas of high ridership potential and short headways. The converse is also true; installing LRT systems in areas of low ridership, larger headways and slow growth will make them very costly to operate. In order to determine if Hamilton would benefit from LRT or BRT, solely on the basis of

operating costs, this same parameterized analysis could be done for Hamilton specific information. We can also use this research in conjunction with research completed by IBI Group (see the Economic Impact Study – Appendix E) to develop general rules which can guide our decision making.

Other Research

Additional research conducted by the United States General Accounting Office (GAO) and the City of Houston, Texas, provide additional research comparing the cost of LRT and BRT. According to the GAO, results are mixed when comparing LRT and BRT operating costs. Results varied between cities which could possibly be attributed to the configuration of the transit network, urban planning strategies, types of vehicles used, the financial climate of the region and several other factors. While this evidence does not provide a definitive answer as to which technology is cheaper, it confirms that, depending on the system characteristics, operating and maintenance costs for LRT can be less costly than BRT and vice versa (GAO, 2001)

The Houston Evaluation for Build Alternatives: Major Investment Study/Environmental Assessment, Conducted by the Metropolitan Transit Authority of Harris County, Texas in 1999 found that the benefits of LRT over BRT were quite numerous, while the operating costs were similar (MTAHC, 1999).

Beyond Operating Costs

The examination of gross operating costs for transit vehicles looks at one aspect of a much larger and more intricate analysis. The net operating costs are of particular interest and depend on a variety of factors, including ridership. In addition to costing data, the projected economic spin-offs, increase in property values, and increase in transit oriented development all play a role in the success of the system and its costs over the entire life-cycle. When analyzing costing data or deciding between two alternatives, the overall benefits of the system will play a much larger role in decision making then a focus on operating costs, especially when these benefits offset the costs immensely.

This analysis focused on gross operating costs in order to examine one piece of the overall puzzle. It identified that at 1800 passenger spaces per hour the cost to operate BRT is higher than the cost of operating LRT. The specific number for Hamilton, in terms of passenger spaces per hour, differx from this value, as it is based on averaged data from a variety of American cities. The study conducted by IBI in appendix E of the Economic Impact Study (2009) puts this “crossover” value at closer to 2500 passenger-spaces per hour for Hamilton.

Overall, it is clear from the analysis that given the proper amount of transit oriented development and ridership numbers, LRT is a viable option as a form of rapid transit for the city of Hamilton.

Figure 1 - Costing Data from Eric Brunn's Mathematical Paramaterization Research (Bruun, 2005)

TABLE 6 Trunk Line Service Comparison with Peak Service Added for 6 h per Weekday

Service Condition	h (min.)	*N*	Line Capacity (spaces/hour)	Annual Cost (1000)	Cost per Space-km	If Added Off-Peak	Cost per Space-km
LRT							
Base service	15	5	744	$6,907	$0.038	N/A	N/A
Add 1st car to each consist	15	10	1488	$2,285	$0.054	$470.9	$0.011
Add 2nd car to each consist	15	15	2232	$2,285	$0.054	$470.9	$0.011
Add 3-car train to line	12.5	18	2678	$1,513	$0.059	$424.7	$0.017
Add 2nd train to line	10.7	21	3125	$1,513	$0.059	$424.7	$0.017
Add 3rd train to line	9.4	24	3561	$1,513	$0.059	$424.7	$0.017
BRT $Z = 1.2$							
Base service for equal budget	9.25	8	778	approx. $6,907	$0.037	N/A	N/A
Add to double capacity	4.6	16	1556	$2,524	$0.057	$1,257	$0.029
Add to triple capacity*	3.1	24	2334	$2,524	$0.057	$1,257	$0.029
Same capacity as LRT h = 12.5*	2.68	28	2687	$1,262	$0.057	$628.3	$0.029
BRT $Z = 1.4$							
Base for equal budget	10.6	7	679	approx. $6,907	$0.041	N/A	N/A
Add to double capacity	5.3	14	1358	$2,576	$0.067	$1,466	$0.038
Add to triple capacity*	3.5	21	2037	$2,576	$0.067	$1,466	$0.038
Same capacity as LRT h = 12.5*	2.68	28	2687	$2,576	$0.067	$1,466	$0.038
Tangential bus							
Unit cost for 18-h service	15	1	320	$593.5	$0.056	$593.5	$0.056
Base network costs							
LRT	15	20		$27,600			
BRT $Z = 1.2$	15	32		$27,600			
BRT $Z = 1.4$	15	28		$27,600			
Tangential bus	15	258		$153,100			

*Headway and revenue speed may not be maintainable.

References

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