URBAN TRANSIT IN CANADA
TAKING STOCK

PLEASE NOTE: the Transit Studies are distributed for discussion purposes only. The views and findings of these studies are the opinions of the consultants and do not necessarily represent the views of Transport Canada or any of the study steering committee members.

MRC

January 2002

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background

McCormick Rankin Corporation was retained by Transport Canada in July 2001 to undertake the study, "Urban Transit in Canada – Taking Stock". This is one of three background studies commissioned by Transport Canada to provide the federal government with a better understanding of today's transit industry, a vision of a robust and progressive transit future and the challenges of achieving it, and a framework to assess future transit investments. The two complimentary studies are "National Vision for Transit in Canada to 2020" undertaken by IBI Group and Richard Soberman and "Economic Study to Establish a Cost-Benefit Framework for the Evaluation of Various Types of Transit Investments" undertaken by HLB Decision Economics.

The purpose of this study is to describe and assess the current state of the Canadian transit industry, compare it with other places internationally, project the current industry into the future based on targets outlined in the National Vision study and identify the pressure points and resource gaps related to achieving this future vision.

Much of the historical and current information in this report has been obtained from the Canadian Urban Transit Association (CUTA). CUTA is a national organization whose membership represents all but a very few transit systems in Canada. Member's vehicles comprise 98% of the fleet in the country. The Association surveys its members annually and collects a wide variety of statistics about ridership, revenues and costs.

Current Situation

Key findings about the current contribution that public transit makes to urban travel in Canada include:

- Annual transit ridership in Canada has been increasing since 1998, reaching 1.5 billion in 2000, with service available to approximately 95% of urban residents and 61% of the 30 million residents of Canada.
- Transit usage (passenger trips per capita) has not kept pace with population growth over the years.
- On average, 10% of work trips in Canada are made on public transit. In some larger Canadian cities, 50% of work trips to downtown are made on transit but the growing suburban market is more difficult to serve effectively.
- Some of the more important factors that influence ridership levels are population density, quality of transit service, demographics, land use, congestion levels, and the cost of car ownership.
- Canadian cities provide the full complement of public transit modes, ranging from subways, bus rapid transit, light rail transit, heavy rail transit, to a variety of buses (from low floor articulated to small community buses).

- There are 14,335 active transit vehicles in operation in Canada, averaging 10.7 years of age (roughly 3 years more than desirable).
- Transit agencies are increasing their stock of fully accessible low floor buses.
- New technologies such as automatic vehicle location, automatic passenger counting and transit priority are used in up to half the transit systems.
- About $3.5 billion is expended annually to cover operating costs, about 63 percent of which is funded by fares. The remaining 37% is covered primarily by municipal funding.
- Direct operating costs per passenger have decreased from $1.31 in 1992 to $0.78 in 2000. Service (revenue hours per capita) has also been in decline.
- Between 1992 and 2000, the Canadian average revenue to cost ratio (total passenger fare revenue to total operating costs), steadily increased from 53% to 63%.
- Seventy percent of operating costs are labour-related. Public transit employs almost 40,000 people across Canada.
- Productivity (defined as revenue vehicle km/employees) has remained relatively stable since 1992.
- In Canada, there is substantial experience and practice of alternate service delivery, although this has been limited to private sector operating and maintenance contracts.
- Expenditures for transit capital projects reached almost $1 billion annually in 2000, double that of 1992.
- Provincial government contributions to capital funding of transit are in decline. To account for this, higher fares have covered a larger portion of expenses, and new funding sources such as regional gas taxes in British Columbia have very recently been introduced.

How Canada Compares

Compared with other cities and countries in the world, Canadian transit service and results are similar to Australia, higher than the United States and lower than in Europe. Some of the more interesting results of this review are:

- Boardings per capita (a measure of transit use) in Canada is, in general, slightly higher than Australia, much higher than in the US, but significantly lower than in Europe.
- Transit's mode share (percentage of travel by transit) in Canada, as with boardings per capita, are slightly higher than Australia, higher than the US and lower than Europe for the higher population cities. Smaller Canadian cities are closer in mode share to US cities with similar population densities.
- Large Canadian cities have a higher revenue to cost ratio (or putting it another way, recover more of the operating cost from fares) than most other cities in the comparison groups, including the European cities. As Canadian cities decrease in size, their revenue to cost performance decreases.

Looking Ahead

In order to examine the future of public transit in Canada, three scenarios were developed:

1. Declining Modal Share Scenario

   This scenario assumes that the transit industry will not grow or change as the population of Canada grows. Ridership, fleet size, revenues and costs will remain at today's levels, resulting in a continual decline in modal share.

2. Stable Modal Share Scenario

   This scenario projects the Canadian transit industry into the future by assuming that the transit industry will grow in the same proportion as the population of Canada. Overall ridership will grow at the same rate as the population, modal share will remain constant and average revenue and cost per passenger will not grow in real terms in this scenario. It is also assumed that the nature of Canadian cities in terms of density, land use characteristics and population distribution will not change, even as the cities grow.

3. Increasing Modal Share Scenario

   This scenario examines the indicators and targets in the report "National Vision for Urban Transit in Canada to 2020" prepared by IBI Group and Richard Soberman. This National Vision assumes that the transit industry will grow more quickly than the overall Canadian population, increasing the potential and benefits of an improved transit industry in Canada.

The results of the analysis of the three scenarios and their comparison to the current (1999) indicators are summarized in Exhibit ES.1

Exhibit ES.1

Comparison of Current and Future Transit Scenarios

Point of Comparison	Current (1999)	Declining Modal Share Scenario (2021)	Stable Modal Share Scenario (2021)	Increasing Modal Share Scenario (2021)
Annual Transit Ridership in Canada	1.4 billion	1.4 billion	1.7 billion	2.2 billion
Annual Rides per Capita	80 - 85	< 70	80 – 85	105 – 110
Transit Work Trip/Total Trips	10%	8.5%	10%	12%
Total Bus Fleet	11,548	11,548	13,396	18,477
Total Rail Fleet	2,444	2,444	2,835	3,910
Total Fleet Capital	N/A	$7.9 billion	$9.7 billion	$16.9 billion
Annual Fleet Capital	N/A	$395 million	$440 million	$766 million
Annual Total Service Hours	35.3 million	35.3 million	40.9 million	51.2 million
Operating Cost Per Hour	$77.12	$77.12	$77.12	$74.81
Total Annual Operating Costs	$2.92 billion	$2.92 billion	$3.39 billion	$4.11 billion
Average Fare	$1.23	$1.23	$1.23	$1.23
Total Passenger Revenue	$1.8 billion	$1.8 billion	$2.1 billion	$2.7 billion
Revenue to Cost Ratio	62%	62%	62%	66%

Notes: all costs in constant 1999 dollars.

In July 2001, the Canadian Urban Transit Association (CUTA) surveyed its members in order to determine their capital infrastructure needs over the next five years. Projects included in the survey may or may not have been subjected to an economic analysis. The overall results of the survey identify approximately $13.5 billion in equipment and infrastructure during the five-year period 2002-2006. About half of this total amount is for projects that are currently planned and budgeted, while the other half is for projects that would require new funding from other sources. Transit agencies anticipate having about 80% of the funding necessary for rehabilitation and replacement, but only 30% of the funding identified for expansion and ridership growth.

The transit capacity of the three future scenarios analysed in this report is generally consistent with the transit capacity that would result from the capital expenditures identified in the CUTA survey for 2002-2006. The following summaries of transit investments are therefore based upon the infrastructure survey results, which provides the only comprehensive data readily available to explore the specific needs of Canadian cities.

The Three Large Urban Areas

The three large urban areas in Canada, namely Montreal, Toronto and Vancouver, account for 73% (or $9.8 billion) of the $13.5 billion of transit infrastructure expenditures identified in the CUTA survey over the next five years.

These areas have already planned and budgeted for 87% of their overall system replacement and rehabilitation requirements. The largest gap between planned projects and those that would require new funding is in the area of facility (transit-only corridor) rehabilitation, where one third of the identified funding is not currently available.

For service expansion, the agencies in the three regions have already planned more than $2.2 billion worth of projects, about 65% of which are related to rolling stock and rapid transit rights-of-way. This represents only about 35% of the cost of the projects these transit providers have identified as being necessary to accommodate current and future ridership growth. This is a gap of almost $4 billion. Approximately 90% of this gap is for rolling stock and rapid transit rights-of-way.

Overall, the biggest transit infrastructure issue for the Montreal, Toronto and Vancouver regions is the desire to supply rapid transit rights-of-way totalling about $3.55 billion in projects that are currently beyond the capacity of the transit agencies to fund. Of the remaining $900 million funding gap, about $430 million is for rolling stock and almost $400 million is for advanced technology and fare system related projects.

The Mid to Large Sized Urban Areas

Of the approximately $13.5 billion in total transit infrastructure expenditures identified in the CUTA survey over the next five years, 24% or $3.3 billion were identified by the nine mid to large sized transit agencies in Canada, namely Calgary, Edmonton, Grand River (Kitchener/Waterloo/Cambridge area), Halifax, Ottawa, Gatineau (formerly Outaouais), Quebec City, Victoria and Winnipeg.

The situation for this group of urban areas is similar to that of the three large regions. Approximately three-quarters of the projects identified that require new funding are for rapid transit rights-of-way. Most of the remaining gap between planned projects and those that would require new funding is for rolling stock (more than $400 million).

A significant difference between this group and the three large urban regions is that only about one third of the projects identified have already been planned and budgeted, compared with more than half of the projects in the larger regions. While there is no absolute data available to explain this difference it is likely a result of two factors:

- Two of the three large urban regions (Montreal and Vancouver) have access to alternative funding sources providing them with a significantly more stable funding environment.
- Only three of the nine mid to large sized urban areas have extensive, high quality rapid transit facilities. The remaining six areas view some form of rapid transit in the future as the only way of achieving their local visions. However, they are not in a position to fund a major program. This compares with the large urban areas where the projects are largely additions to the existing system rather than completely new endeavours.

The Small to Medium Sized Urban Areas

Only two percent of the $13.5 billion of transit infrastructure investments identified in the CUTA survey are for projects in small to medium sized urban areas. This is because the needs of these systems are different than those of the larger urban areas. This group of transit systems does not have or seek rapid transit rights-of-way. Their needs are primarily for vehicles.

Of the $330 million in investments identified in the survey for this group, $267 million is for bus purchases. Approximately three-quarters of the bus expenditures identified have already been planned and budgeted. The fact that this gap exists for replacement and rehabilitation expenditures indicates that these communities are having difficulty keeping up with their existing needs. While some of them are able to accommodate expansion of service, the gap in this area indicates that the agencies have a desire to do more if new sources of funding become available.

Pressure Points

The information and analysis presented in this study illustrates a number of challenges that would be faced in achieving the National Vision for transit in Canada.

Pressure Point #1 – Demand Management

The National Vision calls for a 50% increase in transit over the next 20 years, with demand for transit growing faster than the Canadian population (forecast to increase by 16% over this period). This would represent a tremendous challenge for all concerned.
To even make the attempt would require a systematic assessment of the factors that influence transit demand and a concerted effort to improve and adjust practices and policies related to these factors. For example:

- Policies that recognize and support transit’s integral role in creating a sustainable transportation system would be needed at all levels of government;
- Transit priority measures (tools to improve the mobility and “on-time” performance of transit vehicles through congested urban streets) would need to be the standard rather than the exception;

- Policies that allow flexibility of zoning requirements with respect to parking and development intensity adjacent to transit facilities would need to be established by urban municipalities;
- Policies that facilitate increased urban density would need to be researched, developed and implemented;
- Policies to integrate transit efficiency and service considerations into land use decisions would be needed at the municipal level;
- Improvements would be needed to transit service availability and reliability to a level as yet not obtained in Canada;
- Rapid Transit infrastructure development would be needed to ensure that transit could be competitive, particularly in a congested traffic environment;
- Policies that provide for increased charges for car use such as road tolls, complementary congestion charges, license surcharges and parking surcharges would be needed.

Pressure Point #2 – Access to Capital for Infrastructure Investments

Canadian transit agencies currently spend approximately $1 billion annually on capital projects, 25% of which relies on debt financing. With their municipal partners, capital spending grows to more than $1.3 billion annually. Lack of access to capital funding would constrain the ability of transit properties to support the desired growth in demand. Extrapolating from the list of projects that municipalities across Canada identified in the CUTA survey, new capital expenditures of almost $1.4 billion annually would be required.

Two basic types of programs to address the gap would be needed:

- Large-scale infrastructure programs geared to the needs of the large transit agencies and residents of the urban areas they serve. Over 70% of capital funding would likely be for rapid transit projects in the three largest urban regions and the nine mid-to-large sized transit systems
- Programs to assist with vehicle purchase and small infrastructure projects for all transit agencies.

Pressure Point #3– Access to Operating Funding

If all of the projects put forward by municipalities in the CUTA survey were implemented (a rough proxy for the transit capacity which would be needed under the National Vision), annual operating expenditures by the transit industry would increase by 40% to $4.11 billion (from $2.92 billion today). This amount assumes a decline in per hour operating costs of the industry, as it takes advantage of new technologies and economies of scale. However, it is unlikely, under the present taxing powers, that revenues for municipalities (the main agencies that pay for net operating costs) will grow at this rate given the expected 16% increase in the Canadian population. Thus, approximately half of the funding for the increase in operating costs would not likely be accounted for without a new source of funding being available.

Fare revenue from transit users in the National Vision scenario is assumed to grow from an annual amount of $1.8 billion today to $2.7 billion in the future. The difference between this future revenue and the future total annual operating costs of $4.11 billion is $1.41 billion (compared with a gap of $1.1 billion today). Thus, the potential gap in operating cost funding under the National Vision, would be approximately $300 million annually. This operating funding gap essentially reflects the additional funds that would be required to pay for the extra peak period service necessary to allow transit to compete effectively with the automobile. It would apply mainly to the larger transit systems, as their peak hour services are operating at capacity now.

Pressure Point #4 – Fleet Availability and Durability

When considering fleet expansion to support the substantial increase in transit demand envisioned, it is important to consider the capacity of the transit manufacturing industry. The three Canadian transit bus manufacturers have all experienced significant change over the past several years and have products that can generally meet the requirements of the transit systems. However, they are structured to serve the current Canadian market as well as compete in the U.S. market and they would face a challenge to quickly increase their manufacturing capacity to meet an ongoing expanded market. To address this, they would have to invest and grow based on the future vision, and/or other manufacturers from the U.S. or elsewhere would have to become active in the Canadian market.

The U.S. transit bus market is much larger than Canada. Because the Canadian bus manufacturers compete in both markets, they naturally design their products to meet the needs of the largest market. Since U.S. transit systems typically replace their bus fleet after twelve years of life, the vehicles accommodate this and do not always meet the needs of Canadian agencies that traditionally keep their buses longer. Ensuring that buses purchased in Canada can meet the unique requirements of the Canadian environment for the desired time frame is a key issue.

The availability of long-term sustained and guaranteed funding support for transit agencies would provide the agencies with the ability to plan and commit to vehicle purchases in a stable and predictable environment. This would in turn, allow the equipment manufacturers to invest in their production capability to meet the needs of an expanded market.

1.0 INTRODUCTION

1.1 Background

The public transit industry in Canada is at a crossroads. Overall ridership in Canada has been growing steadily in the past few years following a period of some decline and no growth. This renewal has been largely a result of a combination of a good economy in most urban centres, changing demographics in Canadian society, growing urban populations and local commitments to improved service.

With this growth, urban municipalities are having difficulty keeping up with the demand for transit. Operating costs are becoming more difficult to fund and infrastructure, equipment and fuel costs are rising. At the same time, many Provinces have reduced their commitment to transit funding. While Vancouver, Edmonton, Calgary and Montreal have obtained new revenue sources through innovative provincial initiatives, most municipalities continue to struggle with limited resources to accommodate expanding transit demand.

Where urban transit was once viewed as a local matter with limited impacts beyond the immediate municipality, there is a growing recognition in Canadian society that improving and expanding public transit is a key element in moving towards a more sustainable transportation system. Citizens and agencies across Canada are discovering that urban transportation without extensive transit is not a desirable future. Public transit is also recognized as an important component in reducing greenhouse gases and meeting Canada's environmental commitments.

Canada's escalating urbanization, and increasing international attention to global warming and sustainable living have raised the Federal Government's interest in becoming involved with urban transit. This commitment comes at a time when provincial funding of the transit industry has decreased to levels that, in many provinces, are not considered sustainable. Recently, federal support for urban transit has been highlighted in the Speech From the Throne, recommendations by the Federation of Canadian Municipalities, the National Climate Change Program, as well as the Federal Budget, which has benchmarked significant funds towards programs for which urban transit qualifies.

To better understand the issues, there is a need to establish what the current characteristics and issues of the transit industry are and what the future requirements of a strong and vibrant transit system would be. To do this, three studies have been commissioned by Transport Canada:

- The "National Vision for Urban Transit to 2020" develops an overall vision or direction for transit in Canada and provides a basis for selecting areas of involvement and actions most appropriate for the federal government;

- "Urban Transit in Canada – Taking Stock", this report, assesses the current state of the Canadian transit industry and looks at the challenges that need to be faced to achieve the national vision;

- An economic study to establish "A Cost-Benefit Framework for the Evaluation of Various Types of Transit Investments".

Together, these three studies will give the federal government a better understanding of today's transit industry, a vision of a robust and progressive transit future and the challenges of achieving it, and a framework to assess future transit investments.

1.2 Objectives

Transport Canada has commissioned McCormick Rankin Corporation to conduct this study to:

- Establish the current status of the transit industry in Canada;
- Determine the current characteristics and needs of the industry;
- Identify the pressure points facing Canadian transit agencies; and
- Forecast the future requirements of a strong and vibrant transit system.

1.3 Purpose

The specific purposes of this project are to:

- Describe the current supply and demand for transit in Canada and to identify any pressure points in the system both nationally and regionally and in major urban settings; and
- Identify where the major pressure points will be over the next 10 to 20 years that need to be addressed in order to fulfill the objective of an improved and sustainable public transit system.

To address these points, this report is structured in three major information and discussion chapters, followed by two summarizing and concluding chapters. Following the Executive Summary and the Introduction in Chapter one, Chapter two presents a comprehensive review of today's Canadian transit industry. This includes an examination of the level of demand being experienced by transit, an assessment of the level of supply and service being offered to meet the demand and a review of the financial elements and performance of the industry.

Chapter three compares some key factors that describe the Canadian transit industry with examples from other countries and cities. This is necessary in order to understand Canadian transit's successes and challenges within the current policy framework and how other counties have addressed many of the same issues.

Chapter four builds on information provided in the National Vision Report. The key indicators for the future are discussed and applied to three future transit scenarios for Canada. These are compared with the results of a recent transit infrastructure needs survey, including a discussion of the needs of various types of Canadian cities.

The first of the two concluding chapters, Chapter five, looks at the pressure points that exist between the current industry and the future scenarios developed in Chapter four. Finally, Chapter six concludes the study by summarizing the information presented and recommending future action.

1.4 Primary Data Sources

Several sources were utilized in preparing this document, for which a complete list can be found in the bibliography. The numerical information supplied in Chapter two is obtained from several Canadian sources including Statistics Canada, and primarily the Canadian Urban Transit Association (CUTA). CUTA undertakes a rigorous annual survey of their member transit agencies and compiles the information annually in their Canadian Transit Fact Book. The Fact Book provides information on over 70 individual transit agencies across Canada, as well as compiles the information into provincial and national public transit statistics. The Fact Book was an indispensable resource in this project, as were the CUTA staff that answered questions and provided insight into the numbers on many occasions.

The international data presented in Chapter three was sourced from the Millennium Cities Database compiled by J. Kenworthy and F. Laube, for the International Association of Public Transport (UITP), and the Institute for Sustainability (ISTP). Also indispensable to the completion of this project, the Millennium Database presents a multitude of statistics for public transit, transportation, and city characteristics for cities around the world, allowing this project to explore the international perspective, and compare Canadian cities to cities in other parts of the world.

It is prudent to recognize that, despite the comprehensiveness, and expansiveness of the source data, there are limitations to how this project is able to use it. First and foremost is that the information provided by the CUTA Fact Book and the Millennium Database is not comparable. The information provided by the CUTA Fact Book describes year 2000 conditions, while the Millennium Database documents 1995 conditions. Not to mention, the two often have different sources and different compilation criteria. For example, the Millennium Database uses "total urban population" when calculating per capita rates, while the CUTA Fact Book uses quite correctly, "service population", (meaning only the urban population defined as being serviced by public transit). This incompatibility is the reason why this study has not compared data between the two sources.

Other limitations exist within the data sources, mostly resulting from the fact that different transit agencies collect and report information in different ways, which will result in a statistic based upon slightly different criteria. Case specific limitations are discussed within the text of the report, where it is applicable. All this being said, the data is effective and useful in achieving the ends of this study, which is to provide an overview of the current transit situation in Canada, and outline how Canada compares within the international spectrum.

2.0 THE CURRENT TRANSIT SITUATION IN CANADA

This chapter reviews and describes the state of the transit industry in Canada today. This is done by assessing information about the current demand for transit, the supply of transit service and the cost structure of the industry. The following sections provide information and discussion on these three main areas of interest.

Many of the sections use data collected by the Canadian Urban Transit Association (CUTA) in their annual survey of member transit systems. Analysis for Canada as a whole covers a time series of nine years ending in 2000. The data for the year 2000 is broken down by province/territory and by population group. There are four CUTA population groups: less than 50,000 people, 50,000 to 150,000 people, 150,000 to 400,000 people and over 400,000 people.

2.1 The Current Demand for Transit in Canada

The mobility needs of the people that live in urban Canada create a demand for transit service. This section reviews the current annual transit usage in Canada, the portion of the population of Canada served by transit, the per capita use of transit services, transit modal share and the factors that influence transit usage.

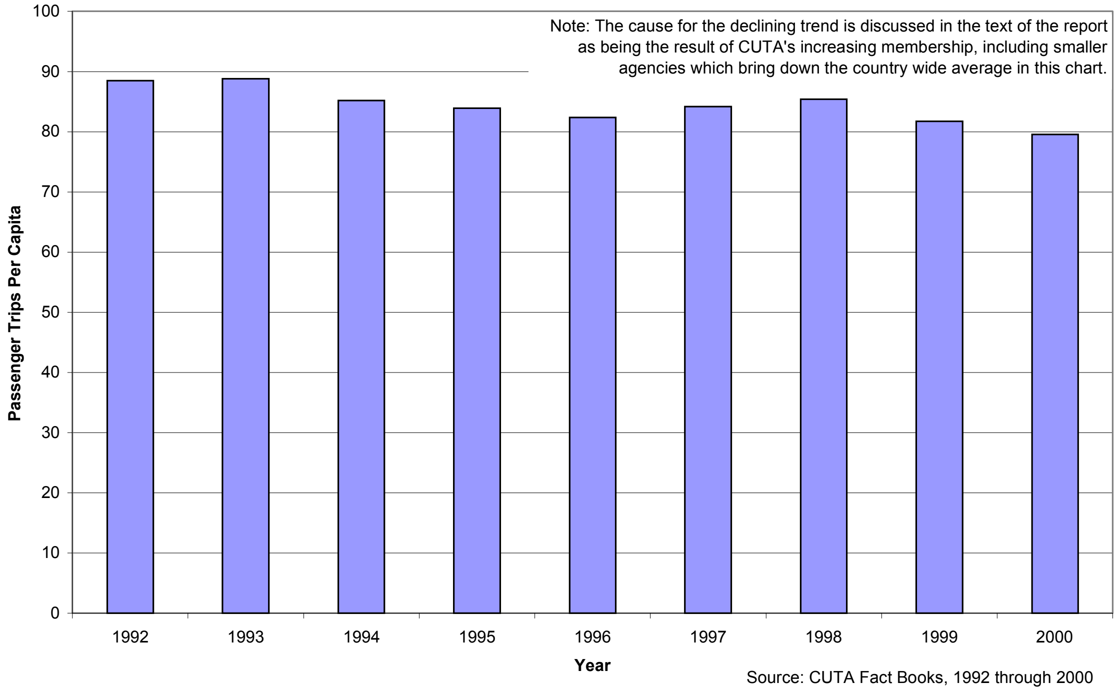
2.1.1 Transit Ridership in Canada

Urban transit ridership in Canada reached almost 1.5 billion passenger trips in 2000, supplying service to 18 million of Canada's 19 million urban residents that year. Roughly translated, transit service was available to 95% of urban residents and 61% of the 30 million residents of Canada in 2000.

Historically, transit ridership has fluctuated with the prevailing trends of Canadian society, particularly demographics and economics. Overall ridership grew from the mid 1970's and peaked in the late 1980's. Ridership declined somewhat until 1998 and in the past two years has begun to increase again. Overall, transit usage has not kept pace with population growth over the years. Details of these general trends are provided in Chapter 12 of the Canada Transportation Act Review Panel Report.

As shown in Exhibit 2.1, in the past nine years, annual transit ridership per capita has ranged from 88 in 1992/1993 to 80 in 2000. This overall decline is consistent with the decline in ridership through most of the 1990's while population grew. Note that CUTA calculates per capita data based on the population served by transit rather than total population.

Exhibit 2.1 Transit Ridership in Canada

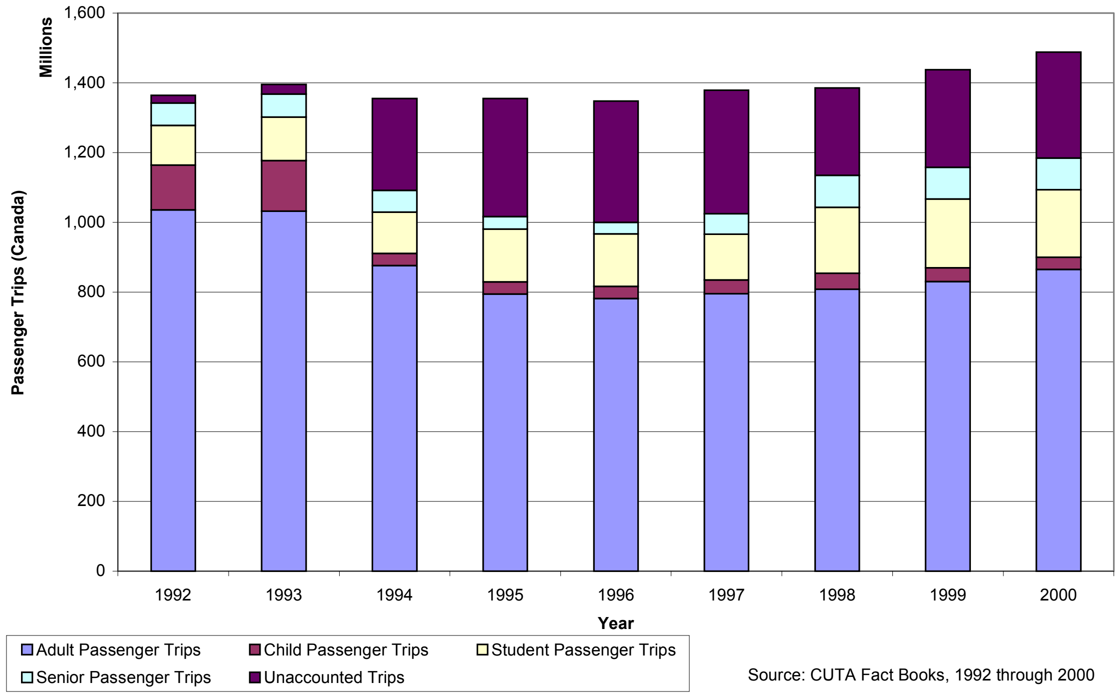


Source: CUTA Fact Books, 1992 through 2000

Passenger trips over the past nine years are shown in Exhibit 2.2. Although the trend in this Exhibit shows an increase in ridership from 1996 onwards, the numbers are still somewhat lower than those at the beginning of the series in 1992 and 1993.

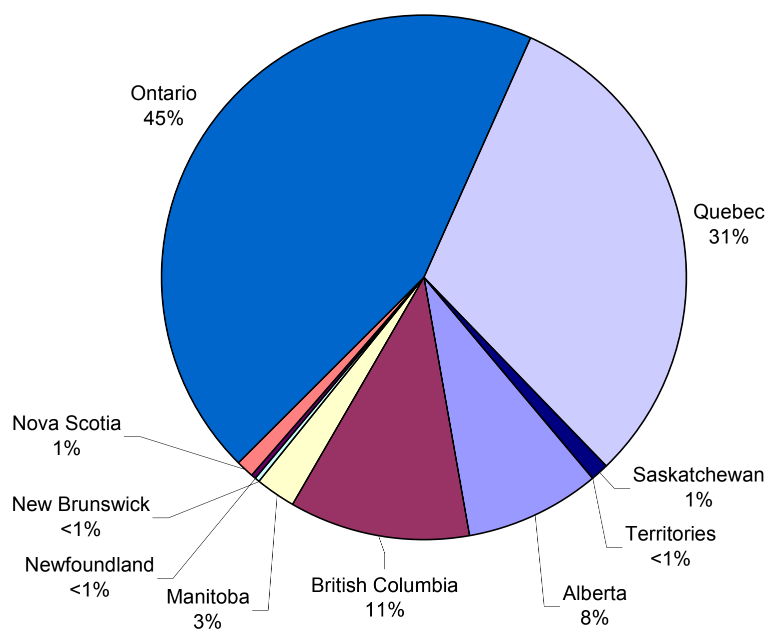
Of the trips shown in Exhibit 2.2, 76% were made by adults, 13% by students and 5% by seniors and children. The data appears to show an increase in the proportion of students and seniors riding transit. This is likely the case, as the increase matches demographic trends. However, it should be cautioned that some of the increases are likely due to marketing or service schemes initiated by some service providers to delineate students and/or seniors from the regular adult fare schedule. Thus, although more students may not be riding transit, more are taking advantage of reduced fare programs, which would differentiate them in ways that were not available in the past. In essence this means that students that rode transit previously are now being recognized within the system as students, thus the increase shown in the data may be larger than the actual increase in student ridership. In general, the passenger breakdown proportions are an estimate, with most providers estimating the proportions by randomly sampling the riders on any given bus on any given day. More concise estimation methods are dependent on the introduction of new technology.

Exhibit 2.2 Transit Patronage in Canada - Total of Passenger Type Breakdown



Source: CUTA Fact Books, 1992 through 2000

Exhibit 2.3 2000 Trips by Province



Source: CUTA Fact Book, 2000

Not surprisingly, Exhibit 2.3 shows that Ontario and Quebec make up the greatest proportion of transit passenger trips in Canada, servicing over 650 and 460 million passenger trips respectively, in 2000. The remaining Canadian provinces all serviced less than 200 million passenger trips each. Exhibit 2.4 shows the ridership in 2000 for some of the largest Canadian urban areas (note that these are the overall urban areas that, in some cases, include multiple transit systems serving multiple jurisdictions).

Exhibit 2.4

Year 2000 Transit Ridership in Canadian Urban Areas

Urban Area	Transit Service Population	Total Ridership (Millions)	Per Capita Ridership
Calgary	860,749	73.5	85
Edmonton	658,000	43.0	65
Grand River [1]	372,000	9.9	27
Halifax	300,000	13.4	45
Montreal [2]	2,480,625	406.6	164
Ottawa/Gatineau [3]	932,147	93.2	100
Quebec City	494,082	37.4	76
Toronto [4]	4,933,921	519.8	105
Vancouver	1,878,545	129.1	69
Victoria	333,953	19.3	58
Winnipeg	621,900	38.9	63

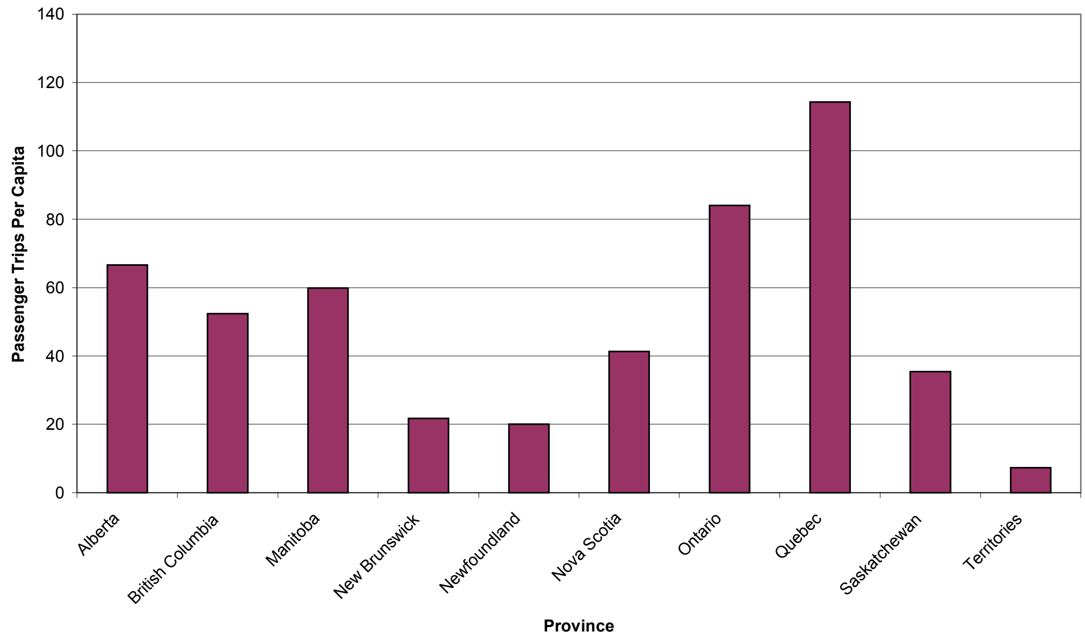
Source: CUTA Fact Book, 2000 – Individual System Pages

Note 1. Grand River includes Kitchener, Waterloo and Cambridge served by one transit provider.
Note 2. Montreal includes information from 4 transit providers: AMT, Laval, Montreal and Montreal R.S. Per capita ridership in these systems ranges from 50 to 196.
Note 3. Ottawa/Gatineau includes information from 2 transit providers: OC Transpo in Ottawa and STO in Gatineau. Per capita ridership in these systems ranges from 55 to 115
Note 4. Toronto includes information from 15 transit providers: Ajax, Pickering, Whitby, Brampton, Burlington, GO Transit, Hamilton, Mississauga, Oakville, Oshawa, Toronto, Markham, Newmarket, Richmond Hill, and Vaughan. Per capita ridership in these systems ranges from a low of 6 to a high of 172.

Upon examination of the trips per capita statistics, it is again apparent that Quebec and Ontario are the leaders in Canadian transit ridership. Exhibit 2.5 illustrates a few interesting trends:

- Quebec has higher trips per capita than Ontario although Ontario services more passengers. One factor that may be contributing to this outcome is the result of the low cost of monthly passes in Montreal relative to Toronto.
- British Columbia does not conform to the general trend in the relationship between population and trips per capita, whereby the more populated cities have a higher trips per capita average (as is the trend in Exhibit 2.6).

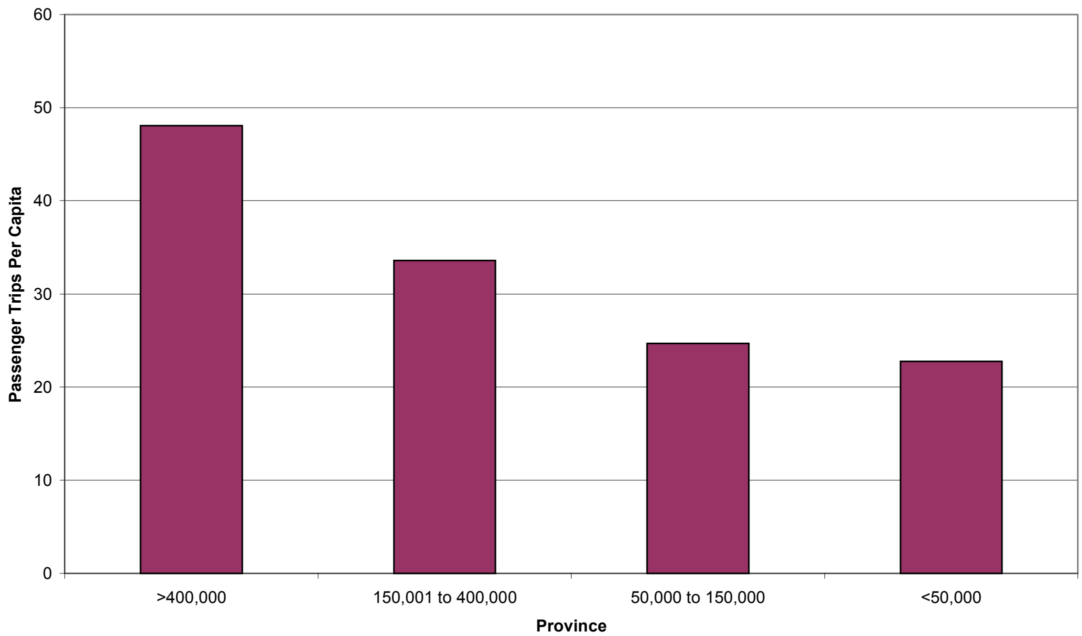
Exhibit 2.5 2000 Trips per Capita by Province



Source: CUTA Fact Book, 2000

As a supplement to the material presented in Exhibit 2.4, Exhibit 2.6 clearly indicates that larger cities support larger ridership levels per capita in Canada, although there are ranges of ridership in each population group. For the largest city group (greater than 400,000) ridership per capita ranges from 40 in Mississauga to 193 in Montreal. The second group (150,001 to 400,000 population) ranges between Vaughn, Ontario at 13 passenger trips per capita to Montreal South Shore at 80 passengers per capita. Population group 3 (50,000 to 150,000) passenger trips per capita ranges between 6 in Richmond Hill, Ontario to 52 in Sherbrooke, Quebec. In the smallest population group (less than 50,000) the transit service in Corner Brook Newfoundland services 4 passenger trips per capita, while North Bay services 47.

Exhibit 2.6 2000 Trips Per Capita - Population Group



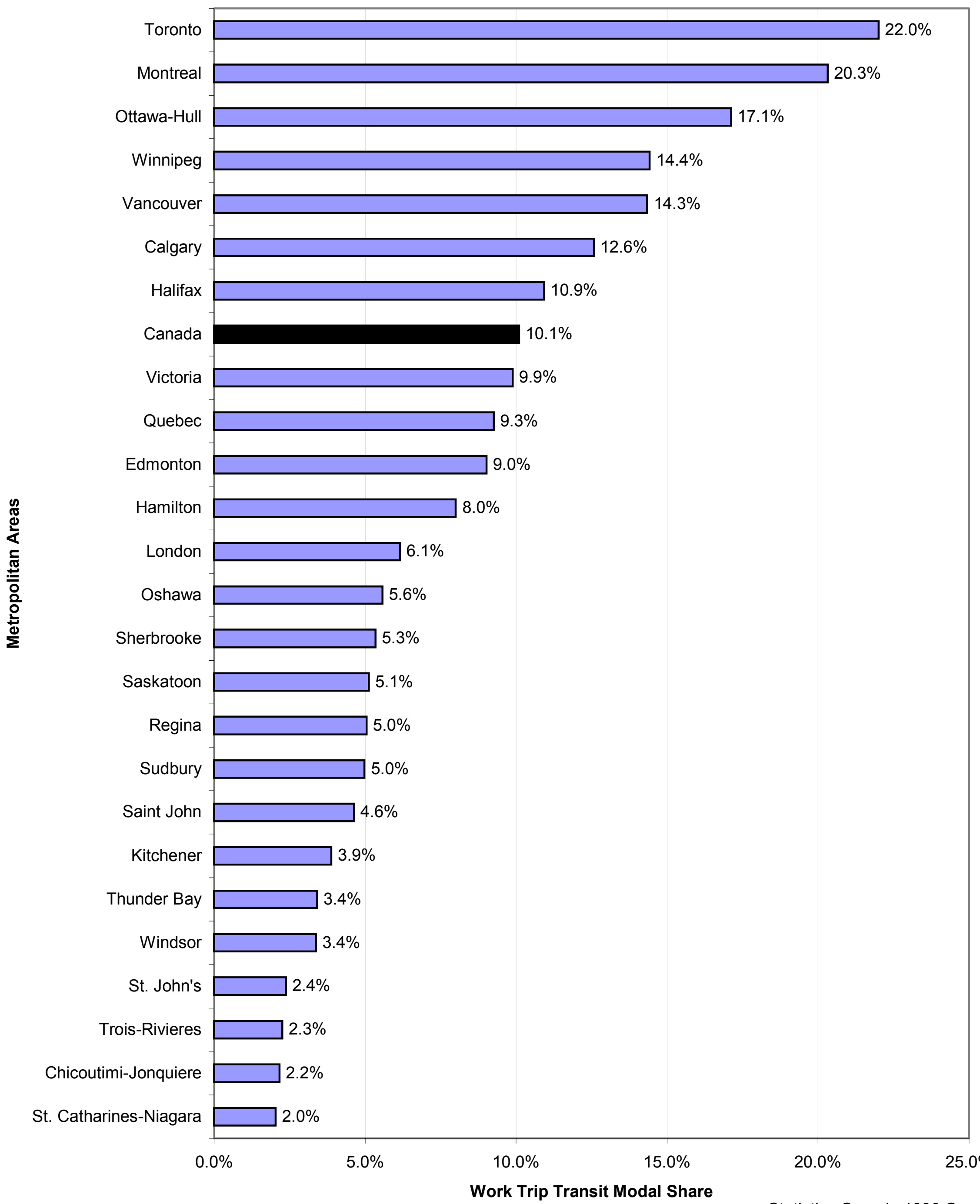
Source: CUTA Fact Book, 2000

2.1.2 Transit Modal Share in Canada

The 1996 transit modal share for work trips in major urban centres across Canada is shown in Exhibit 2.7. This information, collected as part of the long form of the Canadian Census every five years, indicates a range of transit modal share over a 24-hour period of between 22% in Toronto and 2% in St. Catharines. In Canada, on average in a 24-hour period, 80.7% of work trips are made by car, truck or van (including passengers), 10% by public transit, 7% by walking and 2.2% by other means. Higher proportions of females walk or take public transit to work than their male counterparts. Although data was not collected for the peak hour period, surveys done in large cities show a much higher proportion of work trips by transit in this critical time period.

It is worthy to note that daily transit mode share of downtown work trips is significantly higher for most of the larger urban centres. For instance, in Toronto, approximately 42 percent of the people working downtown took transit in 1998. In Ottawa, approximately 50% percent of downtown employees take transit. In Calgary, 51% of downtown work trips from the City's northeast community take transit, which is likely due to the a combination of convenient light rail access, the economics of the community, and roadway congestion from the northeast into the downtown core. The lowest transit modal shares in Calgary for downtown work trips occur in communities where a large proportion of people walk, for instance the downtown core, where 71 percent of downtown employees walk, and the central community where 30 percent walk. Overall, Calgary Transit accommodates 37 percent of all downtown work trips in a given day (information provided by Calgary Transit).

Exhibit 2.7 Public Transit Mode Share for Work Trips



source: Statistics Canada 1996 Census

Exhibit 2.7 also shows that in general, transit modal share increases in accordance with city size. This predictable trend is likely a factor of several obvious influences such as higher levels of congestion in larger urban centres, higher population densities, as well as the ability for larger cities to provide a more comprehensive range of transit services to its residents. Exceptions to this trend such as Vancouver, Calgary, Halifax and Edmonton, are likely influenced by factors such as relatively low urban density, and the affluence of the population. Influences on transit modal share are discussed in Section 2.1.3.

2.1.3 Factors That Influence Transit Demand

Transit demand is a multidimensional function encompassing areas of urban form (land use distribution) and transit service, as well as facets of demographics, economics and culture. Factors can be influenced in a positive or negative way, in the sense that a positive influence would be outstanding service standards, while a negative influence would be excessive traffic congestion.

In this section, the factors that influence transit demand will be delineated into the categories of those that directly influence transit ridership, and those that indirectly influence transit ridership. Urban form, the economics of personal car use, and similar points are factors that indirectly influence transit ridership since they are not likely to be directly controlled by a transit agency, but more by culture, history, and politics. Factors that directly influence transit ridership are related to service standards, and new community planning. Exhibit 2.8 summarizes the factors that influence and encourage transit usage. Discussion of these factors can be found in the "Millennium Cities Database for Sustainable Mobility, Analyses and Recommendations", published by UITP (International Association of Public Transport) and ISTP (Institute for Sustainability and Technology Policy); and "Making Transit Work, Special Report 257" published by the Transportation Research Board.

Exhibit 2.8

Factors that Influence and Encourage Transit Usage

Direct Influencing Factor	Indirect Influencing Factor
Availability of transit	Population density
Variety of transit modes	City size
Price of transit service (fares)	Journey to work distance
Quality/Reliability of transit service	Travel time to work (level of congestion)
Convenience/Density of transit service	Cost of car ownership
	Marginal cost of car ownership
	City demographics

Priority ranking the influencing factors in order of which have the most impact on ridership levels is a heavily debated topic. It is generally agreed upon that population density and ridership levels are the most closely correlated. The remaining have varying degrees of influence depending upon how much of a factor the other influencing factors present. In other words, they are all inter-related, including population density.

Population density facilitates transit usage in several ways and is one of the greatest influences on transit ridership. Population density allows for economic viability of transit service, in that the more people who use it regularly, the better the service standards can be provided in a cost effective manner. Density also is conducive to roadway congestion, which makes transit more attractive from a time perspective to the rider or potential rider. Density also means that land costs will be higher, thus, owning a car, and storing it is more expensive than in less dense neighbourhoods, which provides a direct economic incentive to the traveler, which favours transit. When considering density as an influencing factor, it must be considered that good transit service is an influencing factor on population density. Across Canada, dense urban development has occurred in areas surrounding transit nodes, whether it is Skytrain stations in Burnaby, or Transitway stations in Ottawa.

City size influences transit ridership, especially in Canada, for the simple reason that the larger Canadian cities are more likely to have a higher population density than the smaller. Transit agencies require a "critical mass" of potential customers such that service can be provided in an economically feasible manner, and this critical mass is unlikely to be found in smaller communities.

City demographics such as population age, gender, family income are all influencing factors on transit ridership, since they define the portion of the population that fall into the category of "captive market". For instance, people who are too young or too old to legally drive a car or have a low income, rely on public transit for their means of transportation. And, although this is changing, younger adults and women have in the past been less likely to be able to afford a car, and as such were more likely to be "captive" to public transit as well.

Number of vehicles per household, the cost of car ownership, and the marginal cost of car ownership all influence transit ridership in that they help to define the potential market.

Distribution of land use relates to the dispersion of major trip generators, such as business districts, colleges or universities. The more cohesive these generators are, the easier it is to provide transit service (in the same way that population density improves the feasibility of transit). Simply put, transit works when there is a need to move a lot of people between two major trip generators, and the various locations in between. It is not feasible to provide transit to all small trip generators.

From an individual rider perspective, the decision between driving and taking transit (for the "non-captive market"), is strongly influenced by the difference in time it will take to drive to a destination versus taking transit. Transit is much more competitive for shorter distances because the difference in time between driving and taking the bus is less significant. This also relates back to density and traffic congestion.

The remaining categories all relate to the level and quality of transit service that is provided to the customer. Since the economics of car ownership in Canada are essentially achievable at all levels, resulting in a small captive market, the choice to take transit for the average Canadian is strongly influenced by the reliability, convenience and comfort of the ride. It is also a widely held belief that riders are significantly influenced by the transit modes available to them. The non-captive market is much more amenable to using public transit if the transit vehicle is operating in a rapid transit or other high priority mode. Examples include Toronto, Montreal, Ottawa, Vancouver and Calgary.

2.2 The Current Supply of Transit in Canada

This section reviews and discusses how the demand for transit described in the previous section is satisfied. What types of transit service are provided in Canada today, how much service is offered, what type of equipment is used, how service is provided and some information about the labour force that provides the service, are all described.

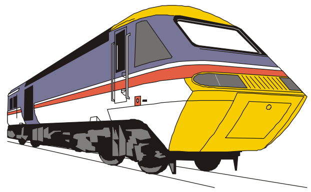
2.2.1 Types of Transit Service in Canada

The easiest way to classify and describe transit service in Canada is to consider services in a hierarchical framework based on the capacity they provide. Figure 2.9 outlines this hierarchy.

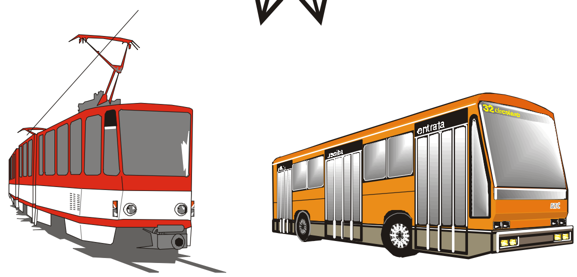
High capacity mass transit services can achieve capacities of 50,000 passengers per hour. Examples include the subways in Toronto and Montreal, Commuter rail services offered by GO Transit, AMT and West Coast Express in Toronto, Montreal and Vancouver respectively. Generally the definition of these services considers long multi-unit vehicles, each offering a high capacity, and in the case of the subways, a high frequency of service. The two Canadian subways have passenger volumes of approximately 30,000 people in the peak hour, peak direction.

Light rapid transit (LRT) and bus rapid transit (BRT) services refer to facilities that would typically be able to carry from 3,000 up to 15,000 passengers per hour, usually on separate lanes or rights-of-way. LRT services are typically rail services and are as varied as the systems in Edmonton and Calgary, the Ottawa O-Train and the Spadina median streetcar in Toronto, while BRT can describe exclusive busways such as the Ottawa Transitway or on-street bus lanes such as the Vancouver B-Line and the Pie IX contra-flow lane in Montreal. In general, LRT and BRT systems do not provide the same capacity as the heavy rail transit services described above, but can offer the same and higher range of frequencies. Ridership examples include the Scarborough RT with up to 4,000 passengers per hour in the peak direction, and the Ottawa Transitway and Calgary C-Train with volumes approaching 10,000 passengers per hour.

Exhibit 2.9
Hierarchy of Transit Services

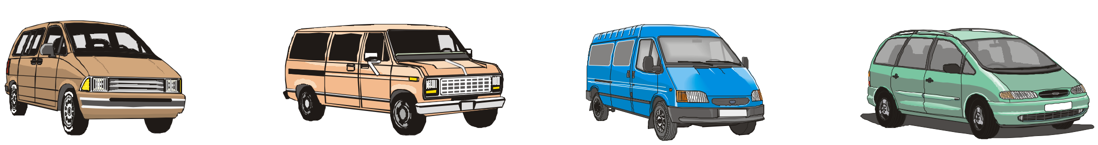


High Capacity Mass Transit (~ 30,000 passengers/hour)



LRT and BRT (3,000 to 15,000 passengers/hour)

Conventional Mixed Traffic Transit (50 to 1,500 passengers/hour)



Low Capacity Transit

As with all classification systems, there is some overlap. Services such as the Calgary and Edmonton LRT, the Vancouver Skytrain and the Scarborough RT have some of the elements of both classifications. The important point is that all of these services provide a rapid transit service of a quality and frequency that is a step above conventional on-street bus transit services and they demonstrate the wide range of options available for implementing rapid transit.

Conventional on-street transit is provided by a variety of buses. These buses can range from high capacity articulated (Ottawa and Mississauga) and double decker buses (Victoria) to minibuses operating on a conventional low volume route (Calgary). The key element of this classification is that the service operates in mixed traffic on a scheduled bus route. The streets operated on can include major suburban arterials, downtown roads, and residential collector streets. Capacities offered can range from less than 50 passengers per hour to more than 1,500.

Low capacity services describe a range of transit options that include Paratransit, demand responsive routes and flexible community bus services. These are different from conventional bus services because they offer more personalized, on demand service with a much higher degree of flexibility. They usually use small buses but can sometimes operate with large conventional cars. It is usually more difficult to assess capacity because of the flexibility of the routes.

Alternate Service Delivery

In the context of urban transit, alternate service delivery (ASD) refers to the provision of transit services by resources other than the traditional public sector.

In Canada, there is substantial experience and practice of ASD. Private sector operating and/or maintenance contracts are in place in a number of transit agencies including:

- Grande Prairie, Alberta;
- St. Albert, Alberta;
- Strathcona County, Alberta;
- Fort McMurray, Alberta;
- Yellowknife, NWT;
- Churchill, Manitoba;
- Barrie, Ontario;
- Chatham, Ontario;
- GO Transit, Ontario;
- York Region, Ontario;
- Kenora, Ontario;
- Orillia, Ontario;
- Orangeville, Ontario;
- Owen Sound, Ontario;

- Woodstock, Ontario;
- AMT (Montreal), Quebec;
- Drummondville, Quebec;
- St. Hyacinthe, Quebec;
- Victoriaville, Quebec;
- Corner Brook, Newfoundland & Labrador;
- BC Transit Municipal Systems, including Central Fraser Valley, Campbell River, Chilliwack, Comox Valley, Cowichan Valley, Cranbrook, Dawson Creek, Fort St. John, Kamloops, Kelowna, Kitimat, Kootenay Boundary, Nelson, Penticton, Port Alberni, Powell River, Prince George, Prince Rupert, Quesnel, Squamish, Sunshine Coast, Terrace, Vernon, and Whistler.

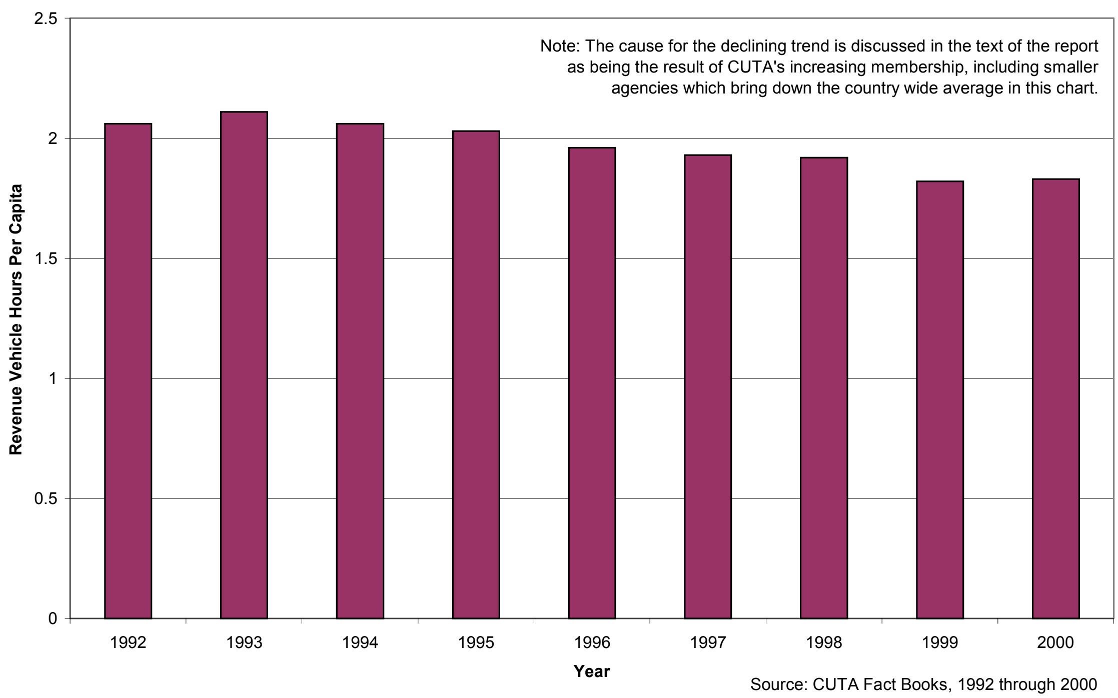
In addition to these conventional transit services, many Canadian cities have private sector contracts for the operation and/or maintenance of their specialized systems (for persons with disabilities). These include Victoria, Vancouver, Saskatoon, Regina, Laval and Ottawa, to name a few.

The examples listed in the previous paragraphs refer to situations where the private sector is responsible for operating and/or maintaining significant elements of the transit system. Many of the other transit agencies in Canada that are largely publicly operated also incorporate elements of ASD into their operations. A key example is in the area of major vehicle maintenance where most systems use a tendering process for major work such as engine and transmission rebuilding and vehicle refurbishing including major structural repairs and body and paintwork. Only the largest transit agencies have these capabilities in house and most of them cannot keep up with the volume of work without private sector assistance.

2.2.2 Amount of Transit Service in Canada

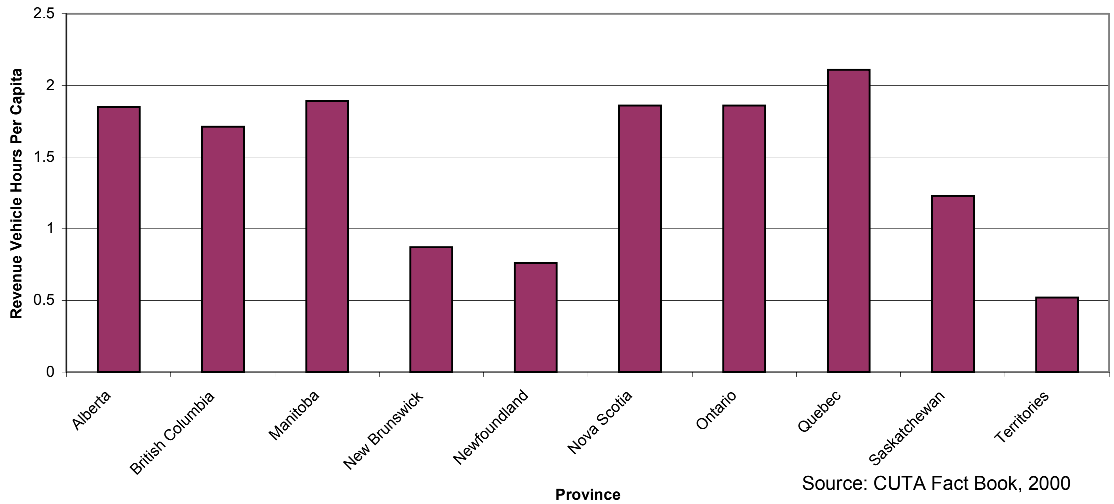
Transit revenue vehicle hours have stayed relatively steady across Canada over the past 9 years, fluctuating between 29.9 million in 1998 and 32.4 million in 1994. A time series of revenue vehicle hours per capita is shown in Exhibit 2.10, which indicates a declining trend in service. It should be noted that one of the reasons the data shows a declining trend is as a result of the efforts of CUTA to continuously enlist all transit agencies to submit local statistics. The agencies that have been enlisted in recent years are the smaller, more rural providers, which understandably bring down the Canadian average in service provided per capita. There was, however, a decline in service in Ontario as the Province pulled out of the financial support for transit and municipalities had to cut back service to meet their budgets.

Exhibit 2.10 Amount of Service in Canada - Annually



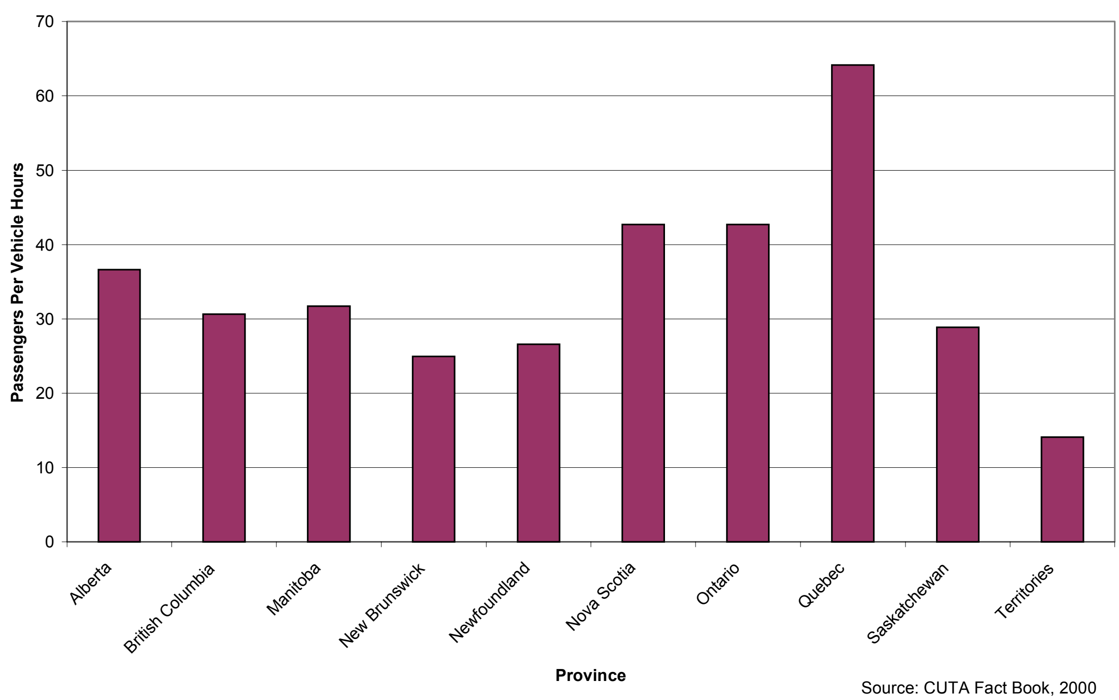
As should be expected, the largest contributors to the across Canada total are Ontario, Quebec, British Columbia and Alberta. On a per capita basis, the surprising contenders are Manitoba and Nova Scotia, which are in line with Alberta and Ontario in the amount of service provided per capita, as can be seen in Exhibit 2.11. Nonetheless, in general, the larger the service population base, the more revenue vehicle hours per capita logged.

Exhibit 2.11 Amount of Service - by Province (2000)



Source: CUTA Fact Book, 2000

Exhibit 2.12 Service Utilization - by Province (2000)



Source: CUTA Fact Book, 2000

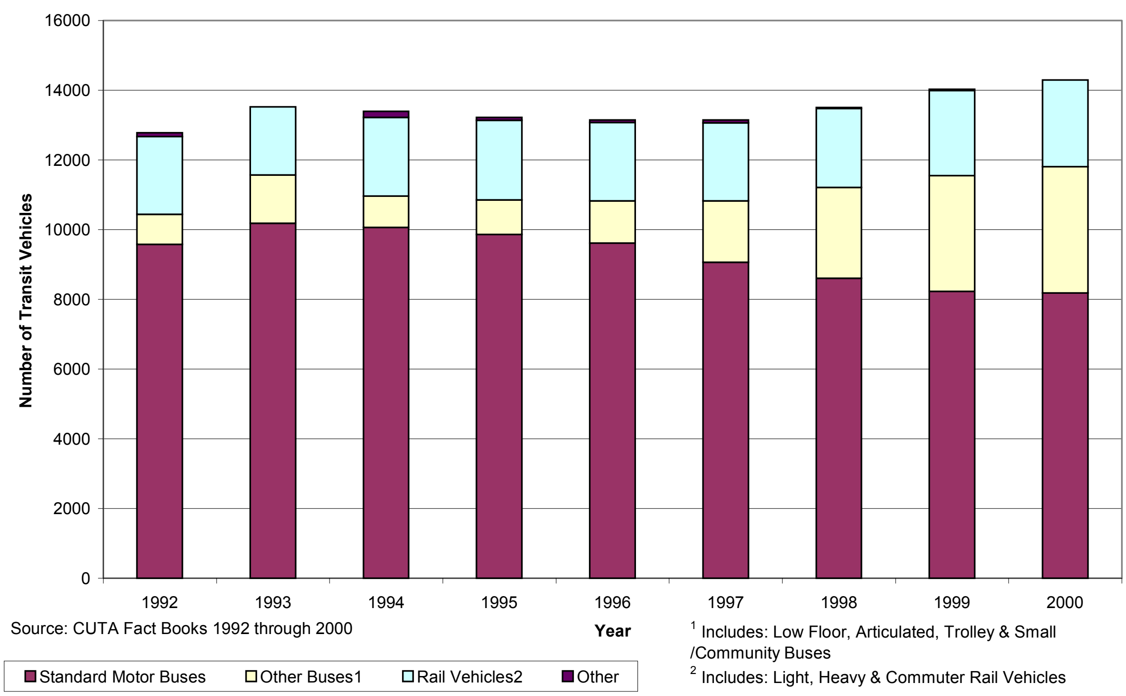
An indication of service efficiency is provided in Exhibit 2.12, which illustrates the service utilization of transit across Canada in 2000. Quebec records the highest rate of passengers per vehicle hour, with other provinces falling in the range between 25 and 43 passengers per vehicle hour. Over the past nine years, the Canada wide average for service utilization has shown little fluctuation falling between 40 and 45 passengers per vehicle hour. The population group analysis results indicate that service utilization increases with city size.

2.2.3 Transit Equipment and Technology in Canada

Number of Transit Vehicles

In 2000, 14,335 active transit vehicles were reported to CUTA. In the past nine years the active vehicle fleet across Canada has increased in size by 12 percent. Transit agencies have been slowly modernizing their fleets, as can be seen in Exhibit 2.13, where new vehicle purchases have been made up of primarily "other" bus types which includes low floor, articulated, trolley and small community buses. It is also evident that "other" types of buses are replenishing the fleet of standard motorbuses. Although the increase of low floor buses is evident in most major cities, and in this analysis, the replenishment rate is not nearly what it should be to meet the demands for increased accessibility of vehicles.

Exhibit 2.13 Transit Vehicles by Type - Canada



Source: CUTA Fact Books 1992 through 2000

[1] Includes: Low Floor, Articulated, Trolley & Small /Community Buses
[2] Includes: Light, Heavy & Commuter Rail Vehicles

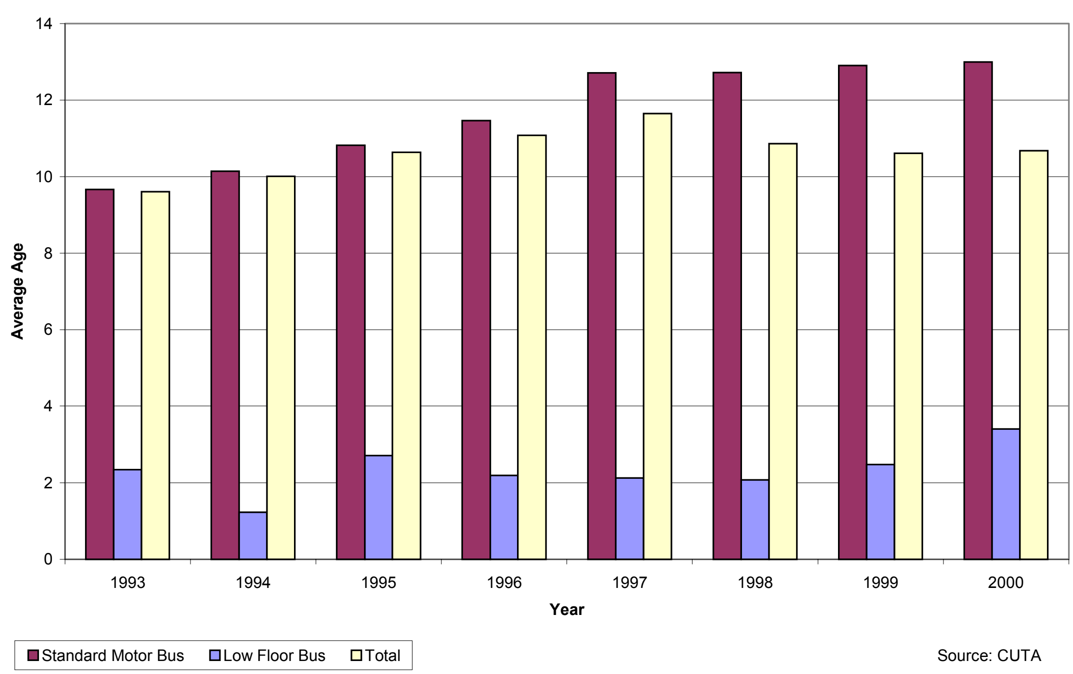
Ontario and Quebec have over 700 low floor buses each (making up 16 % of Ontario's and 25% of Quebec's bus fleet), followed by British Columbia, which has over 600. In general, British Columbia and Ontario have the most varied vehicle fleets, with large stocks of articulated, community and low floor buses as well as a variety of rail vehicles. The smallest fleet belongs to the Yukon Territory with 20 vehicles. Across Canada, only 23% of the bus fleet is made up of low floor buses.

Transit providers for cities with a population greater than 400,000 are the only ones to provide rail service. Additionally, they have a larger proportion of non-standard motorbuses than do the smaller community providers.

Year of Manufacture

One of the critical issues facing municipalities, as they plan for the future, is their aging transit fleet. The US standard is to expect an average service life of approximately 12 years, while most transit managers in Canada plan for their vehicles to last around 15 or 16 years. Thus the system should be supporting an average fleet age of around 8 years old to be sustainable. Exhibit 2.14 illustrates the average fleet age over the past eight years. In 2000, the average fleet age across Canada was almost 11 years. It peaked in 1997 at almost 12 years, and has been declining slowly since then.

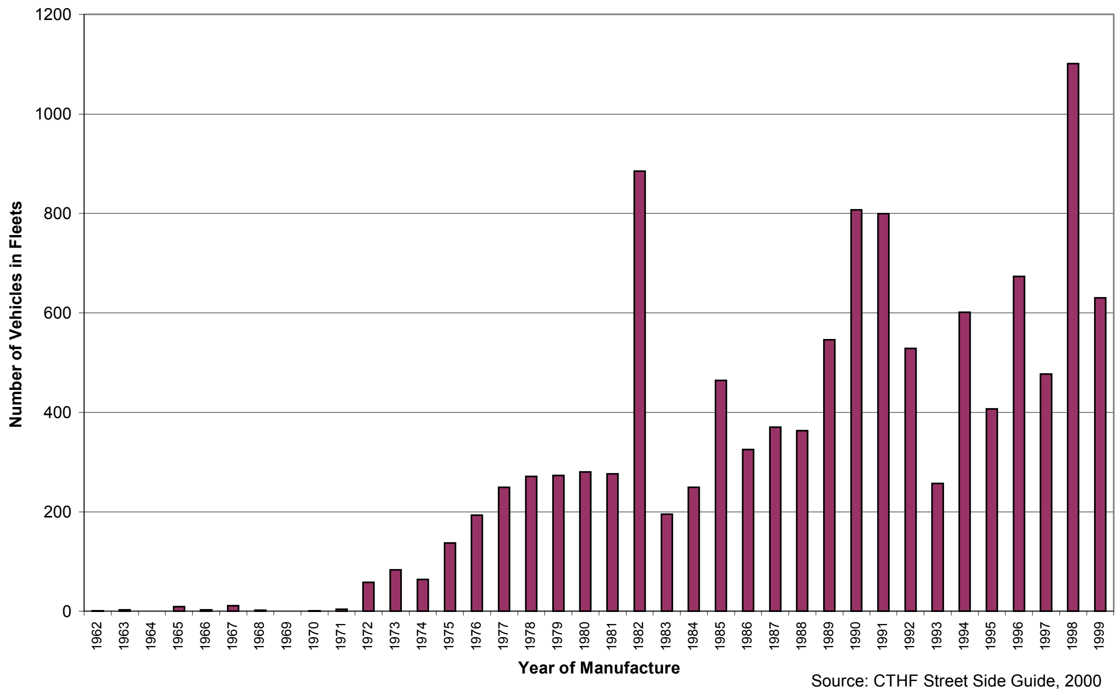
Exhibit 2.14 Average Age of Bus Fleet (1993-2000)



Source: CUTA

Exhibit 2.15 shows the prevalent years of manufacture for the Canadian bus fleet as 1998 and 1982 (source: Street Side Guide to Urban Transit Fleets in Canada, 2000 Edition, published by the Canadian Transit Heritage Foundation). Fluctuation in timing for bus purchases is a function of availability and the ability to provide funding. If anything, it has not been consistent over the past 10 years, which has the by-product of making it difficult for Canadian bus manufacturers to manage their businesses.

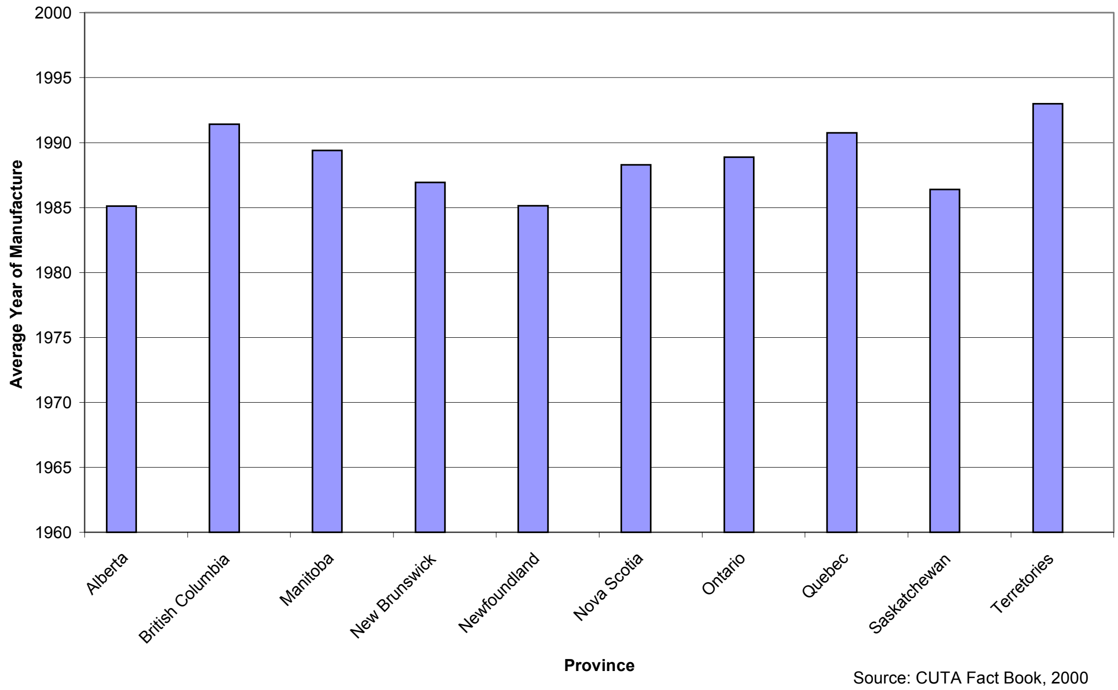
2.15 Year of Manufacture - Canada Wide as of 2000



Source: CTHF Street Side Guide, 2000

The average year of manufacture for each of the provinces is displayed in Exhibit 2.16. The youngest fleet is in the Yukon, followed by Quebec and British Columbia. The oldest fleets are in Alberta and Newfoundland. On closer examination of the larger individual systems shown in Exhibit 2.17, it can be seen that few of them are able to achieve an average fleet age below nine years. The average age of buses in Edmonton is older than the expected lifespan of a bus, which may put the Edmonton transit agency in a precarious position since their buses will likely need replacing at a fast rate in the near future.

Exhibit 2.16 Average Year of Manufacture by Province



Source: CUTA Fact Book, 2000

Exhibit 2.17

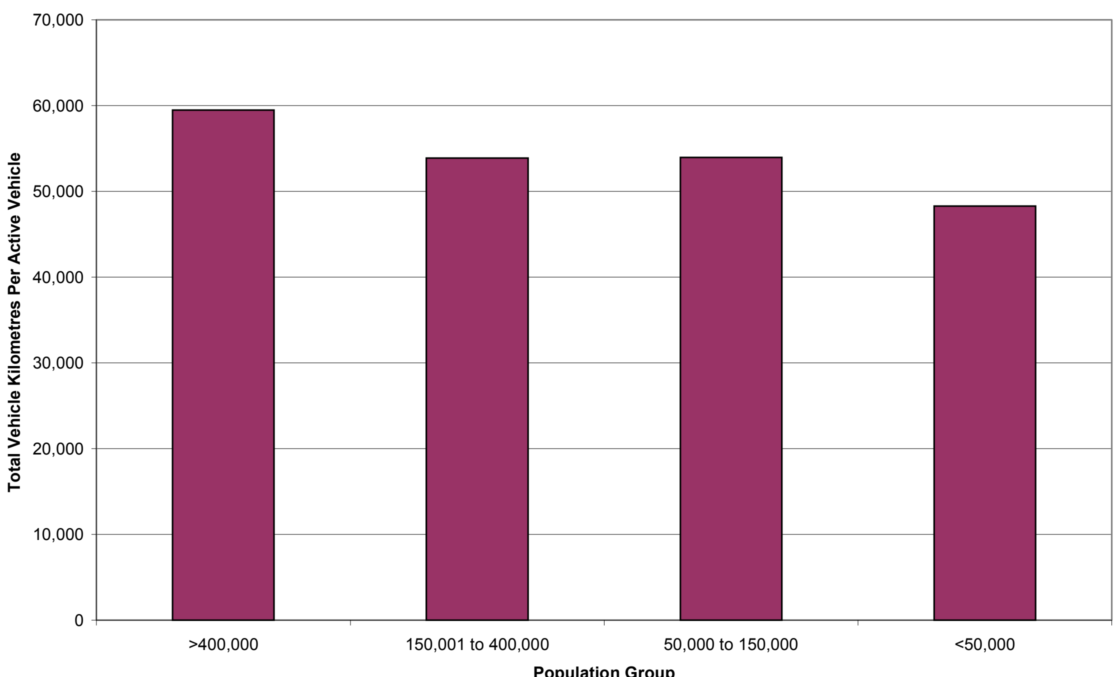
Average Fleet Age in 2000
Selected Cities

City	Average Age
Montreal	8.23
Toronto (TTC)	12.34
Ottawa	11.44
Vancouver	8.18
Edmonton	17.48
Calgary	12.94
Winnipeg	10.49
Quebec City	12.04
Montreal (STRSM)	9.52
Mississauga	7.30
Toronto (GO)	11.44
Victoria	11.10
Laval	9.53
Hamilton	8.16
Outaouais	9.61
Source: The Street Side Guide to Urban Transportation Fleets in Canada, Canadian Transit Heritage in Canada	

Kilometres per Vehicle

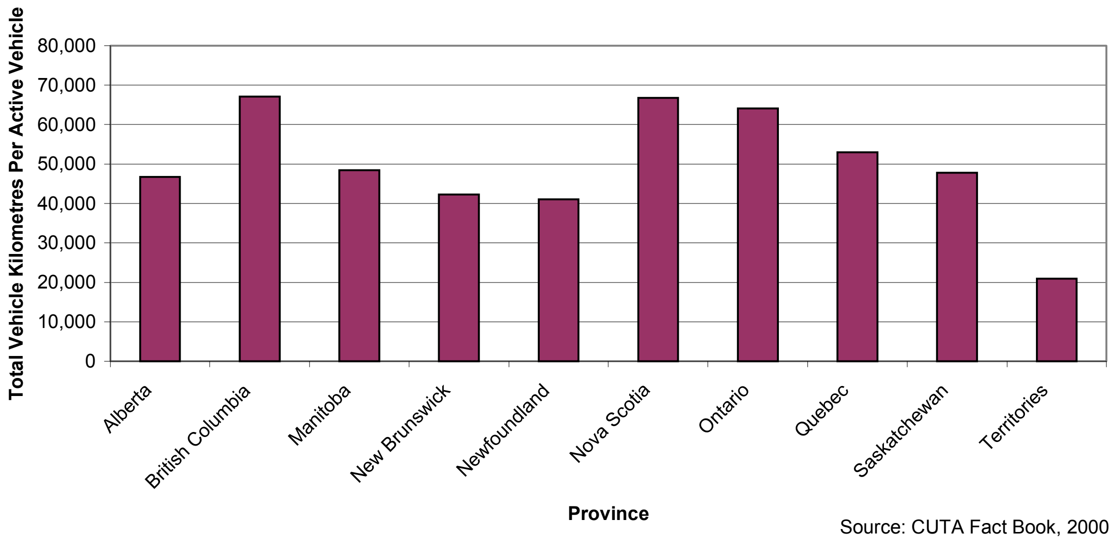
In the year 2000, the average transit vehicle in Canada logged over 58,000 kilometres. Over the last nine years, this has changed minimally, showing a slight increasing trend, with the 1992 rate at over 56,000 kilometres per vehicle. On a population group basis, there is a 15% difference between the larger communities and the smaller, with the larger communities logging almost 10,000 kilometres per vehicle more than the smaller, as is illustrated in Exhibit 2.18. The provincial breakdown is shown in Exhibit 2.19, and indicates that although city size has some impact on the vehicle usage, it is not a direct correlation, with British Columbia and Nova Scotia topping the group. The factors that affect distances traveled include city size and geographical barriers, such as harbours and hills, as well as the type of service provided and the location of the storage facilities. For instance cities in British Columbia and Nova Scotia have several geographical barriers resulting from being on the coasts, in and around major waterways. Ontario cities which are mostly large, and in some cases suburban, provide more express route service, which results in the accumulation of out-of-service kilometres, known in the industry as "deadheading".

Exhibit 2.18 Vehicle Utilization - by Population Category (2000)



Source: CUTA Fact Books, 2000

Exhibit 2.19 Vehicle Utilization - by Province (2000)



Source: CUTA Fact Book, 2000

Energy Use

Public transit vehicles are powered by several different types of fuels:

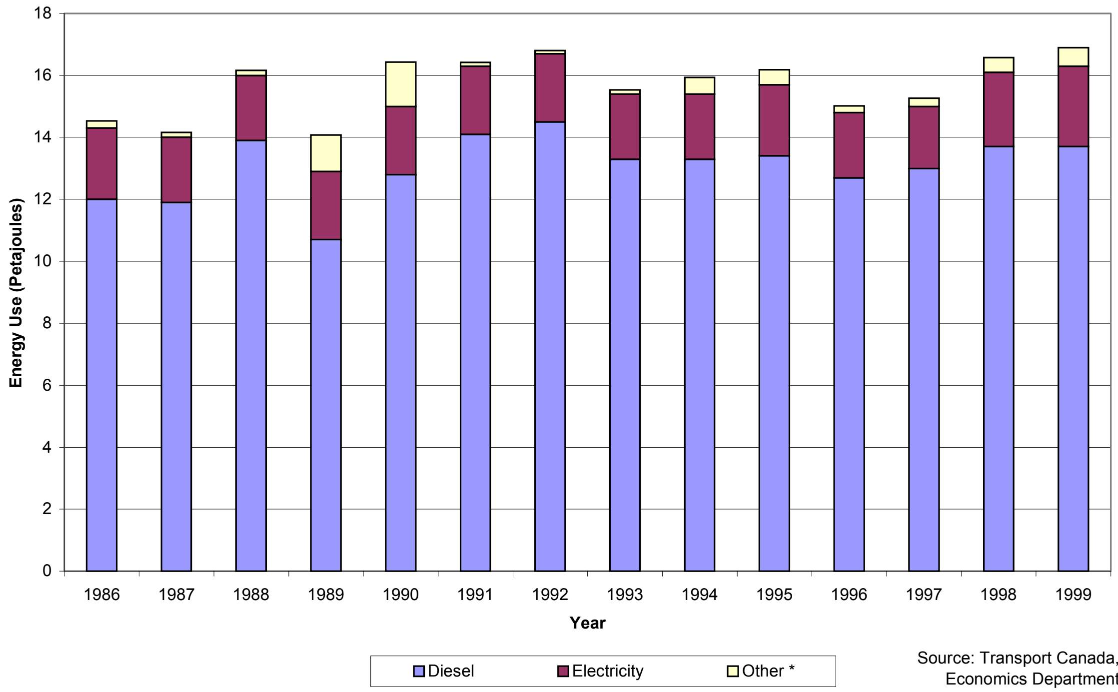
- Diesel;
- Gasoline;
- Propane;
- Natural Gas;
- Electricity.

Exhibit 2.20 illustrates that diesel is the predominant fuel used by Canadian transit systems, primarily for conventional buses and commuter rail services. Electricity is used to power services such as the Toronto and Montreal subways, the Vancouver Skytrain, the Calgary and Edmonton LRT and a variety of streetcars and trolley buses. The other fuel types do not play a large role.

The energy efficiency of Canadian transit is shown in Exhibit 2.21. This demonstrates that energy efficiency per passenger has been declining, or expressed another way, energy use per passenger has been increasing. This downward trend in energy efficiency was most prominent prior to 1992 and has largely stabilized since. Increasing suburbanization where transit systems have to travel farther to reach their customers has largely caused the decline.

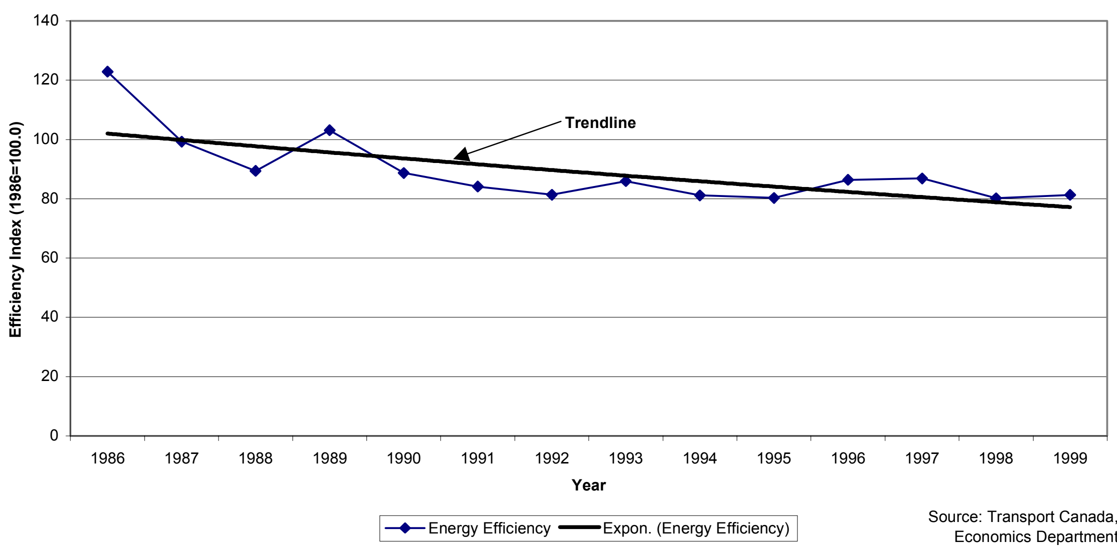
The information presented in Exhibits 2.20 and 2.21 was provided by Transport Canada and expresses the amount of energy produced by different fuel types using a common and comparable unit – petajoules.

Exhibit 2.20 Energy Use in Petajoules



Source: Transport Canada, Economics Department

Exhibit 2.21 Energy Efficiency per Passenger, Transit Systems



Source: Transport Canada, Economics Department

Emissions

Tracking emissions is a difficult task due to the complexity and variability of emission rates based upon various vehicle and roadway characteristics. Emissions can vary substantially based upon the vehicle characteristics of:

- Age and maintenance,
- Size,
- Fuel type, and
- Emission control technologies (of which there are many).

And, the roadway, environmental or traffic characteristics of:

- Speed of travel,
- Congestion,
- Temperature,
- Terrain (presence of hills), and
- Frequency of stops.

For example, an Australian study (*Green Buses on Schedule*, Smart Urban Transport, vol.1, no. 1, September 2001) tested vehicles under a variety of speed and congestion scenarios and found that CO_2 emissions ranged from 865 g/km for a constant speed of 50 kilometres per hour to 1541 g/km for congested flow. Carbon dioxide is not the only harmful emission produced by motorized transportation, although it is the most significant in terms of weight. Other harmful emissions include nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide, sulphur, and hydrocarbons. Diesel fuel is still the predominant fuel type used by transit vehicles in Canada, and its exhaust has been found to contain over 40 toxic substances, 15 of which are considered carcinogenic. Diesel fuel technologies are however continuously improving emission rates, and environmental standards are continuously pushing the industry to improve.

A document prepared for the Pollution Data Branch of Environment Canada entitled: Updated Estimate of Canadian On-Road Vehicle Emissions for the Years 1995-2020 (draft), documents the modeling of future emission rates (not including green house gases), for different new vehicle types, including buses. This document predicts bus emission rates of the variety of pollutants to decline to mere fractions of their current levels by 2010. Additionally, the model predicts that bus engines will not produce increased pollutants as they age because there is insufficient data available about how emissions change as current engines age. Exhibit 2.22 outlines the emission rate standards selected for the model used in the report, as they pertain to buses, which are expected to be fully phased-in by 2009. Phase 1 will reduce NO_x and NMHC emissions by 55 percent in new vehicles will take effect in 2004. Phase 2 NO_x, NMHC, and PM emission standards will reduce emissions in new vehicles by 90 to 95 percent starting in 2007. Inspection and maintenance is expected to play a large role in maintaining these standards in vehicles as they age.

Exhibit 2.22

Emission Rate Standards for Canadian Buses

Pollutant	Year	New Vehicle Emission Rate (g/bhp-hr)
NMHC (Non-methane hydrocarbon)	2004-2006	0.080
	2007	0.020
NO_x	2004-2006	2.21
	2010	0.18
PM	2004-2006	0.08
	2007	0.01
CO	2004-2006	1.06
	2007	0.11
Source: Table 4, Updated Estimate of Canadian On-Road Vehicle Emissions for the Years 1995-2020 (draft), Pollution Data Branch, Environment Canada, July 2001 g/bhp-hr refers to grams per brake horsepower hour.		

Additionally, it is important to note that although new vehicles will produce greatly reduced emissions, the older vehicles will continue to produce the same emissions as they do today. Therefore, especially in the case of bus fleets with a long service life relative to private vehicles, noticeable reductions in emissions may take many years to be realized. Replacing the vehicle fleet with new buses that meet the new emission standards may be the most effective method of reducing emissions generated by public transit vehicles.

The Pollution Data Branch study, unfortunately, merges buses with other heavy vehicles for the purpose of the modelling, and therefore only produces emission estimates combining all heavy-duty vehicles, which is not useful for the purposes of this transit study.

For the purpose of this study, a gross estimate of annual emissions by transit vehicles in Canada is 1.3 billion kilograms of CO_2 equivalents in the year 2000. This is simply the product of 1,600 g/km (the average of 3 estimates of current emission rates) and the total vehicle kilometres reported to CUTA.

Currently, information available on bus emissions, both greenhouse gases and pollutants is limited. Understandably, industry efforts are being directed towards determining the harmful effects of non-public transportation modes, resulting in very little knowledge of public transit emission impacts.

The manufacturing industry has indicated that they will be able to provide diesel products that meet the new emission standards without any significant additional costs to the transit industry. The limiting factor for these new diesel products at the current time is the limited availability of the best clean diesel fuel. It is this fuel that is required for the new engine products to meet the emission standards.

Transit Technology

The term ‘technology’ can be applied to the transit industry from two different perspectives: on-vehicle and off-vehicle. On-vehicle technology refers to systems, materials and machinery contained completely on the vehicle while off-vehicle systems are support systems that usually relate to so-called soft technology and often involve both on and off vehicle equipment. The transit system operators in Canada are concerned with all of these elements. Exhibit 2.23 provides a comprehensive list of transit technologies that exist today and indicates how commonly they are found in Canada today. Those technologies in common use are found in more than half of the systems or vehicles in Canada. Occasionally used technology is found in up to half of the systems or vehicles while emerging technologies are in the pilot project phase, operating as prototypes or are available but have not penetrated the market significantly. The Exhibit is followed by a general discussion of these technologies.

Exhibit 2.23

Transit Technology in Canada

Technology Item	Usage		
	Common	Occasional	Emerging
Engine/Propulsion/Fuel – Diesel	✓		
Engine/Propulsion/Fuel – Natural Gas		✓	
Engine/Propulsion/Fuel – Alternative			✓
Electronic Transmission	✓		
Exterior LED Lighting		✓	
Alternative Frame Material			✓
Alternative Skin Material			✓
Climate Control – Air Conditioning		✓	
Low Floor Vehicle		✓	
Registering Fare Boxes	✓		
Smart Card Fare Collection			✓
Transfer Printers		✓	
Automated Vehicle Location		✓	
Computer Assisted Service Control	✓		
Computerized Scheduling/Runcutting	✓		
Automated Passenger Counting		✓	
Powertrain Data Analysis		✓	
Transit Priority		✓	
On Board Video Monitoring		✓	
Collision Avoidance System			✓
Driver Communications Radio	✓		
Driver Information System			✓
On Board Broadcasting			✓
On Board Vending			✓
Electronic Route/Destination Signage	✓		
On Board Public Address		✓	
Automated Next Stop Video/Audio			✓
Automated At-Stop Information			✓
Automated Telephone Information	✓		
Wheelchair Accommodation		✓	
Bicycle Accommodation			✓
Web-based Information and Services	✓		

Propulsion systems comprising engines with fuel and related equipment: Diesel technology is by far the most common used in Canada today. Transit agencies are continuing to purchase diesel-powered vehicles in greater numbers than any other propulsion technology. As these purchases are made, the advantages of the more efficient and cleaner diesel systems now available and emerging are being incorporated into the fleets. Natural gas propulsion is used in a variety of systems across Canada. Some hybrid propulsion and fuel cell buses are being tested, but common use of these systems in Canada is a number of years away.

Electronic Transmissions: These are becoming more and more common as older vehicles are being replaced. Manufacturers are continuing to innovate and improve the electronic component of the transmissions, however, the mechanical aspect of this equipment remains largely unchanged.

Exterior LED Lighting: Light Emitting Diodes are replacing more conventional bulbs in rear and marker lighting on many heavy vehicles. They are brighter, more durable and much more easily seen. This equipment is being introduced as vehicles are replaced.

Alternative Frame and Skin Material: Corrosion resistance is the biggest issue with transit vehicle frame and skin material. A variety of materials and coatings are emerging. The weight of frame and skin material is also an issue and research is ongoing with a variety of lightweight composite materials.

Climate Control: While there are ongoing engineering advances related to heating and ventilation on buses, the largest change in climate control technology relates to air conditioning systems. They are starting to become more common in Canada as transit systems decide that the availability of air conditioning makes their service more attractive. The manufacturing sector is continuing to develop and improve these systems in ways that make them more environmentally friendly and more fuel-efficient.

Low Floor Vehicle: The use of low floor vehicles is the easiest way to make transit service more accessible to the disabled and more attractive to an increasingly aged Canadian population. Virtually all new bus purchases in Canada in recent years are of low floor vehicles and manufacturers are increasingly focusing on this area.

Registering Fare Boxes: These fare boxes count money as it is dropped in the box and display the amount to the driver, allowing easier verification that the correct fare has been paid. These intelligent machines can also be programmed to collect information about the number of different types of fares paid.

Smart Card Fare Collection: Smart Cards are credit card sized devices that can act as electronic wallets for paying transit fares. They can function as cash for casual transit users or as passes for regular commuters. They can have a magnetic strip on the back that requires the customer to swipe the card or be contactless and only require the customer to bring the card within a close proximity of the reader. Use of smart cards can ease fare payment and fare collection and can be part of larger networks incorporating a multitude of services beyond transit. Transit smart card use is small in Canada at the moment, but most transit agencies expect to use them in the future.

Transfer Printers: These machines allow drivers to provide customers with accurate, fraud resistant transfers compared with the traditional tear off transfers and can provide a mechanism for introducing more varied fare media. The equipment can be incorporated into registering fare boxes or provided independently. Use depends on the fare system in each transit agency.

Automated Vehicle Location: Detecting where transit vehicles are currently located is the key to improving service reliability and control, and providing real time information to customers. Most of the medium and large sized transit systems either have AVL or intend to introduce it. Original AVL systems were based on electronic signpost technology and newer ones incorporate the increasing cost-effective GPS network.

Computer Assisted Service Control: Effective monitoring and control of transit service is fundamental to providing reliable service for transit customers. A variety of computer-based tools includes on line databases of schedules, vehicles and drivers, and decision-making software.

Computerized Scheduling and Runcutting: All medium and large transit systems and many smaller ones use computerized scheduling and runcutting (organizing transit schedules into work shifts) software. The leading developers of these systems in the world are Canadian companies.

Automated Passenger Counting: Some larger transit systems use passenger counting equipment on a portion of their fleet to measure passenger activity, monitor service performance and plan future service requirements. Some elements of APC are available on registering fare boxes but these do not provide the same level of information as a complete APC system does. While considered a new technology, it has in fact been available for some time. At least one Canadian system has had APC equipment for about twenty years.

Powertrain Data Monitoring: Equipment is now available that allows vehicle maintenance staff to plug a computer into an on-board data collection module. The technician can then view information about the performance of the engine and take appropriate action. The option of providing the vehicle performance information to maintenance staff in real time via wireless transmission is also being developed. This would allow maintenance staff to identify serious problems more quickly and to better schedule maintenance operations.

Transit Priority: A combination of on-bus equipment, on-street equipment and control centre software allows transit vehicles to be detected and priority given to them in mixed traffic situations. Most medium and large sized systems are experimenting with or using transit priority equipment and algorithms to a varying degree and even smaller systems could take advantage of the equipment. Examples of transit priorities include signal phase extension, signal pre-emption, transit-only signals, queue jump facilities and bus lanes.

On Board Video Monitoring: This is safety and security related equipment that usually consists of video equipped transit vehicles. The video cameras view the passenger compartment as a crime and vandalism deterrent. Sometimes, cameras are aimed at rear doors and a monitor is in the driver's compartment. This allows drivers to ensure that the doors are clear prior to moving the vehicle.

Collision Avoidance System: Video, radar and sonar equipment provides drivers with information about objects that may be in the path of travel, allowing the driver time to take corrective action. Such systems can be especially attractive on large vehicles such as buses. At the moment, these systems are still largely experimental, but there is interest within the transit industry about their potential benefits.

Driver Communications Radio: Communications between the driver and the maintenance garage and service control centre is an important element in transit operations management. Traditional radio systems are still the most common, but other options using the newest wireless and cellular technologies are becoming increasing available.

Driver Information System: Most transit drivers bring with them a variety of written material that tells them their daily schedule and route information as well as a variety of other data they need to refer to from time to time. On board systems that provide this information electronically either through the driver placing an access card in the on board equipment or remotely through a wireless connection are being developed.

On Board Broadcasting: Systems are available that can broadcast video or audio signals to transit vehicles as both information service for customers and a commercial revenue generator for transit systems.

On Board Vending: This can consist of on board cellular payphones as well as traditional small-scale vending machines for products like transit tickets, stamps and print media. These are more likely to be found on large transit systems and on higher order mass transit equipment.

Electronic Route/Destination Signage: Some transit systems still use the hand cranked Mylar sign rolls, but more and more are introducing the electronic route and destination signs that can be controlled from the driver's seat. This equipment provides greater flexibility in customer information and is easier for the driver to operate.

On Board Public Address: Clear and effective on board public address systems are vital to safety management on larger vehicles and trains and are a requirement on all vehicles.

Automated Next Stop Video/Audio: These systems provide video and/or audio announcements to customers about the next stop location. This is important for customers with a variety of disabilities and is helpful in the Canadian context with slush covered and fogged up windows and short daylight hours in the winter months.

Automated At-Stop Information: At major transit terminals and stops, automated information telling customers about the schedule status of the service reassures passengers about their bus or train. The information can be provided in real time using an AVL system.

Automated Telephone Information: Many transit systems provide telephone answering equipment that can automatically provide customers that dial in, information about the current transit service.

Wheelchair Accommodation: While low floor buses are the first step to improving accessibility for transit users, accommodating as many customers as possible requires equipment for wheelchair users. Ramps, either flip-over or telescopic, to bridge the gap between the vehicle and the curb or platform are the first step. On the vehicle itself, it is necessary to provide space for wheelchairs, often at the expense of other seats. Whether or not there is any mechanism to secure the wheelchairs is also a question.

Bicycle Accommodation: There is growing interest in improving the multi-modal integration of the transit industry. Some systems are outfitting portions of their fleets with equipment to accommodate bicycles. The most common bus equipment is a two bike rack attached to the front of the bus. Rail vehicles will accommodate bikes inside, often with restrictions during peak passenger times.

Web-based Information and Services: All of the large transit systems in Canada and most of the small ones have transit service information available on web sites. While most of the information currently available this way is simply a replication of common printed information, unique services such as web-based trip planning and detailed information for wireless devices are becoming available and will become common in the foreseeable future.

Within the technology components listed above are dozens of research studies and entrepreneurs working to improve the transit industry. Most of these efforts focus on the North American market as a whole and do not distinguish Canada as a separate market. As a result, the Canadian transit industry benefits from the breadth of technological advancement and research that is focused on the U.S. market and there is virtually no difference in the availability and penetration of technology between Canada and the U.S. Further good news is that many of the leading companies working in this area are Canadian.

2.2.4 Transit Labour Force in Canada

A significant majority of the urban transit labour force in Canada is unionized with negotiated collective agreements governing the wages and work rules that the transit systems operate under. These play a significant role in the transit industry in terms of cost structure and system flexibility, as discussed below.

Cost Structure

With most of the labour force being unionized and labour being the most significant component of operating costs (approximately 70% of operating costs is labour), the collective agreements have a significant impact on the overall cost of transit. The presence of collective agreements and the fact that labour is a large part of operating costs makes it difficult for transit managers to deal with issues such as other funding changes as they arise.

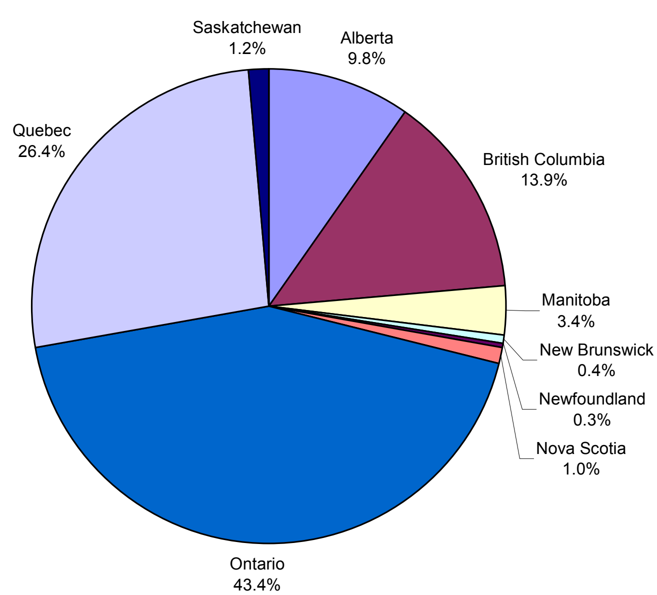
There is a view held among some observers of the transit industry that because of the high level of organized labour in the public transit agencies, costs could be reduced through greater involvement of the private sector. While in some situations in some municipalities this may be true, it is not appropriate to apply this view to the industry as a whole. In fact, the private sector labour force providing the service to the transit industry is also often unionized and there is not always a difference in the wages and work rules.

System Flexibility

Work rules governing transit operations in most cities are complex and care must be taken not to violate them when developing service schedules. This complexity can limit the ability of transit managers to implement new and innovative ideas quickly. While labour groups are usually willing to discuss work rule adjustments that will benefit transit users, it is often the case that the complexity of the proposal must wait for full discussion at the time of renegotiation of the collective agreement. This makes it difficult for transit managers to implement change and be aggressive in the marketplace.

Canada wide, the number of people employed in public transit has remained relatively unchanged over the past 9 years, at just under 40,000. In 2000, Ontario employed over 17,500 of these people, with Quebec following at just over 10,000 employees. British Columbia and Alberta, the next largest employers, employed almost 6,000 and 4,000 respectively. Exhibit 2.24 illustrates Ontario's dominance of Canada's labour market.

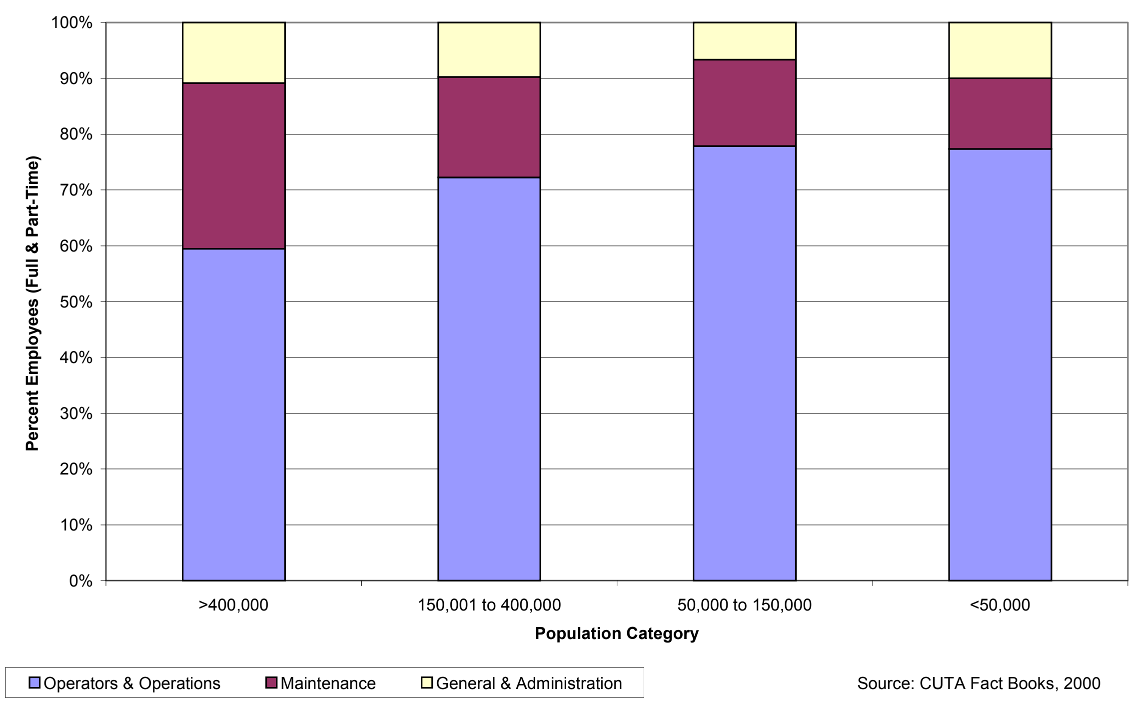
Exhibit 2.24 Transit Employees by Province (2000)



Source: CUTA Fact Books, 2000

Municipalities with populations larger than 400,000 people, employ over 30,000 of the transit employees, with the remaining smaller communities employing less than 10,000 transit workers. Exhibit 2.25 illustrates the proportional difference between operators, maintenance, management and administration, for each of the population categories. Proportionally, maintenance staffing levels diminish as community size decreases, which is likely reflective of larger transit providers' abilities to effectively utilize full time specialized maintenance staff, whereas smaller communities would find it more cost effective to contract out for these types of services. Proportionally, management and administration positions are relatively standard across all population categories.

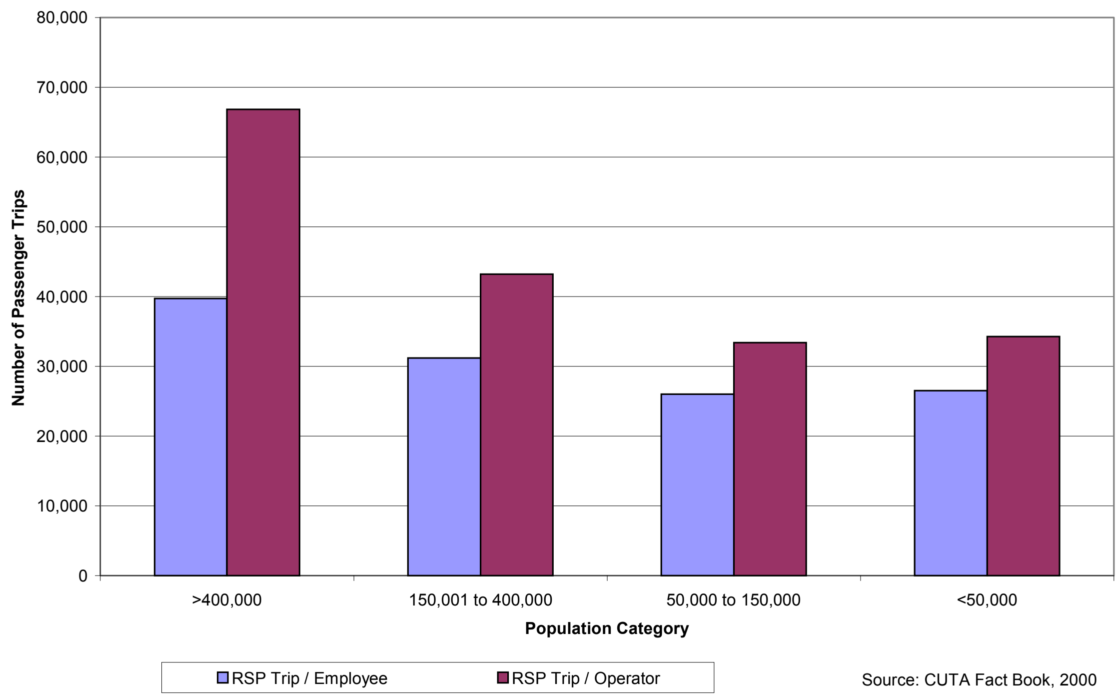
Exhibit 2.25 Job Classification Proportions by Population Category (2000)



Source: CUTA Fact Books, 2000

Exhibit 2.26 displays the number of regular passenger trips per transit employee, and per operator, to determine the efficiency of the staffing for the various population groups. The trend of the chart indicates that as the transit provider size increases, their passenger trip to staff ratio increases. This comparison could be considered a surrogate for fiscal efficiency considering that labour costs make up such a large portion of operating costs.

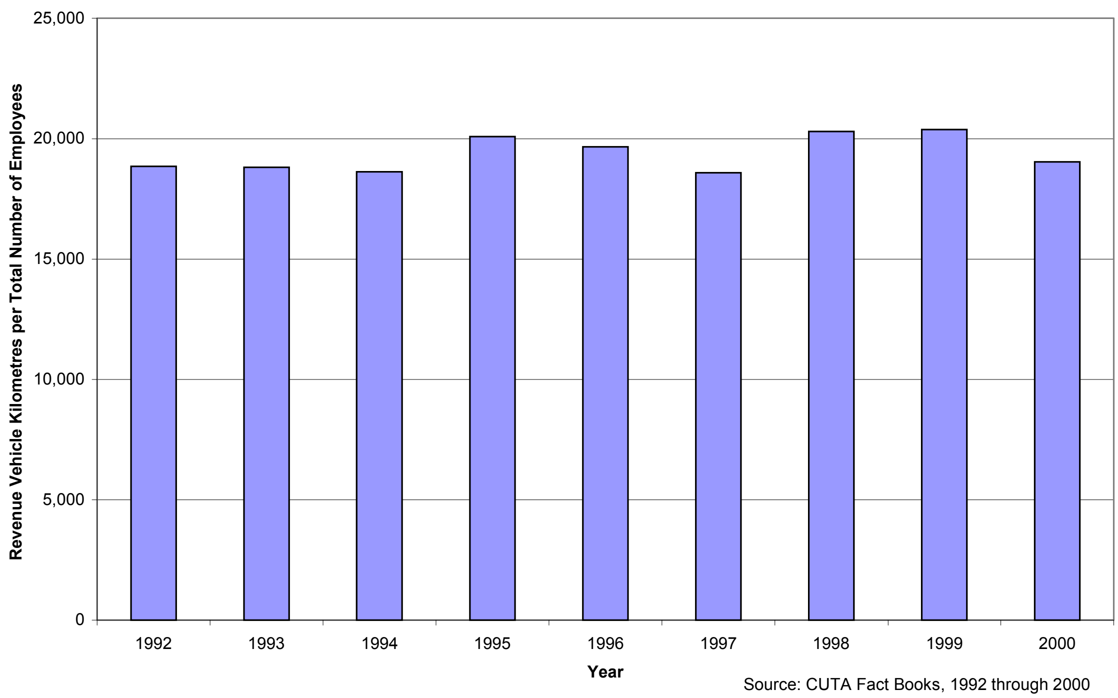
Exhibit 2.26 Regular Service Passenger Trip per Transit Employee (2000)



Source: CUTA Fact Book, 2000

Labour productivity can be measured in terms of revenue vehicle kilometres per total employees in the labour force. Exhibit 2.27 illustrates a fairly stable trend in labour productivity in the range of 18,000 to 20,000 revenue vehicle kilometres per total labour force. Provincial productivity, shown in exhibit 2.28, fluctuates between 17,500 in Quebec to 22,000 revenue vehicle kilometres per employee in British Columbia. In general, larger municipalities are less productive, with communities in the 50,000 to 150,000 population range achieving the highest revenue vehicle kilometres per employee rates, as is shown in exhibit 2.29. This is likely explained by the fact that larger municipalities employ more people in equipment and facility maintenance, where economies of scale allow for departments such as major engine rebuilding that smaller transit agencies would not be able to accommodate.

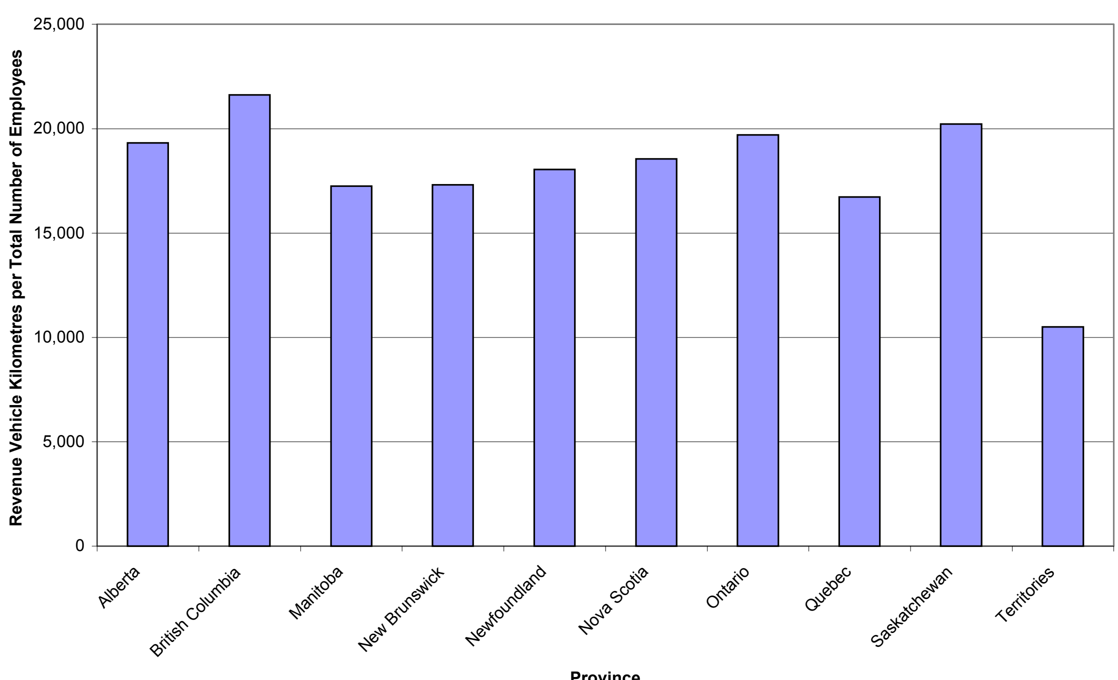
Exhibit 2.27 Transit Labour Productivity in Canada, Annually



Source: CUTA Fact Books, 1992 through 2000

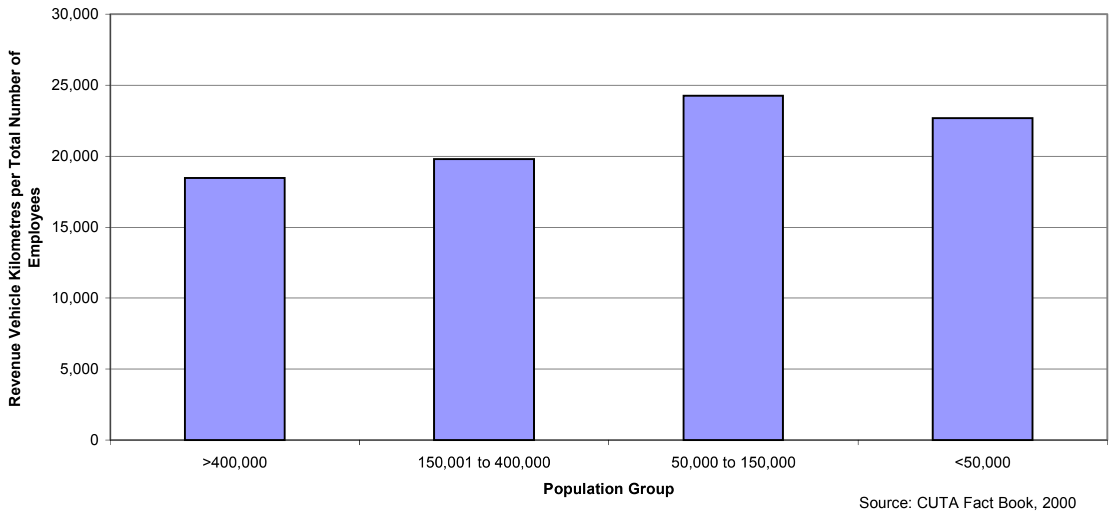
Note: Three caveats should be mentioned. First, according to Transport Canada studies, 1992 exhibited the lowest productivity levels in decades. Second, other indicators may produce different results. Third, a more comprehensive approach would use total factor productivity but this was beyond the scope of this report.

Exhibit 2.28 Transit Labour Force Productivity, by Province, 2000



Source: CUTA Fact Book, 2000

Exhibit 2.29 Transit Labour Force Productivity, by Population Group, 2000



Source: CUTA Fact Book, 2000

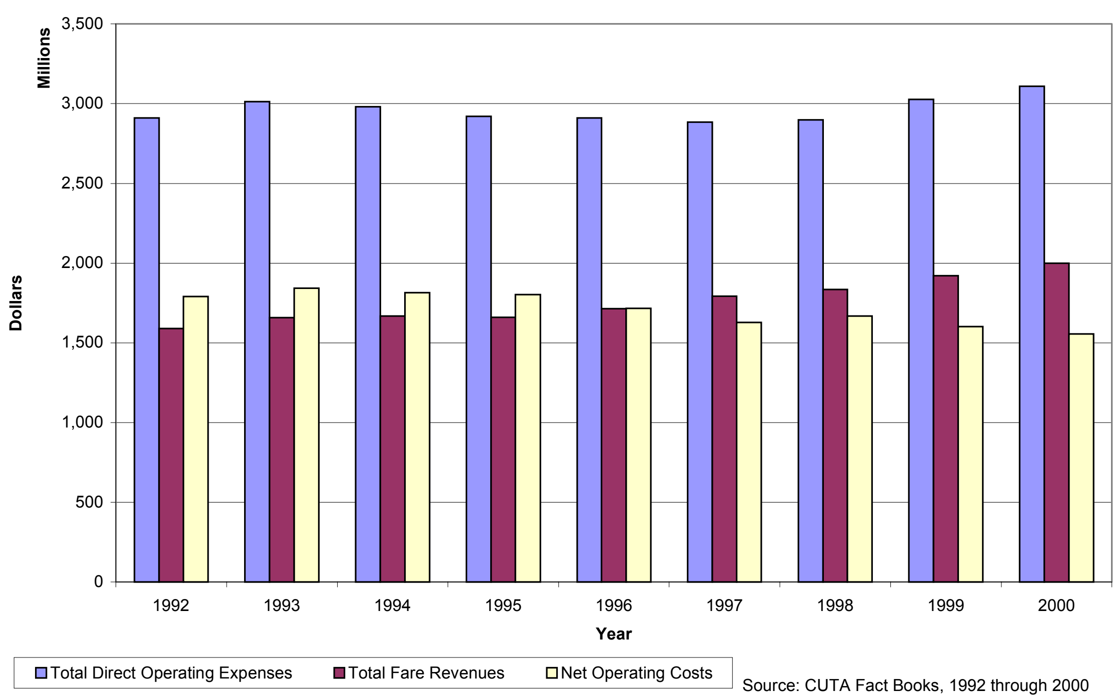
2.3 The Current Cost Structure of Transit in Canada

Understanding the demand and supply components of the transit industry are important, but they do not show the complete picture. The cost structure of the transit industry includes consideration of operating revenue and expenses, capital revenues and expenses, financial performance, the costs of equipment and infrastructure and the sources of funding.

2.3.1 Operating Revenues and Expenses

Exhibit 2.30 shows the total direct operating expenses (operating expenses not including debt servicing), total revenues (passenger fares) and in the third column, the publicly funded portion of operating expenses, which is the difference of total operating expenses and total revenues. This time series has been adjusted for inflation using changes in GDP. Since revenues essentially cover half of the operating expenses, costs represent the portion of operating expenses that must be paid for by other funding sources, which have traditionally been the municipal, and provincial government. It should be noted that there is a slight trend of increasing revenues, and a fairly significant trend of decreasing public funding requirements. This can be explained by the corresponding reductions in service hours illustrated earlier in this chapter.

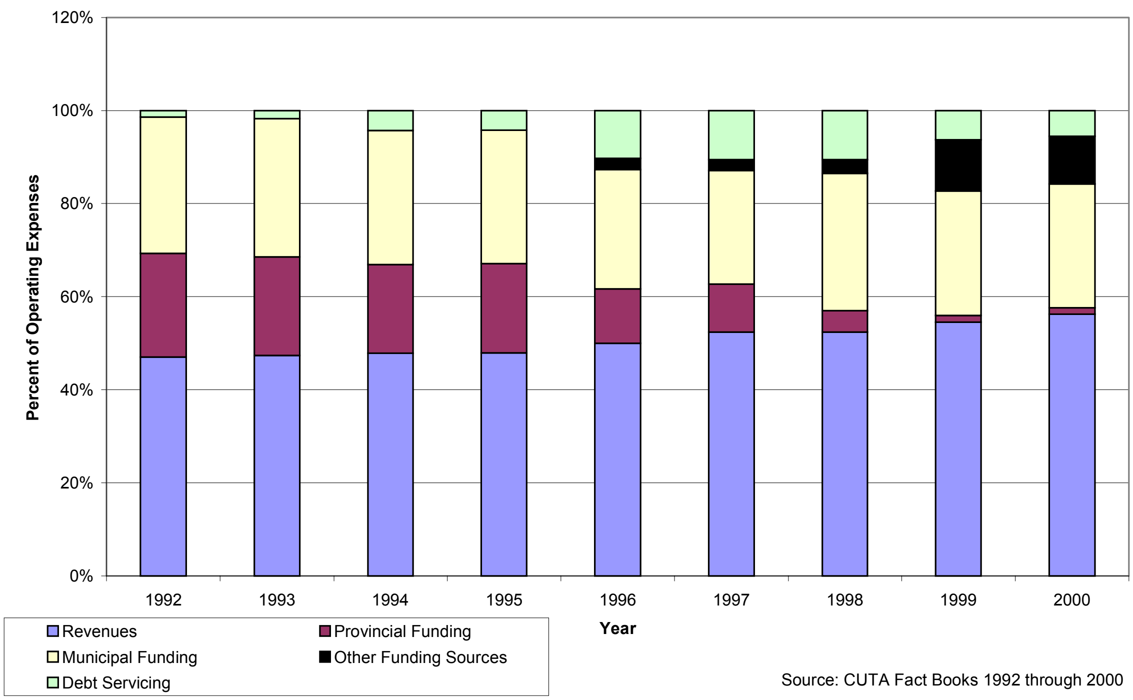
Exhibit 2.30 Operating Costs - Canada
Adjusted for Inflation (GDP)



Source: CUTA Fact Books, 1992 through 2000

Operating expenses are paid for by operating revenues (customer fares), municipal funding, provincial funding and other sources, which might include a gas tax allocation, as is the case in British Columbia and Alberta. During the nine years of examined data, funding from operating revenues has increased slightly, while provincial funding decreased to almost non-existence by 1999. As is shown in Exhibit 2.31 municipal funding has stayed fairly constant, and other funding sources have increased. Some agencies report debt servicing as part of their operating budget. The debt may be a result of operating or capital expenses not fully covered in previous years.

Exhibit 2.31 How Operating Expenses are Paid For



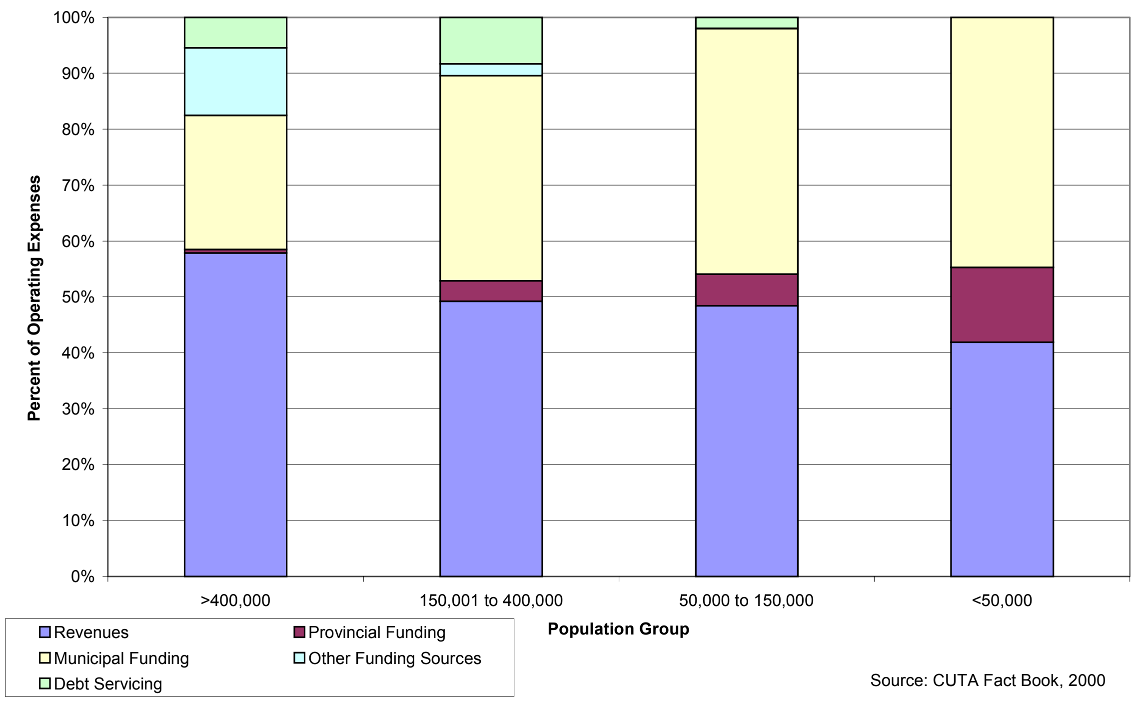
Source: CUTA Fact Books 1992 through 2000

The 2000 provincial perspective indicates that Alberta, British Columbia, Newfoundland, Manitoba, Saskatchewan and the Territories did not report any debt servicing in 2000.

From a population group perspective, the larger transit agencies (greater than 400,000) cover more of their operating expenses with revenues, and receive less provincial and municipal funding, while utilizing other funding sources more than the smaller agencies. The smallest agencies (less than 50,000) are able to cover their operating expenses fully through revenues, provincial and municipal funding, while the larger groups generally servicing some debt. This and other related information is shown in Exhibit 2.32.

Transport Canada has completed additional analysis on the CUTA information that shows that operating costs make up approximately 70% of total transit costs, including capital. Of the operating costs, about 70% are for labour, 7% for fuel, 3% for leases and rents and the remaining 20% for other materials and services.

Exhibit 2.32 How Operating Expenses are Paid For (2000)



Source: CUTA Fact Book, 2000

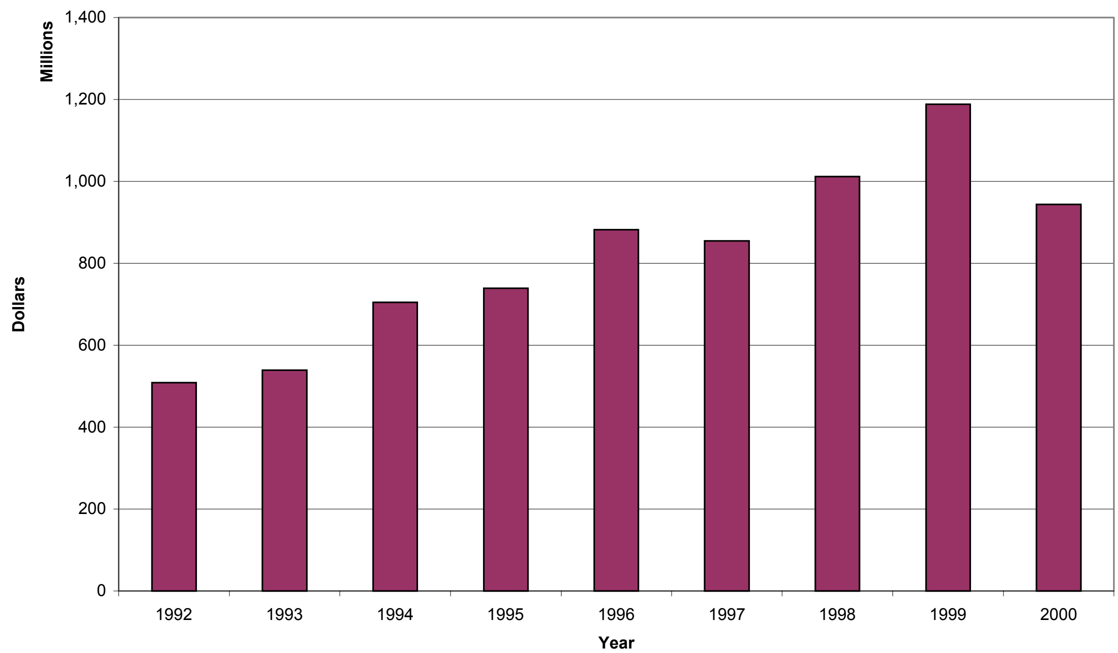
2.3.2 Capital Revenues and Expenses

Exhibit 2.33 shows that capital expenses in the year 2000 reached almost $1 billion Canada wide, with every province except Nova Scotia purchasing transit equipment or infrastructure. Funding in the order of $750 million came from provincial, municipal and other sources to cover capital expenses, with the remaining $250 million being covered by debt or unused funding from previous years. Capital expenses increased steadily between 1992 and 1999, declining to 1998 levels in 2000. Funding in the same time frame has also increased, but never kept up to expenses. Almost all of the reported capital expenses and funding was directed towards cities larger than 400,000 in population, with smaller systems logging in the order of $60,000 in expenses and $50,000 in funding.

Similar to operating funding, capital funding from the provincial governments has experienced a general downwards trend. Unlike operating funding, the difference has had to be made up entirely by municipal contributions, which have risen steadily in response to the declining provincial funding. The results of this analysis are displayed in Exhibit 2.34.

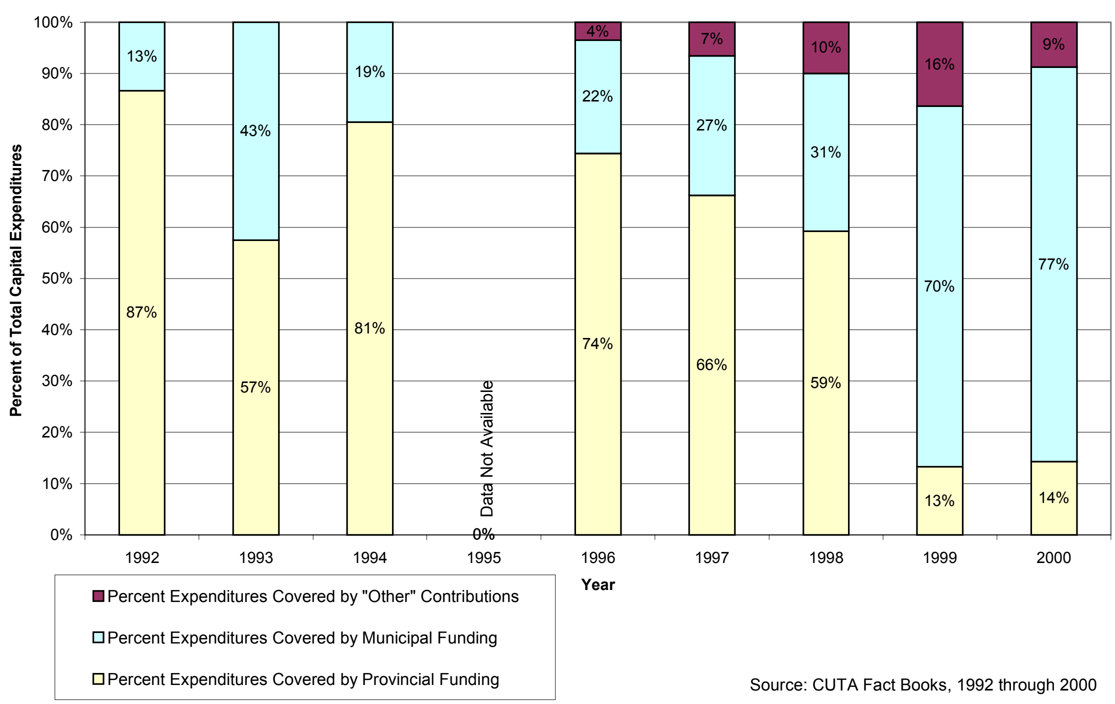
It should be noted that municipalities and transit agencies across Canada have different ways of reporting their financial information. Some report their capital expenses in the year they occur while others depreciate their capital expenses over a number of years. This can make it difficult to compare capital expenses between individual agencies. Fortunately, the CUTA database is large enough that a realistic picture of overall capital expenses for Canada is provided because the agencies that report year by year balance each other out and the average can be added to those that use the depreciation method.

Exhibit 2.33 Capital Expenditures



Source: CUTA Fact Books, 1992 through 2000

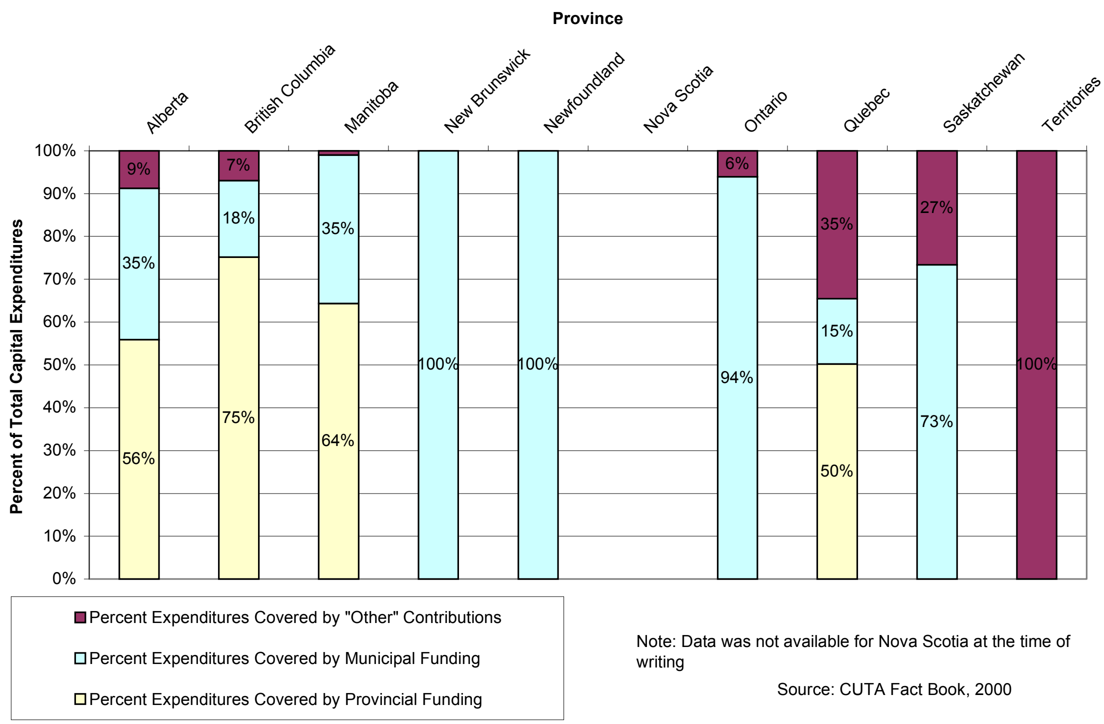
Exhibit 2.34 Capital Expenditure Funding



Source: CUTA Fact Books, 1992 through 2000

The funding sources for each province in 2000 are illustrated in Exhibit 2.35, and clearly show the variations between the provinces. It should be emphasized the proportions and amounts of capital funding vary substantially from year to year as the various provinces announce new initiatives. Industry funding is discussed in more detail in section 2.3.5. (Note: Ontario recently announced renewed funding for transit. Unconfirmed discussions with CUTA indicate that Nova Scotia provides no capital funding assistance.)

Exhibit 2.35 Capital Expenditure Funding (2000)



2.3.3 Financial Performance

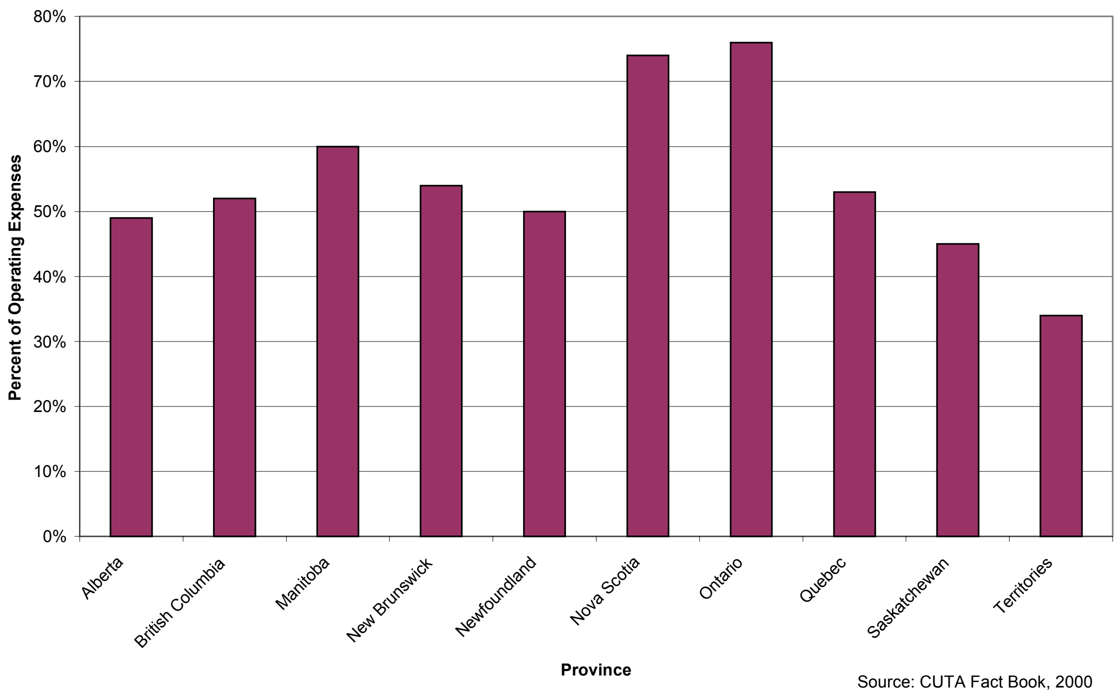
Revenue-Cost

The revenue to cost ratio is a standard financial performance indicator, which is utilized by transit agencies to gauge the proportion of operating expenses that are covered by operating revenues. Between 1992 and 2000, revenue to cost ratios Canada wide have steadily increased from 53% to 63%. The reasons for this change are two-fold:

- Many transit systems have maintained or increased fares relative to inflation, resulting in revenues that declined at lower rates than ridership did during the same period, and;
- Faced with declining ridership and changes in funding structure, many transit systems reduced service and, as a result, costs.

Ontario and Nova Scotia have the highest revenue to cost ratios of the provinces, as is shown in Exhibit 2.36. Higher average fares in these two provinces as well as lower than average operating costs explain the higher revenue to cost ratio. These are the two provinces without Provincial funding support in 2000. In general, revenue-cost ratios increase with city size.

Exhibit 2.36 Total Operating Revenue/Total Operating Expenses (2000) - by Province

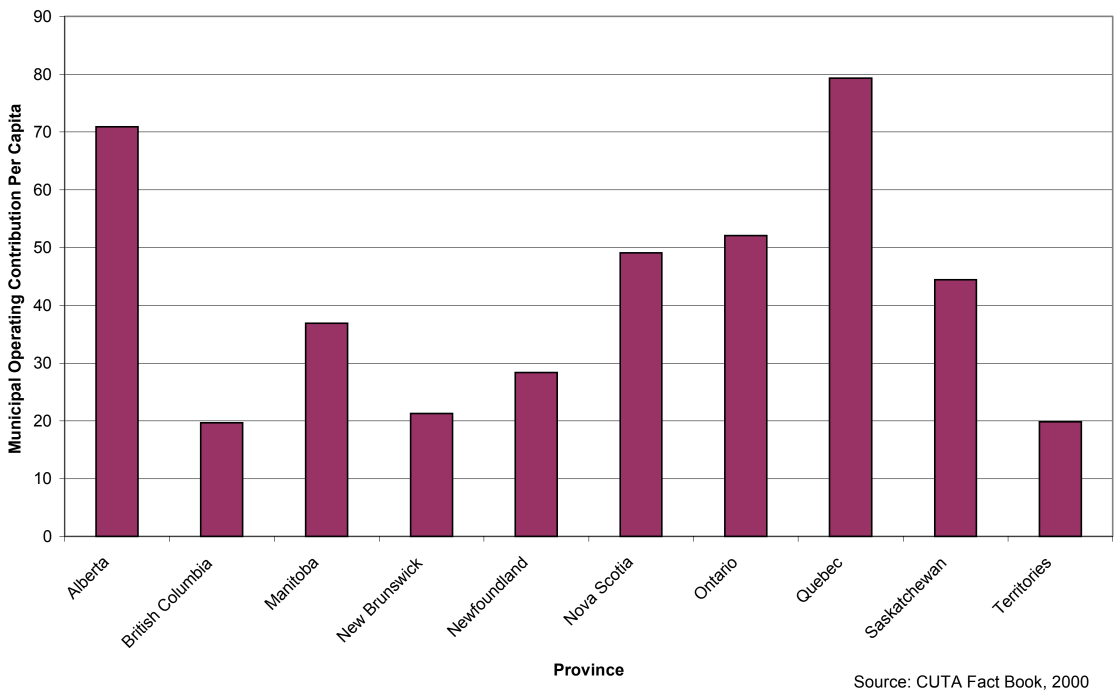


Source: CUTA Fact Book, 2000

Municipal Operating Contribution per Capita

Municipal operating contribution per capita is another financial performance indicator, which is defined as the municipal operating contribution of net operating costs divided by service area population. Over the past nine years this value has fluctuated between $51 and $67 per capita. As is shown in Exhibit 2.37, Quebec and Alberta receive the greatest municipal funding per capita of Canadian provinces, while British Columbia and the Yukon receive the least. The reason for the low municipal contribution in British Columbia has to do with the structure of BC Transit, which is provincially operated, rather than in other provinces where the transit agencies are operated by the municipality. Quebec and Alberta both charge lower than average fares, which would increase their per capita municipal funding requirements. Also, Alberta supplies light rail transit in both of its major cities, which has a higher operating cost than bus transit. In general, as city size increases, municipal funding per capita increases.

Exhibit 2.37 Municipal Operating Contribution Per Capita (2000) - by Province

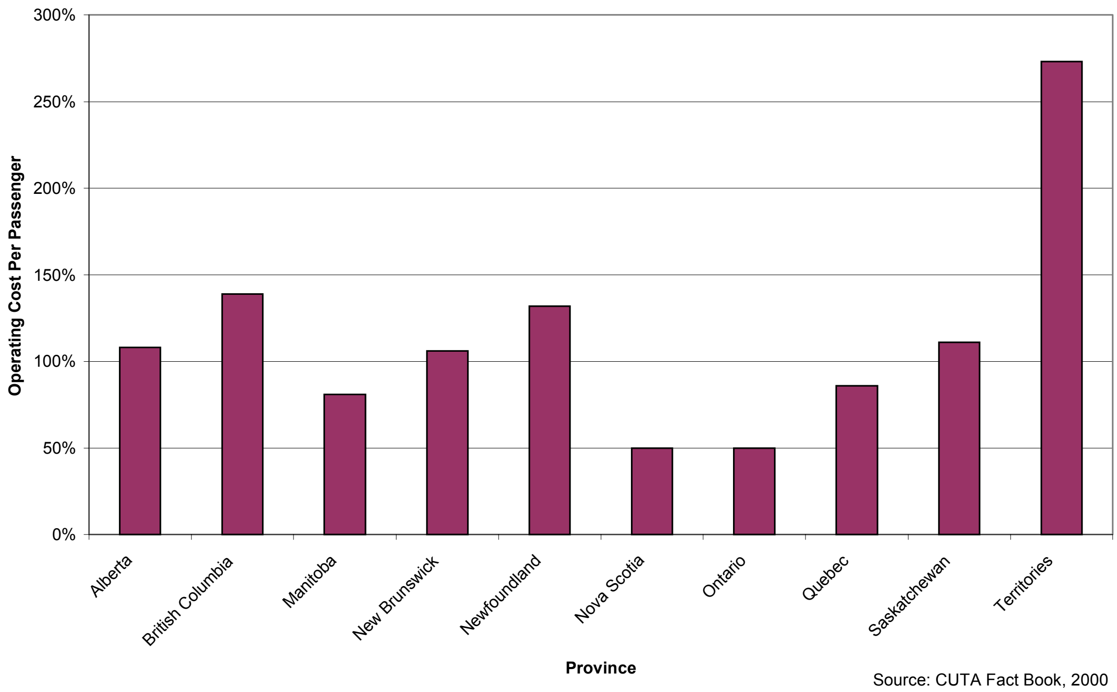


Source: CUTA Fact Book, 2000

Net Direct Operating Cost per Passenger

Net direct operating cost per passenger has declined significantly over the past 9 years, decreasing from $1.31 in 1992 to $0.78 in 2000. Across Canada, the lowest cost per passenger service is provided in the provinces of Ontario and Nova Scotia, while the highest is provided in the Yukon. The provincial variation is illustrated in Exhibit 2.38. From a city size perspective, as a city increases in size and ridership per capita increases, the operating cost per passenger decreases in dollar value.

Exhibit 2.38 Net Direct Operating Cost Per Passenger - by Province (2000)



Source: CUTA Fact Book, 2000

2.3.4 Equipment and Infrastructure

The costs of purchasing and building transit equipment and infrastructure are high because of the complexity and multidisciplinary nature of the machinery, systems and infrastructure. Exhibit 2.39 lists costs of typical transit equipment and infrastructure.

Exhibit 2.39

Costs of Transit Equipment and Infrastructure

Item	Cost
Standard Low Floor Bus	$420,000
Articulated Low Floor Bus	$660,000
Small Bus	$75,000 to $300,000
Complete GO Train	$29.5 million
GO Train Locomotive	$4.5 million
GO Train Car	$2.5 million
Subway Car	$1.2 million
Light Rail Vehicle	$2.5 - $3.0 million
Bus Rapid Transit[1]	$10 - $25 million/km
Light Rail Transit[1]	$24 - $42 million/km
DMU[2] Rail[1]	$10 - $14 million/km
Subway[1]	$160 million/km

[1] Does not include vehicle costs
[2] Diesel Multiple Unit – Each railway car has its own diesel engine.

It should be noted that there can be wide variation in the costs indicated in Exhibit 2.39. For example, the infrastructure costs per kilometre will vary depending on a number of geographic and engineering factors and the scope of the individual project. While vehicle costs are not quite as wide ranging as with infrastructure, they can also vary depending on the specifications and requirements of transit agencies making the purchase.

2.3.5 Industry Funding

Until recently, funding for both capital and operating expenditures has come from provincial and municipal governments, with provincial governments covering a larger portion of the total costs. Of late, provincial funding has declined significantly, forcing transit providers to become more reliant on municipal funding, fare revenues and alternative funding sources.

As discussed in Section 2.3.1, provincial funding has declined significantly, and interestingly enough, although nominally, municipal funding has also declined. As should be expected, budget shortfalls increased, as transit providers tried to adjust to funding changes. Adjustments have been made, with revenues covering an increasing portion of operating costs and innovative funding sources such as regional gas tax and other allocations making significant contributions to transit in Alberta, British Columbia and Quebec.

Capital funding has also gone through substantial changes over the past several years, with the proportion of provincial funding dropping from 87% in 1992 to 13% in 1999. The shortfall in capital funding has been made up more and more by municipal property taxes and with the introduction of innovative funding sources.

In total, provincial, municipal and other sources accounted for over $2 billion in funding for both capital expenditures and operating expenses. Ontario municipalities received almost $1 billion, Quebec almost $500 million, British Columbia $300 million and Alberta $250 million, with the remaining provinces and territories receiving approximately $78 million.

Due to the structural changes transit funding has undergone over the past several years, reporting has lost some of its continuity. CUTA has summarized the current funding schedule for the different municipalities and provinces responsible for transit across Canada, in a report titled: *Provincial and Territorial Funding of Urban Transit: A Cross-Jurisdictional Comparison*, published in November 2000. The report describes funding sources for conventional versus specialized transit services, specialized involving paratransit operations. Direct and indirect investment is also delineated, with direct investment defined as grants made to a municipality with the specific purpose of financing transit. Indirect investment is defined as funds made available to the municipality that may be spent on transit, but may also be designated to other projects.

The report found that direct provincial investment in specialized transit was provided in the majority of provinces and territories, excluding Alberta, Greater Vancouver Regional

District (GVRD), New Brunswick, Ontario and PEI. Conventional transit receives less direct provincial investment, with only British Columbia, Manitoba and Quebec receiving grants. Indirect funding of conventional and specialized transit was much more inclusive, with almost every province and territory supporting transit with unconditional grants, dedicated taxes or tax transfers.

2.4 Chapter Summary

Transit ridership levels have declined in Canada since a high point in the late 1980's, but have begun to increase again in the past two years. They are currently at 1.5 billion passenger trips per year, resulting in a per capita ridership of 80 in the year 2000. Seventy-six percent of transit trips were made by adults, 13% by students and 5% by seniors. 1.25 billion trips occurred in cities with populations greater than 400,000, a majority of those occurring in Quebec and Ontario, Canada's two most populated provinces. Interestingly, Ontario services more passengers than Quebec, although Quebec has a higher ridership per capita rate.

In the 1996 Canadian Census, Statistics Canada found that 10% of Canadians take transit to work. The 24-hour journey to work transit modal share ranges from 22% in Toronto to 2% in St. Catharines. However, in many of the larger Canadian cities the transit modal share for downtown work trips exceeds 50 percent. In general, transit modal share increases with city size.

The demand for transit is more closely correlated to population density than any other city characteristic. Ridership levels are also greatly influenced by the quality of transit service such as the availability of transit, reliability, convenience and price. Factors such as demographics, distribution of land use, congestion, the cost of car ownership, and the like also influence the demand for transit.

Canadian transit agencies support the full complement of transit vehicles and services, including commuter rail and light rapid transit in the larger cities, as well as buses that provide the majority of service in cities large and small across Canada. Paratransit, smaller community buses and ferries enhance and contribute to the flexibility of the transit industry's service in Canada.

Transit revenue hours have stayed fairly steady over the past nine years at approximately 30 million annually. Ontario, Quebec, British Columbia and Alberta are the largest contributors to this figure. Service utilization is the highest in Quebec at 64 passengers per vehicle hour, with the Canada wide average in the area of 40 to 45 passengers per vehicle hour. As a general rule, service utilization increases with city size. In 2000, 14,335 active transit vehicles supplied this service, an increase of 12% over the last nine years. Transit agencies are increasing their stock of low floored buses, and in 2000, 23% of active buses are low floored buses.

Vehicle age is an area of concern for transit agencies. Ideally, an average fleet age of 8 years is recommended. In Canada the average fleet age is 11 years. Service life for many buses is exceeding 20 years, with a recommended life of 15 to 16 years. Although the vehicle replenishment rate has increased over the past few years it is still a critical issue for transit agencies across Canada, as bus manufacturers are not necessarily outfitted to accommodate the upcoming demand.

Canadian transit vehicles log, on average, 58,000 kilometres annually. In doing so, they consume more than 372 million litres of diesel; the most widely used fuel type, as well as 640 thousand litres of gasoline, 27 million cubic metres of natural gas and 762 million kilowatt-hours of electricity. Emission regulations for buses are continuously being updated, as are technologies to reduce emissions.

Technologies in the transit industry do not stop at reducing emissions, but include vehicle types, construction, fare collection, collision avoidance, security, transit priority measures and information systems. All these technologies are expected to improve the quality of the service to customers and the work environment for the over 40,000 people employed by transit agencies across Canada.

Labour is a significant issue, considering its impact on the cost of transit in Canada. Operating expenses, a majority of which are labour costs, surpassed the $3.5 billion mark in 2000. Revenues (generated from fares) have been increasing over the past nine years and reached $2 billion in 2000, covering more than half of the expenses. Municipal and provincial governments have traditionally subsidized the portion of expenses not covered by fares. Over the past 10 years provincial operating funding has diminished from 22% to 1% of expenses. Although the increase in revenues has helped to cover much of shortfall resulting from diminished provincial funding, the transit industry has stepped up to the challenge of developing promising new and innovative funding mechanisms. In the interim, many transit agencies were forced to carry some debt to pay for the shortfall in their operating budgets.

Capital expenditures reached 1 billion dollars in 2000. Provincial funding for capital expenditures has diminished, with the difference now mostly paid for by municipal funding on a Canada wide spectrum. The different provinces treat capital funding very differently, with some provinces, such as Ontario, utilizing mostly municipal funding, and others, such as British Columbia financing 88% of their capital expenditures with debt.

3.0 CANADIAN TRANSIT IN CONTEXT WITH OTHER COUNTRIES

Chapter 2 established the current transit situation in Canada. This chapter compares what is known about Canadian transit with what is known about transit agencies around the world. The original intent was to determine city pairs using a Canadian city and an international city with similar characteristics in population, culture, density and geography. This task was made immeasurably easier with the release of *The Millennium Cities Database for Sustainable Transport*, produced by J. Kenworthy and F. Laube, published by UITP, International Association for Public Transport, and ISTP, Institute for Sustainability and Technology Policy. The database contains statistical information on 100 different cities around the world, including the Canadian cities of Calgary, Montreal, Ottawa, Toronto and Vancouver. Sixty raw indicators were used to create 223 indicators that can be used to compare transit systems around the world. The data supplied in the database is from 1995, and every reasonable attempt to standardize the data to make it comparable has been made by the authors. Thus, as is the case with all data that is collected from hundreds of different sources, some inconsistencies are sure to exist, nonetheless, the database provides a valuable tool in allowing a high level comparison, as is the purpose of this exercise. Detailed information describing how the various database indicators were developed is not provided in this report, but can be found in the *Millennium Cities Database* documentation.

The breadth of information in the *Millennium Cities Database* revealed that it is impossible to pick city pairs based upon the selected criteria; cities are just too unique. The multifaceted nature of cities leaves too many discrepancies in the comparison to really shed any light on why our transit systems operate differently, or what may be done to improve Canadian systems. The good news is that the database opened a new opportunity of analysis in comparing Canadian cities to a breadth of similar cities. Thus, the following section documents the analysis of city groups. Three groups are assembled based upon having either similar populations, and/or population densities, shown in Exhibit 3.1.

Exhibit 3.1

City Comparison Groups

Group 1	Group 2	Group 3
Toronto (CMA)	**Calgary**	**Victoria, BC**
Montreal	**Ottawa**	**London, ON**
Vancouver	Oslo, Norway	Wellington, New Zealand
Atlanta, US	Zurich, Switzerland	Geneva, Switzerland
Chicago, US	Helsinki, Finland	Berne, Switzerland
Denver, US	Stockholm, Sweden	Atlanta, US
Houston, US	Curitiba, Brazil	Houston, US
San Francisco, US	Johannesburg, South Africa	Washington, US
Washington, US	Wellington, New Zealand	Melbourne, Australia
Berlin, Germany		
Madrid, Spain		
Melbourne, Australia		
Sydney, Australia		
Johannesburg, South Africa		
Curitiba, Brazil	Note: Shaded cells indicate cities used in more than one comparison group	

Source: The Millennium Cities Database for Sustainable Transportation

Since the cities were grouped based upon the two criteria of population and population density, there are several cities that may seem unmatched upon first glace, for instance, Victoria and Atlanta. Strangely enough they are matched on the basis of density, since Atlanta has a similar density to Victoria. Curitiba and Johannesburg matched Canadian city populations and densities more closely than US or European cities, and were therefore included for interest sake.

To provide additional context, several other indicators are presented, including:

- Gross Domestic Product (GDP) per capita,
- Parking spaces per 1000 jobs in the Central Business District (CBD),
- Number of personal vehicles per 1000 people,
- Journey to work distance,
- And public transportation investment (capital expenditures).

Exhibit 3.2 provides this information for the selected cities, and corresponding charts are provided in Appendix A.

Exhibit 3.2

General City Indicators (1995)

City	Group	Population (1000s)	Population Density (persons/hectare)	GDP/Capita (1000 USD/Person)	Parking Spaces/ 1000 CBD jobs	Cars/1000 People	Journey to Work Distance (km)	Transit Investment (USD/person)
Toronto (CMA)	**1**	**4,629**	**25.5**	**19.5**	**236**	**464**	**16.3**	**51.2**
Montreal	**1**	**3,224**	**31.7**	**16.1**	**455**	**429**	**11.9**	**31.8**
Vancouver	**1**	**1,899**	**21.6**	**25.8**	**444**	**520**	**13.0**	**34.2**
Atlanta	1,3	2,897	6.4	31.0	727	746	26.8	48.1
Chicago	1	7,523	16.8	32.1	114	573	16.3	75.4
Denver	1	1,985	15.1	32.4	623	630	16.2	36.3
Houston	1,3	3,918	8.8	30.7	698	693	20.8	28.2
San Francisco	1	3,838	20.5	37.1	157	600	20.4	112.6
Washington	1,3	3,739	14.3	34.4	271	573	20.7	105.7
Berlin	1	3,471	56.0	23.5	174	354	9.8	241.7
Madrid	1	5,182	85.9	17.6	263	431	10.8	169.2
Melbourne	1	3,138	13.7	21.5	349	594	15.6	34.0
Sydney	1	3,741	18.9	22.4	197	516	16.9	108.7
Johannesburg	1	2,448	29.6	5.1	221	269	20.2	29.2
Curitiba	1,2	2,432	30.3	6.5	84	216	11.8	11.4
Calgary	**2**	**767**	**20.8**	**24.0**	**465**	**703**	**11.5**	**14.1**
Ottawa	**2**	**972**	**31.3**	**18.8**	**348**	**532**	**10.5**	**42.7**
Oslo	2	918	24.0	39.0	164	384	12.0	163.8
Zurich	2	786	44.3	50.2	130	462	10.8	279.2
Helsinki	2	891	33.0	28.3	381	322	12.0	96.8
Stockholm	2	1,726	29.0	33.4	137	386	13.2	73.1
Wellington	2,3	366	22.0	18.0	1057	513	10.9	12.4
Victoria	**3**	**330**	**5.4**		**320**	**470**		**57.2**
London, ON	**3**	**326**	**6.3**					**40.2**
Geneva	3	399	52.4	45.3	570	491	6.1	83.0
Berne	3	296	43.9	43.5	154	400	10.4	183.2

Source: The Millennium Cities Database for Sustainable Transportation

Population**:** The Group 1 population ranges from 1.8 million people in Vancouver to 7.5 million people in Chicago. The majority of the comparison cities were in the range of 2 to 4 million, similar to Toronto and Montreal. Chicago is an outlier, but was included because of its geographical similarities to Toronto. Group 2 cities range in population from 366,000 in Wellington to 1.7 million in Stockholm. Stockholm and Wellington are outliers from the majority of cities in this group that are in the area of 900,000, but were included due to their similarity in population density. Group 3 was a hard group to compile a comparison set for, due to the small population size. Very few of the cities included in the database have populations below 400,000, nevertheless, there were several cities that had comparable population densities to Victoria and London in the United States, and therefore were included on the basis of density. The population of Group 3 cities ranges between 300,000 and 3.9 million.

***Population Density*:** Canadian cities are more densely populated than most of their American counterparts, and less densely populated than comparable cities in Europe. Interestingly, based on population and density statistics, Curitiba, Brazil and Johannesburg, South Africa were the closest matched cities in the database. In general, across all three groups, population density was low in the US and Australia, moderate in Canada and high in Europe. Asian cities were not used in this comparison because the population densities were significantly higher than those found in Canada.

***GDP per Capita*:** GDP per capita was included to provide a gross comparison of the relative wealth of the cities. In general, US and European cities have a much higher GDP per capita than Canadian cities, while Australian and New Zealand cities are similar, and Curitiba and Johannesburg have a much lower GDP per capita.

***Parking Spaces per 1000 Jobs in the CBD*:** This category was included in the indicators, to examine whether or not the availability of parking spaces influences transit ridership. This is a highly variable indicator with values ranging from over 1000 (more spaces than jobs) in Wellington, to 114 in Chicago, and 84 in Curitiba. Most cities provide in the range of 200 to 300 parking spaces per 1000 jobs in the CBD, with Canadian cities falling on the high side of this range, at about 400 spaces per 1000 jobs.

***Passenger Cars per 1000 People*:** European cities have in the range of 300 to 400 passenger cars per 1000 people, North American, New Zealand and Australian cities have 500 to 600 and Johannesburg and Curitiba have 200 to 300. The outliers in this category are Atlanta and Calgary, which have over 700 passenger cars per 1000 people.

***Journey to Work Distance*:** Journey to work distances are in the range of 10 to 20 kilometres, with the European cities at the lower end of the range, the Canadian and Australian cities in the middle and the U.S. Cities at the high end. Geneva is a low outlier with a journey to work distance of 6.1 kilometres, while Atlanta's residents travel an average of 26.8 kilometres.

***Public Transit Investment per Capita*:** This is an indicator of investment in capital transit expenditures, and therefore may vary significantly from year to year, but still does indicate the government's involvement in public transit. The range in spending varies from $11US in Curitiba to over $270US in Zurich. Canadian cities fall in the range below $60US, American cities in the range of $50US to over $100US, and European cities in the range of just under $100US to over $200US. These numbers can be misleading, as they are an annual account, but do not consider spending in previous years. Capital investment by public transit agencies fluctuates significantly from year to year in Canada, and likely on the international spectrum. Light rail, subways and other large-scale projects require a large investment by transit agencies, but may allow the agency to reduce capital expenditures in the following years. For instance, in 1995 OC Transpo (Ottawa) built and opened the South East Transitway from Billings Bridge to South Keys, showing a $42.70 investment per person in the Millennium Database. Calgary's annual investment in 1995 was relatively low at $14.10 per person. Calgary had just finished extending their northwest C-Train line to Brentwood, a few years prior, and did not have any more major expansion plans for the next several years.

In summary, as with our nature, Canadian cities are the moderates in city indicators.

Canadian cities operate a diverse range of public transportation services and vehicles. Exhibit 3.3 shows the different types of service available in the comparison cities. Note that this Exhibit reflects the situation in 1995 and does not account for newer services such as Ottawa's O-Train.

Exhibit 3.3

Public Transit Modes (1995)

City	Bus	Minibus	Tramway	Light Rail	Metro	Heavy Rail
Toronto (CMA)	✓		✓		✓	✓
Montreal	✓				✓	✓
Vancouver	✓				✓	✓
Atlanta	✓	✓			✓	
Chicago	✓	✓			✓	✓
Denver	✓			✓		
Houston	✓					
San Francisco	✓		✓	✓	✓	✓
Washington	✓				✓	✓
Berlin	✓		✓			✓
Madrid	✓				✓	✓
Melbourne	✓		✓			✓
Sydney	✓					✓
Johannesburg	✓	✓				✓
Curitiba	✓	✓				
Calgary	✓	✓		✓		
Ottawa	✓					
Oslo	✓		✓			✓
Zurich	✓		✓	✓		✓
Helsinki	✓		✓		✓	✓
Stockholm	✓			✓		✓
Wellington	✓					✓
Victoria	✓					
London, ON	✓	✓				
Geneva	✓		✓			✓
Berne	✓		✓	✓		✓

Source: The Millennium Cities Database for Sustainable Transportation

The report *National Vision for Urban Transit in 2020* describes five key target indicators for the Canadian transit industry in the future. They are:

1. Annual transit ridership,
2. Annual transit ridership per capita,
3. 24 hour transit weekday modal split,
4. Peak hour modal split to central area, and
5. Transit revenue/cost (R/C) ratio.

The *Millennium Cities Database* provides comparative information on three of the above target indicators for the selected comparison cities:

- Total boardings per capita (a function of ridership per capita),
- Mode split (24 hour transit weekday modal split),
- Operating cost recovery (Transit revenue/cost (R/C) ratio), and
- Operating cost per passenger kilometre (USD/passenger kilometre).

As with the city indicators, the transit indicator figures were retrieved from the database and are summarized in Exhibit 3.4, on the following page, and illustrated in bar charts in Appendix A.

Exhibit 3.4

Public Transportation Indicators (1995)

City	Group	Total Boardings/Capita	Transit Modal Share of all Trips (24 hours)	Operating Cost Recovery (R/C)	Operating Cost per Passenger Kilometre (USD/pass.km)
Toronto (CMA)	**1**	**158.16**	**14.21**	**70.7**	**0.15**
Montreal	**1**	**206.26**	**12.57**	**45.3**	**0.20**
Vancouver	**1**	**118.19**	**5.63**	**51.6**	**0.25**
Atlanta	1,3	50.60	2.12	36.4	0.36
Chicago	1	72.09	4.50	44.7	0.29
Denver	1	32.20	1.43	20.0	0.45
Houston	1,3	20.53	1.16	24.2	0.52
San Francisco	1	103.35	5.45	35.8	0.32
Washington	1,3	100.03	6.32	45.8	0.35
Berlin	1	311.23	23.58	39.5	0.35
Madrid	1	280.82	31.53	61.8	0.17
Melbourne	1	101.2	7.09	34.7	0.21
Sydney	1	140.93	7.18	80.5	0.16
Johannesburg	1	145.19	12.47	51.8	0.06
Curitiba	1,2	265.27	21.61	100.5	0.05
Calgary	**2**	**113.47**	**5.81**	**49.6**	**0.14**
Ottawa	**2**	**104.83**	**7.16**	**56.0**	**0.16**
Oslo	2	221.17	14.5	81.2	0.22
Zurich	2	505.22	19.74	50.0	0.31
Helsinki	2	305.15	19.84	63.6	0.18
Stockholm	2	332.57	17.89	42.9	0.20
Wellington	2,3	57.39	3.76	69.5	0.14
Victoria	**3**	**77.91**		**49.0**	
London, ON	**3**	**64.75**		**67.0**	
Geneva	3	336.57	14.06	73.1	0.60
Berne	3	577.77	20.76	61.8	0.31

Source: The Millenium Cities Database for Sustainable Transportation

***Boardings per capita*:** For Canadian cities, boardings per capita generally increase with city size from below 100 in Victoria and London to over 200 in Montreal. This contrasts well compared to US cities where even the larger agencies with notably extensive public transit systems (Washington, San Francisco, and Chicago), only achieve 100 boardings per capita. Australian systems have approximately similar boardings per capita, than in Canada in general. The European comparison cities, as well as Curitiba achieve a much higher boarding per capita rate, in the range of 200 to greater than 500 in Zurich and Berne.

***Transit Modal Share*:** Transit's overall mode share defined ranges between 1.2 in Houston and 31.5 in Madrid, generally following the same trend as boardings per capita, with European cities achieving much higher values than the remainder. Canadian cities in Group 1 have a significantly higher transit mode share than their American counterparts, and slightly higher than the Australian's. Group 2 cities are slightly higher than US cities in general, and about the same as San Francisco and Washington. 24 hour overall mode share information was not available for Victoria and London, Ontario.

***Operating Cost Recovery*:** In 1995, Toronto achieved an R/C ratio of almost 70 percent, which was only surpassed in Group 1 by Curitiba, and Sydney. In general, the Canadian agencies R/C ratios are higher than their American counterparts and even slightly higher than the European agencies in Group 1. Group 2 Canadian cities are consistent with their European and southern hemisphere cities, the exceptions being Curitiba and Oslo, which both have much higher R/C ratios than the rest of the group. The Canadian cities in Group 3 are slightly higher than their American counterparts and lower than the European cities and Wellington, New Zealand.

When compared on the international spectrum, Canadian transit agencies perform surprisingly well. Our closest neighbour, with whom we have many cultural, and geographical similarities, the United States, does not achieve the transit ridership levels found in Canada for comparable cities. On the other hand, European cities, where there are much higher population densities, achieve much higher ridership levels than comparable Canadian cities. It should not be overlooked that European cities spend significantly more money on transit capital investment per capita than comparable Canadian cities, while U.S. cities spend similar or slightly more. A comparison of the operating cost recovery (R/C) ratio indicates that Canadian cities fare better than both European (because they spend so much) and U.S. (because they have such low ridership) cities.

In general, it seems as though Canadian transit agencies are on the right trajectory with regard to ridership and cost recovery. Canadian cities compare well when compared to other international cities, but as always, there is room for improvement. It is clear that this improvement will not come without a cost.

4.0 THE FUTURE OF TRANSIT IN CANADA

The report "National Vision for Urban Transit to 2020" outlines five key indicators and provides targets for these indicators for the year 2020. The indicators and their associated targets are outlined in Exhibit 4.1 below.

Exhibit 4.1

Potential National Urban Transit Targets

2020 Target or Change from 2000, and Quantitative Indicators	Size of Urban Area		
	Small	Medium	Large
Percent increase in annual transit ridership by 2020 from 2000	20-40%	30-60%	40-80%
Annual transit rides per capita in 2020	20-50	30-100	100-250
24-hour transit weekday modal split in 2020	2-10%	5-15%	10-25%
Peak hour modal split to central area in 2020	10-30%	30-50%	50-80%
Transit revenue/cost (R/C) ratio in 2020	40-60%	50-70%	60-80%

Source: "National Vision for Urban Transit to 2020"

What will it mean for the transit industry in Canada to achieve these targets? Can they be achieved? To explore these questions, three scenarios describing possible futures have been developed:

1. Declining Modal Share Scenario.

   This scenario assumes that the transit industry will not grow or change as the population of Canada grows. Ridership, fleet size, revenues and costs will remain at today's levels resulting in a continual decline in modal share.

2. Stable Modal Share Scenario.

   This scenario takes a snapshot of the Canadian transit industry today and projects it into the future. To do this, the scenario assumes that the transit industry will grow in the same proportions as the population of Canada. Overall ridership will grow at the same rate as the population, modal share will remain constant and average revenue and cost per passenger will not grow in real terms in this scenario. It is also assumed that the nature of Canadian cities in terms of density, land use characteristics and population distribution will not change, even as the cities grow.

3. Increasing Modal Share Scenario.

   This scenario is based on the indicators and targets outlined in the report "National Vision for Urban Transit in Canada to 2020" and shown in Exhibit 4.1. These assume that the transit industry will grow more quickly than the overall Canadian population.

Details of the assumptions made for all three scenarios along with supporting background information are provided in the following sections of this chapter. The specific background information includes a discussion of the future population growth in Canada and a description and analysis of the recent Transit Infrastructure Needs Survey carried out by the Canadian Urban Transit Association in 2001. This is followed by a detailed development and discussion of results of the three different scenarios, and a section that compares the scenarios and discusses the impacts and issues around achieving them. Note that all dollar figures for the three scenarios are expressed in current (1999) dollars while those from the CUTA survey are in 2001 dollars.

4.1 Future Population Growth in Canada

Before projecting the future of the transit industry, the growth of the Canadian population as a whole must be understood. Statistics Canada's medium growth projection for Canada shows that the population is expected to increase from almost 30.5 million people in 1999 to approximately 35.4 by 2021, an increase of 16%. The detailed population growth information is provided in Exhibit 4.2 below.

Exhibit 4.2

Population Growth in Canada

Year	Population (millions)
1999	30.5
2001	31.0
2006	32.2
2011	33.4
2016	34.4
2021	35.4

Source: Statistics Canada

4.2 CUTA Transit Infrastructure Needs Survey

In July 2001, the Canadian Urban Transit Association surveyed its members in order to determine their capital infrastructure needs over the next five years. The survey was comprehensive and 80% of transit systems representing 99% of all Canadian transit operations (in terms of annual operating costs) responded.

The overall results of the survey show that transit systems require approximately $13.5 billion in equipment and infrastructure during the five year period 2002-2006. About half of this total amount is for projects that are currently planned and budgeted while the other half is for projects that would require new funding from other sources. The survey also gathered information on whether the plans and projects were for rehabilitation and replacement or for expansion and ridership growth. Details of this breakdown are provided in Exhibit 4.3.

Exhibit 4.3

CUTA Transit Infrastructure Needs Survey Results
For Canada 2002-2006

	CURRENT PLANS (Millions)	CONTINGENT ON NEW FUNDING (Millions)	TOTAL (Millions)
REHABILITATION OR REPLACEMENT			
Bus Purchases/Refurbishment	$1,702	$263	$1,966
Other Rolling Stock	$417	$17	$435
Fixed Guideway/Rights-of-Way	$680	$377	$1,057
Maintenance Facilities	$311	$20	$331
Other/Miscellaneous	$855	$167	$1,023
Subtotal	**$3,966**	**$845**	**$4,812**
EXPANSION OR RIDERSHIP GROWTH			
Bus Purchases	$460	$240	$701
Other Rolling Stock	$300	$395	$695
Fixed Guideway Construction/Enhancement	$1,127	$3,858	$4,985
Stations/Terminals	$87	$49	$137
Parking Facilities (Stations/Terminals)	$67	$17	$84
Transit Priority Measures	$89	$7	$96
Customer Amenities	$28	$9	$37
Maintenance Facilities	$131	$84	$215
Advanced Technology	$211	$47	$259
Other/Miscellaneous	$336	$1,207	$1,544
Subtotal	**$2,838**	**$5,914**	**$8,752**
Total – Current Plans	**$6,804**		
Total – Contingent on External Funding		**$6,759**	
Grand Total			**$13,563**

Source: Canadian Urban Transit Association

A quick observation from this data is that Transit agencies anticipate having about 80% of the funding necessary for rehabilitation and replacement, but only 30% of the funding for expansion or ridership growth.

Analysis of this data for Canada as a whole is incorporated into the discussion of the various future growth scenarios provided in the following sections of this chapter. A discussion of how this information breaks down for cities of various sizes is also provided in a later section of this chapter.

4.3 Declining Modal Share Scenario

The Declining Modal Share Scenario assumes that the transit industry will not grow as the population of Canada grows. If this were to occur, overall annual transit ridership would remain at 1.4 billion while ridership would decline from more than 80 trips per capita today to less than 70 as the population grew.

The fleet size would remain at 11,548 buses and 2,444 rail vehicles in the Declining Modal Share Scenario. Assuming that all of the buses and half of the rail vehicles will have to be replaced by 2021, the replacement cost of the fleet will be $7.9 billion ($4.9 billion for buses and $3 billion for rail vehicles). This represents $395 million per year if the expenditures were equal each year (these numbers assume that all of the buses are standard low floor vehicles that cost $420,000 per unit and that the rail vehicles are represented by a simplistic average vehicle costing $2.5 million).

For comparison, the CUTA survey found that transit systems are planning to spend $2.12 billion over the next five years on bus and other rolling stock rehabilitation and replacement, or $424 million annually (Note that this number is in 2001 dollars compared with the 1999 dollars developed by the Scenario. The 2001 figures have not been adjusted back to 1999 because of the desire to be able to clearly link with the CUTA information outlined in Exhibit 4.3, and the fact that the resulting difference would not be significant).

The similarity of these annual expenditure numbers ($395 million vs. $424 million), both derived independently, indicates that the plans of transit systems for basic maintenance and replacement of the current fleet are consistent with the requirements of a Declining Modal Share Scenario.

No changes in operating costs per hour or average fare paid have been assumed for this scenario. As the annual ridership will remain constant, the amount of service provided and the total annual operating expenses and revenues will also remain constant.

If the ridership remains constant as the population grows, then overall transit modal share will fall. The all-day transit modal share of all work trips reported in the 1996 Census was 10%. This share would fall to approximately 8.5% by 2021 in this scenario.

4.4 Stable Modal Share Scenario

This scenario looks at the Canadian transit industry today and projects what it might look like in 2021 if the ridership grew at the same rate as the population. The projection does not consider past trends in reaching today's situation, but simply takes the current data and assumes that these results would apply in the future.

If the demand for transit service in Canada grows at the same rate as the population over the next twenty years, then 1999 total annual ridership will grow from more than 1.4 billion to almost 1.7 billion trips by 2021. As this scenario assumes that the transit modal share will remain constant and that the structure of cities and the demographics of the country do not change during this time period, the overall ridership for Canada would remain in the range of 80 to 85 trips per capita.

To accommodate this level of demand in 2021, in the same proportions as experienced in 1999, will require the transit fleet to be increased by the same proportion. This applies both to overall fleet requirements as well as to peak fleet needs. Thus, the number of buses would increase from 11,548 in 1999 to 13,396 in 2021 and the number of rail vehicles would increase from 2,444 to 2,835. The cost of this additional fleet in 1999 dollars would be slightly more than $775 million for buses and $975 million for rail vehicles (using the same vehicle costs as in the Declining Modal Share Scenario).

These numbers are over and above the fleet replacement costs that are necessary. For this scenario, the same assumptions about fleet replacement that were used in the Declining Modal Scenario have been used. Therefore, the total capital cost for fleet through 2021 would be approximately $9.7 billion, which represents about $440 million per year if expenditures were equal each year.

The comparable information from the CUTA survey shows that transit systems have current plans to purchase fleet for both replacement and expansion purposes totalling $2.9 billion over the next five years, or about $575 million annually. This is substantially higher than the $440 million estimated in the Stable Modal Share Scenario. The difference might be explained by the fact that many transit systems have been experiencing ridership growth in excess of their local population growth over the past couple of years and consequently, their resulting fleet plans would reflect this. To check this, the information from a very similar survey that CUTA conducted in 1999, when ridership growth was much less optimistic, was examined. This survey showed that transit agencies had current fleet replacement and expansion plans totalling $2.3 billion over five years or $469 annually. This is more comparable with the Stable Modal Share Scenario assumptions and indicates that transit systems have indeed become more optimistic in the past two years.

In addition to the cost of the fleet, infrastructure costs to support the fleet are necessary. For this scenario, however, it is assumed that no additional infrastructure is required except for the necessary storage and maintenance facilities to accommodate the increased fleet size. Costs for these facilities can vary widely, however, an average of $160,000 per bus (based on a recent bus garage project) has been assumed. In the absence of any current rail information, the bus cost number has been used for storage and maintenance facility costs for rail vehicles. Thus, a total of $360 million in capital would be required for fleet support infrastructure for just the expansion component of the fleet. No costs for rehabilitating any of the existing support or running infrastructure has been accounted for in this scenario.

For this scenario, it has been assumed that operating costs per hour and average fare paid remain constant in real terms. This means that the average revenue to cost ratio of 62% achieved by the transit industry in 1999 would be maintained in the future and overall service provided and the associated operating expenses would grow at the same rate as the population. Thus, total direct operating expenses would grow from more than $2.9 billion in 1999 to almost $3.4 billion while operations revenue will grow from more than $1.8 billion to $2.1 billion over the same time frame.

4.5 Increasing Modal Share Scenario

In the report "National Vision for Urban Transit to 2020", targets are provided for the five primary indicators as outlined at the beginning of this chapter and in Exhibit 4.1. Application of these targets to the transit industry form the basis for this scenario. It should be noted that no discussion of how this scenario could be achieved is undertaken in this section. It is simply assumed that a combination of service, policy and funding changes are made that allow this vision to be achieved.

Ridership

It is proposed that annual transit ridership increase by between 20% and 80% by 2020, depending on the size of the urban area. For the purpose of analyzing this scenario, it is proposed that an overall Canadian transit growth of 50% be assumed. This compares with the population growth of 16% assumed by 2021 and results in ridership increasing from more than 1.4 billion trips in 1999 to almost 2.2 billion trips in 2021. Note that for the purpose of this scenario, there is assumed to be no difference between the target year 2020 and the population growth year of 2021.

While the Stable Modal Share Scenario described previously assumed that annual transit rides per capita would remain constant as population grew, the much higher ridership of the Increasing Modal Share Scenario will result in a significant increase in annual rides per capita. Simply calculating per capita transit usage using the future ridership and population information within this chapter shows that the Increasing Modal Share Scenario will result in figures that are 30% higher than the Stable Modal Share Scenario. Applying this percentage to the urban population based per capita data discussed in Chapter 2 results in an increase in annual transit rides per capita for Canada as a whole from the low 80's to almost 110. This represents a reasonable number based on the urban area size based targets presented in Exhibit 4.1.

Modal Share

According to "Transportation and Climate Change: Options for Action", overall travel by car and light truck throughout Canada is expected to increase by approximately 36% from the year 2000 through 2020. For this analysis, the 36% increase in car and light truck use in all of urban and rural Canada combined has been applied to overall urban travel only and then compared with future transit use. This increase is smaller than the projected transit increase assumed in this scenario and, as a result, the overall modal share of transit will increase. The result is an increase in overall modal share of work trips to approximately 12% compared with the current 10%. This 20% improvement in transit modal share would represent at least 300 million trips annually being carried on public transit that are currently today using cars.

Equipment, Infrastructure and Capital Costs

Continual improvements to transit service brought about by appropriate policy and sustained funding levels will result in increases in transit usage during all time periods and in all market segments. That said, some time periods and segments will see more or less usage than others, depending on a number of factors. Most cities and transit agencies believe that a substantial amount of their future transit growth will come during the traditional peak periods when transit priority initiatives and rapid transit infrastructure can more effectively compete with congested urban roads. This is reasonable given that most transit systems typically already accommodate about two-thirds of their customers during peak periods.

For the Increasing Modal Share Scenario, it is assumed that peak period ridership will grow more quickly than off-peak ridership. If three-quarters of the increase occurs during the peak period, then the implication is that overall peak period ridership would increase by almost 60% while off peak usage would increase by 40% (compared with the overall average of 50% assumed early in this section of the report). This result is extremely important because of the capital costs associated with accommodating peak period ridership growth – most transit systems have to add fleet capacity to address peak growth, while fleet already exists to serve off-peak growth.

Assuming that there is no change in the relative proportion of bus and rail transit vehicles in the future compared with today, and applying the peak period growth rate to the overall fleet numbers, then the number of transit buses in Canada will grow from 11,548 in 1999 to approximately 18,477 by 2021 and the number of rail vehicles will increase from 2,444 to more than 3,910. Using the same assumptions about vehicle types and costs as in the other two scenarios, the capital cost of the additional buses would be $2.91 billion and the additional rail vehicles would require $3.67 billion. Storage and maintenance infrastructure for these vehicles would require $1.34 billion.

The condition of the existing transit fleet also needs to be addressed. The current bus fleet is older than it should be with an average age in excess of ten years. Various industry guidelines suggest that the average age of the bus fleet should be between 6 and 9 years of age. Most Canadian transit maintenance managers feel that an average age of 7.5 to 8 years is appropriate. For this Increasing Modal Share Scenario, it is assumed that an average age of 7.5 to 8 years is in place. The result is that the bus fleet will turn over about one and a half times between 1999 and 2021. Thus, 17,322 buses will need to be purchased by 2021 as replacements for the 11,548 currently operating. The cost of this will be $7.28 billion.

The condition of the urban rail fleet is less of a problem than is the case with the bus fleet. As a result, replacement of half the rail fleet by 2021 has been assumed, as it was in the Declining Modal Share Scenario. This represents a cost of $3 billion.

Thus, the overall capital requirement related to the transit fleet through 2021, not including running infrastructure or rehabilitation of existing infrastructure is $16.9 billion. Expressed in equal annual expenditures from 1999 through 2021, this equates to approximately $766 million per year. It is important to note that these figures were calculated using current costs for vehicles using common diesel technologies for buses and conventional diesel and electric rail technologies. Use of the more expensive alternative fuel and propulsion technologies in the fleet has not been accounted for.

In the 2001 CUTA Transit Infrastructure Needs Survey, transit agencies reported total fleet related needs of approximately $3.8 billion over five years. This is for bus and other rolling stock purchases for replacement and expansion needs that are both currently planned and contingent on new funding. Expressed in annual terms, the amount required is $760 million. This is very close to the amount developed independently as part of the Increasing Modal Share Scenario and indicates that transit systems have, by and large, identified the requirements to meet such a vision.

Service and Operating Costs

Experience in the transit industry has shown that, for example, a doubling of service will only produce a ridership increase of between 50% and 70%. While this is a long established rule of thumb of transit planning, if the ambitious National Transit Vision is to be achieved, then transit trip making behaviour will have to change in the future. All of the factors that influence transit demand that were discussed in Chapter 2 of this report will have to come into play in order for a change such as this to occur.

Thus, it is assumed for the Increasing Modal Share Scenario that ridership will generally grow at the same pace as service hours. Improvements in scheduling efficiency and other initiatives such as the use of higher capacity vehicles on busy routes can contain the increase in service operated somewhat, but the amount is usually small. For the purpose of this scenario, it is assumed that service hours will have to increase by at least 45% over 1999 levels to accommodate the 50% increase in overall ridership. Thus, total vehicle hours will grow from more than 35.3 million in 1999 to almost 51.2 million by 2021.

Total direct operating costs are derived from the total service hours and the average operating cost per hour of service. In 1999, the average operating cost per hour for Canadian transit service was $77.12. In the future, most transit practitioners agree that this figure should not increase in real terms. Some even feel that there may be opportunities to reduce it slightly, especially considering the economies of scale created by higher demand and the increasing use of technology in the transit industry. For this scenario, it is assumed that the average operating cost per hour in 2021 (expressed in 1999 dollars) has been reduced by 3% to $74.81. This results in a total direct operating cost in 2021 of $4.11 billion compared with $2.92 billion in 1999.

(Note that in 1999, Canadian transit systems reported a $2.92 billion total direct operating cost but this number divided by reported total vehicle hours of 35.3 million does not equal the $77.12 per hour operating cost. The difference is due to not all transit systems providing complete data in all categories. To account for the difference, the product of total vehicle hours and per hour operating cost has been adjusted by a factor of 1.074 in order to calibrate to the total direct operating cost value. The calibration was completed on 1999 data and has been applied to all of the future scenarios.)

Revenue to Cost Ratio

Keeping the average transit fare paid by Canadian transit users constant at the 1999 level of $1.23 (as assumed with the unit costs for vehicles and equipment) will ensure that fares do not become more or less of a burden in the future. This would result in total passenger revenues in 2021 of $2.71 billion compared with $1.76 billion in 1999. The resulting revenue to cost ratio in 2021 (using the total direct operating cost results from the previous paragraph) would be 66% compared with 62% in Canada in 1999 and easily meets the targets outlined in Exhibit 4.1.

4.6 Comparison of Scenarios

Exhibit 4.4 summarizes the results of the development of the three scenarios in the previous sections and compares them to each other and to the current situation. All costs are in constant 1999 dollars.

Exhibit 4.4

Comparison of Current and Future Transit Scenarios

Point of Comparison	Current (1999)	Declining Modal Share Scenario (2021)	Stable Modal Share Scenario (2021)	Increasing Modal Share Scenario (2021)
Annual Transit Ridership in Canada	1.4 billion	1.4 billion	1.7 billion	2.2 billion
Annual Rides per Capita	80 - 85	< 70	80 – 85	105 – 110
24 Hour Weekday Work Trip Transit Modal Share	10%	8.5%	10%	12%
Total Bus Fleet	11,548	11,548	13,396	18,477
Total Rail Fleet	2,444	2,444	2,835	3,910
Total Fleet Capital	N/A	$7.9 billion	$9.7 billion	$16.9 billion
Annual Fleet Capital	N/A	$395 million	$440 million	$766 million
Annual Total Service Hours	35.3 million	35.3 million	40.9 million	51.2 million
Operating Cost Per Hour	$77.12	$77.12	$77.12	$74.81
Total Annual Operating Costs	$2.92 billion	$2.92 billion	$3.39 billion	$4.11 billion
Average Fare	$1.23	$1.23	$1.23	$1.23
Total Passenger Revenue	$1.8 billion	$1.8 billion	$2.1 billion	$2.7 billion
Revenue to Cost Ratio	62%	62%	62%	66%

Note: All costs in constant 1999 dollars.

4.6.1 Capital Expenditures

The above sections, which developed and described the three future scenarios, found a correlation between the derived capital expenditures for fleet and the requirements, which were independently identified by transit systems in the 2001 CUTA Transit Infrastructure Needs Survey. This is summarized in Exhibit 4.5 below.

Exhibit 4.5

Comparison of Future Scenarios with CUTA Survey Information

Future Scenario	Derived Fleet Expenditures	CUTA Survey Information
No Growth	$395	$424
Status Quo	$440	$469 *
National Vision	$766	$760

* Based on 1999 Survey

The closeness of the derived and surveyed information demonstrates that the transit systems in Canada clearly understand the needs for various levels of demand: maintaining existing service and managing both moderate and aggressive growth. Given this relationship between the derived and surveyed fleet needs information, it is appropriate to use the CUTA Survey results to assess the capital needs of the transit industry.

It should be noted that while the CUTA Survey summarizes all of the capital and infrastructure requirements of the Canadian transit industry, there is no indication that all of the identified projects would ultimately prove to be appropriate and cost effective. Before any of the identified needs are considered for funding, it will be necessary to assess them using a framework such as that developed in the study *A Cost-Benefit Framework for the Evaluation of Various Types of Transit Investments*.

The CUTA Survey found that approximately $4.8 billion is required over the next five years solely for rehabilitation and replacement of existing rolling stock and infrastructure (refer to Exhibit 4.3). This represents an expenditure of almost $1 billion annually, an amount very similar to the total capital expenditures in the transit industry today. This amount, however, if all spent on the needs of the existing fleet and infrastructure, does not allow for accommodating any growth in ridership. Thus, the industry might be able to maintain itself, at the current levels, if it were to defer expenditures associated with expansion or ridership growth.

Expenditures of approximately $2.8 billion over the next five years have been planned by transit agencies to accommodate expansion or ridership growth (Exhibit 4.3). This translates to about $560 million annually and represents a major gap between what the industry is currently spending for capital needs and a minimum level of need.

The gap widens further when the projects for expansion and ridership growth that the transit agencies identified as being beyond their own financial capability are considered. More than $5.9 billion of infrastructure needs over the next five years are in this category, or $1.18 billion annually.

Thus, based on this analysis, the total gap between the $1 billion being spent annually today and the total identified need is $1.74 billion. Without new funding, the transit industry will not be able to meet the challenges of the National Vision.

Another way of looking at the survey information is to consider the total current plans identified by the transit agencies of $6.8 billion over five years or $1.36 annually. This is more than the actual $1 billion annually spent by Canadian transit agencies. The difference can be explained two ways; one, agencies are planning to spend more in real terms over the next several years, and/or two, some transit capital expenditures are being covered by municipalities separate from the transit agencies. If this were the case, and using the $1.36 billion annually as the base for capital expenditures, the overall annual funding gap identified in the previous paragraph becomes $1.38 billion rather than $1.74

billion. It is this amount that has been assumed to be correct for the purpose of this analysis.

4.6.2 Ridership

It is an ongoing challenge for the transit industry to retain its current market share. The downtown or CBD market, traditionally the easiest for transit to serve well, is being pressured by ongoing decentralization and suburbanization of both employment and retail enterprise. Just to retain market share, therefore, transit must carry more people in its traditional markets, such as downtown, to offset the lower modal share at suburban destinations.

Can transit ridership grow at a higher rate than the population in the face of increasing decentralization and suburbanization and limited growth in downtowns? It can, provided that all of the elements that affect transit use are addressed in a positive manner. These include:

- Transit service improvements in the form of more frequent service, direct routes, and more reliable on time service. The goal of "On Time, Every Time" must be foremost in everyone's minds.

- Expanded transit infrastructure such as commuter rail, light rail and bus rapid transit facilities, and on street bus priority initiatives.

- Enhanced multimodal stations that allow pedestrians, cyclists and motorists to easily access and park at stations to access transit service. Complimentary facilities at the stations (shops and services, such as day care) allow people to easily combine trips.

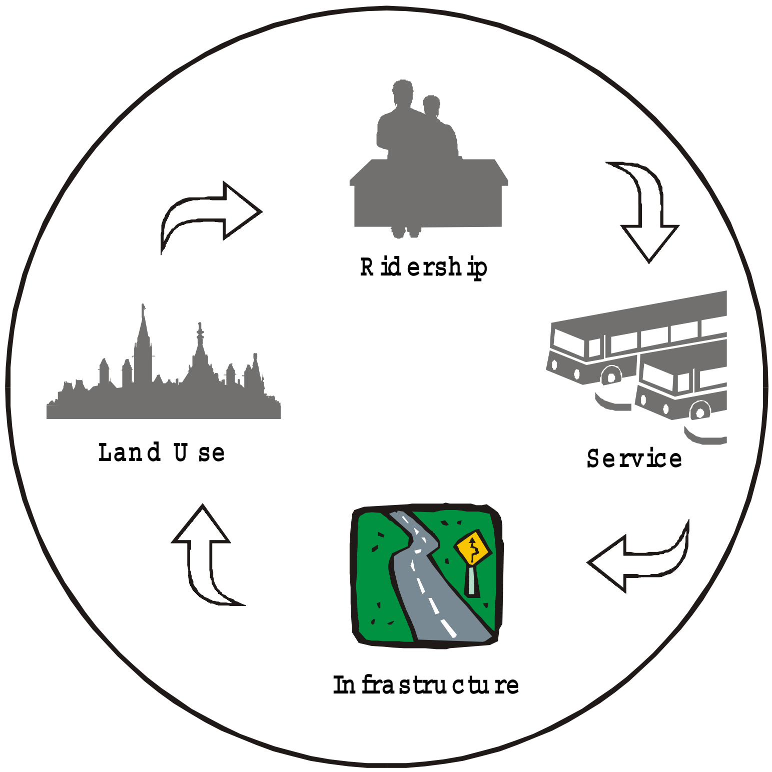
- Overall integrated regional transit services and fares that consider the best approaches to moving people and combine these into a comprehensive package.

- Land use plans that move towards more compact, multi use development patterns that are better suited to transit and the complimentary walking and cycling modes.

Some of these items are easier to implement than others. For example, in the shorter term, service improvements can be implemented once enough fleet is available and the associated operating expenses have been funded. Building infrastructure for transit takes time to complete the planning, design and construction phases and is a more medium to long-term initiative. Changing land use patterns and the nature of development is a very long-term effort.

While all of these elements involve separate and distinct projects and professionals to address them, it is important to realize that they are related. Exhibit 4.6 illustrates that increased ridership can justify increased service which can allow new infrastructure to be constructed and can accommodate the more transit friendly land uses. All of these elements work together to benefit transit.

Exhibit 4.6
The Transit Growth Cycle



4.6.3 Passenger Fares

All of the scenarios assume that the average fare paid by transit users remains constant at current levels. While on the surface, it would be desirable to reduce fares in real terms, experience has shown that transit riders are more likely to respond to changes in service attributes rather than changes in price. Even with much lower fares, people are not going to take transit if it does not provide service that is convenient, reliable, comfortable and safe. When service is improved, new riders will be attracted. Thus, it is appropriate to assume for this study that fares remain constant in real terms.

4.6.4 Operating Costs

For the Stable Modal Share Scenario, which assumes that ridership growth keeps pace with population growth, the average operating cost per hour was assumed to remain constant. This is appropriate given the status quo nature of this scenario. However, is the assumed reduction in operating cost per hour for the Increasing Modal Share Scenario appropriate?

The reduction in operating cost per hour for the Increasing Modal Share Scenario is based on the assumption that new technologies implemented throughout the industry will provide efficiencies within transit systems. Typical technologies include:

- Onboard vehicle performance monitoring equipment that tracks mechanical performance and provides maintenance reports and recommendations. The information can either be stored onboard for later retrieval, or transferred in real time to maintenance staff;

- Automated Passenger Counting equipment allows accurate reporting of demand and allows service and supply to be planned accordingly;

- Automatic Vehicle Location systems allow manual and automated service control to be implemented resulting in improved schedule reliability and more efficient use of on-street resources. These systems can also drive an assortment of real time public information systems;

- Advanced fare collection and monitoring through the more extensive use of registering fare boxes and smart cards increases convenience while reducing fare evasion options and easing revenue collection;

- Advanced scheduling and runcutting systems that partly or fully automate schedule and work shift creation in a manner that makes most efficient use of resources.

While described separately, all of these technologies are converging in a way that will allow all of the functions to be part of a single multi-dimensional system that could provide for even greater efficiencies.

Some forms of service delivery beyond the conventional municipal public transit system could also possibly result in lower operating costs. However, this approach must be carefully studied so as not to disrupt the needed integration of all services in a given urban area. Transit service must be seamless to the user. Experience in other countries such as Australia has shown that quality of service and level of service can be adversely affected by such arrangements if care is not taken to address these issues in an ongoing manner. These Alternate Service Delivery or ASD options generally involve various degrees of contracting-out different elements of the transit system.

4.6.5 Fleet

The fleet numbers developed in all of the scenarios are based on requirements for replacement and sustaining the existing equipment and to accommodate growth. The equipment required for growth is in turn based on simple growth rates. These do not take into account possible efficiencies that could be gained through improved scheduling or better matching of supply to demand that, in turn, reduce vehicle needs. The increased vehicle numbers also does not account for the inevitable decline in overall urban travel speeds that will be caused by increasing congestion. If steps aren't taken to maintain or improve transit speeds in light of increasing urban congestion, then the impact on the fleet will be more vehicles to provide the same level of service.

For the purpose of these scenarios, it is assumed that the possibility of efficiencies in the future is offset by the reduction in fleet efficiency caused by congestion. Thus the growth in fleet matches the growth in ridership.

4.6.6 Environmental Issues

All of the scenarios use costs for rolling stock that is fitted with traditional propulsion technologies and assumes that these costs will not change in the future relative to today. However, there is a great deal of effort being put forward by government and industry to provide propulsion systems that have very low or zero greenhouse gas emissions. At the moment, these advanced technologies cost more than the traditional ones, with natural gas adding about $100,000 to the capital cost of a bus and fuel cell equipped prototype buses costing substantially more.

While the highly advanced technologies like fuel cells will likely reduce substantially in price as they are perfected and mass production takes place, it is questionable if they will ever reach the price of the current diesel bus. Consider the fact that natural gas propulsion still carries a 25% premium even though the fuel is plentiful and the technology is well established.

What is the incentive for transit agencies to spend the extra money to outfit their fleet with "green" technology, particularly in many parts of Canada where the only funding source is municipal property taxes?

- Buses certainly have a reputation as being polluting vehicles and taking away this issue will provide a key marketing tool. That said, newer diesel vehicles meet or exceed proposed emissions targets without significant additional costs. Will simply meeting new emissions standards using diesel be enough to satisfy the public?

- Transit emissions are a tiny percentage of the total emissions in Canada (1.1% for all transit, school and intercity buses combined) compared with the 44.1% of emissions created by cars and light trucks. With this in mind, providing a "green" transit fleet could arguably be less of a priority than focusing on the real issue of moving people from cars and light trucks to transit.

Particulate emissions are also a concern. Manufacturers of traditional diesel bus engines and fuel suppliers have started to address this issue through cleaner diesel fuel and new technologies and equipment such as particulate traps. Experiments have shown that these technologies can reduce particulate emissions from diesel by more than 90%. As the fleet is replaced over time, the impact of this improvement will become more pronounced. To accelerate this improvement, transit agencies would need new funding sources in order to quicken the replacement of the existing fleet.

Given these points, it is appropriate that the future scenarios assume conventional propulsion technology and consideration be given to an environmental plan that focuses less on the technology and more on the people moved.

4.7 Detailed Transit Infrastructure Requirements

The discussion thus far in this chapter has focused on the future of the Canadian transit industry as a whole. While this is instructive in providing a national picture, more meaningful is a review of how these infrastructure needs break down for the various types of cities in Canada. The transit infrastructure needs information collected by CUTA has been used to do this.

Note that some of the needs identified by the transit agencies in the CUTA survey have not received a rigorous assessment as to their appropriateness or cost effectiveness because they are only at a conceptual stage. As a result, the costs associated with the identified needs should be considered approximate and, taken together, provide an order of magnitude estimate of the overall requirements of the various categories of cities.

A tabulation of the information provided by each of the transit agencies to CUTA was obtained and the data grouped into three main categories.

- The three largest Canadian urban regions, the greater Montreal, Toronto and Vancouver areas. A total of 15 transit agencies reporting to CUTA provide service to these regions and together they provide the full service hierarchy discussed in Chapter 2. All of the transit agencies in these three regions responded to the CUTA survey.

- The nine transit systems that serve mid to large size urban areas and either have or have proposed significant transit infrastructure in recent years. These include Calgary, Edmonton, Grand River (Kitchener/Waterloo/Cambridge area), Halifax, Ottawa, Gatineau (formerly Outaouais), Quebec City, Victoria and Winnipeg. All of these transit agencies provided input to the CUTA survey.

- All of the remaining Canadian transit systems. These include all of the small and medium sized systems that generally provide only bus services in their communities. While some of the transit agencies in this category did not respond to the CUTA survey, the majority did and CUTA has indicated that the results of the survey respondents are representative of the whole group.

4.7.1 The Three Large Urban Regions

Seventy three percent or $9.8 billion of the $13.5 billion of transit infrastructure needs identified in the CUTA survey (Exhibit 4.3) were for the three large urban regions in Canada. A summary of the requirements for the Montreal, Toronto and Vancouver regions is provided in Exhibit 4.7.

Exhibit 4.7

CUTA Transit Infrastructure Survey Results for the Montreal, Toronto and Vancouver Regions – 2002-2006

	CURRENT PLANS (Millions)	CONTINGENT ON NEW FUNDING (Millions)	TOTAL (Millions)
REHABILITATION OR REPLACEMENT			
Bus Purchases/Refurbishment	$1,053	$35	$1,088
Other Rolling Stock	$407	$0	$407
Fixed Guideway/Rights-of-Way	$603	$326	$929
Maintenance Facilities	$260	$0.5	$261
Other/Miscellaneous	$801	$106	$907
Subtotal	**$3,124**	**$468**	**$3,592**
EXPANSION OR RIDERSHIP GROWTH			
Bus Purchases	$260	$108	$368
Other Rolling Stock	$227	$286	$513
Fixed Guideway Construction/Enhancement	$929	$3,221	$4,150
Stations/Terminals	$71	$8	$79
Parking Facilities (Stations/Terminals)	$58	$11	$69
Transit Priority Measures	$72	$3.1	$75
Customer Amenities	$22	$3.6	$26
Maintenance Facilities	$83	$65	$148
Advanced Technology	$187	$14	$201
Other/Miscellaneous	$326	$279	$605
Subtotal	**$2,234**	**$3,998**	**$6,232**
Total – Current Plans	**$5,358**		
Total – Contingent on External Funding		**$4,466**	
Grand Total			**$9,823**

Source: Canadian Urban Transit Association

This table shows that the three largest urban areas have already planned and budgeted for 87% of their overall system replacement and rehabilitation requirements. The largest gap between planned projects and those that require new funding is in the area of facility rehabilitation where one third of the identified need is not currently available.

For service expansion, the agencies in the three regions have already planned more than $2.2 billion worth of projects, about 65% of which are related to rolling stock and rapid transit facilities. Unfortunately, this total represents only about 35% of cost of projects these transit suppliers have identified as being necessary to accommodate current and future ridership growth. This is a gap of almost $4 billion. Approximately 90% of this gap is for rolling stock and rapid transit facilities.

Overall, the biggest transit infrastructure issue for the Montreal, Toronto and Vancouver regions is the provision of rapid transit facilities with about $3.55 billion in projects beyond the current capacity of the transit agencies to fund. Of the remaining $900 million funding gap, about $430 million is for rolling stock while almost $400 is largely for advanced technology and fare system related projects.

4.7.2 The Mid to Large Sized Urban Areas

Of the approximately $13.5 billion of transit infrastructure needs identified in the CUTA survey, 24% or $3.3 billion were identified by the nine mid to large sized transit agencies in Canada. The breakdown is shown in Exhibit 4.8 on the following page.

Exhibit 4.8

CUTA Transit Infrastructure Survey Results
For Nine Mid to Large Sized Transit Agencies – 2002-2006

	CURRENT PLANS (Millions)	CONTINGENT ON NEW FUNDING (Millions)	TOTAL (Millions)
REHABILITATION OR REPLACEMENT			
Bus Purchases/Refurbishment	$484	$185	$669
Other Rolling Stock	$6.4	$17	$23.4
Fixed Guideway/Rights-of-Way	$71	$48	$119
Maintenance Facilities	$44	$10	$54
Other/Miscellaneous	$42	$49	$91
Subtotal	**$647**	**$310**	**$957**
EXPANSION OR RIDERSHIP GROWTH			
Bus Purchases	$141	$110	$251
Other Rolling Stock	$70	$105	$175
Fixed Guideway Construction/Enhancement	$188	$601	$789
Stations/Terminals	$11	$33	$44
Parking Facilities (Stations/Terminals)	$8.7	$4.6	$13
Transit Priority Measures	$14	$3.6	$18
Customer Amenities	$5.1	$4	$9
Maintenance Facilities	$48	$17	$65
Advanced Technology	$16	$27	$43
Other/Miscellaneous	$6.2	$916	$922
Subtotal	**$508**	**$1,820**	**$2,328**
Total – Current Plans	**$1,155**		
Total – Contingent on External Funding		**$2,130**	
Grand Total			**$3,285**

Source: Canadian Urban Transit Association

The situation for this group of urban areas is similar to that of the three large areas discussed in the previous section in that approximately three-quarters of the projects identified that require new funding are for rapid transit facilities ($900 million of the amount identified as “other” for expansion is actually for LRT). Of the remaining gap between planned projects and those that require new funding, more than $400 million is for rolling stock.

A significant difference between this group and the three large urban areas is that only about one third of the projects identified have already been planned and budgeted compared with more than half of the projects in the larger regions. While there is no absolute data available to explain this difference it is likely a result of two factors:

- Two of the three large urban areas (Montreal and Vancouver) have access to alternative funding sources providing them with a significantly more stable funding source. While Calgary and Edmonton also have similar alternative funding, the lack of this in the other seven areas will offset the effect.

- While three of the nine mid to large sized urban areas have rapid transit facilities, the others do not have these types of high quality services in place. The cities have recognized the need for these in the future as the only way of achieving their local visions, but are not in a position to fund a major program. This compares with the large urban areas where the projects are largely additions to the existing system rather than completely new endeavours.

4.7.3 The Small to Medium Sized Urban Areas

Only two percent of the $13.5 billion of transit infrastructure needs identified in the CUTA survey are for projects in the small to medium sized urban areas. This is because the needs of these systems are different than those of the larger urban areas. Exhibit 4.9 on the following page illustrates that this group of transit systems does not require rapid transit facilities. Their needs are primarily for vehicles.

Exhibit 4.9

CUTA Transit Infrastructure Survey Results for All Small to Mid Sized Transit Systems – 2002-2006

	CURRENT PLANS (Millions)	CONTINGENT ON NEW FUNDING (Millions)	TOTAL (Millions)
REHABILITATION OR REPLACEMENT			
Bus Purchases/Refurbishment	$150	$41	$191
Other Rolling Stock	$0.3	$0.1	$0.4
Fixed Guideway/Rights-of-Way	$0	$0	$0
Maintenance Facilities	$4.3	$9	$13
Other/Miscellaneous	$4.5	$11	$15
Subtotal	**$159**	**$60**	**$219**
EXPANSION OR RIDERSHIP GROWTH			
Bus Purchases	$55	$21	$76
Other Rolling Stock	$0	$0.1	$0.1
Fixed Guideway Construction/Enhancement	$0	$0	$0
Stations/Terminals	$4.7	$8.3	$13
Parking Facilities (Stations/Terminals)	$0	$1	$1
Transit Priority Measures	$1.5	$0.7	$2.3
Customer Amenities	$0.8	$1.6	$2.4
Maintenance Facilities	$0	$1.6	$1.6
Advanced Technology	$5.9	$5.9	$12
Other/Miscellaneous	$1.3	$2	$3.3
Subtotal	**$69**	**$42**	**$111**
Total – Current Plans	**$228**		
Total – Contingent on External Funding		**$102**	
Grand Total			**$330**

Source: Canadian Urban Transit Association

Of the $330 million identified in the survey for this group, $267 million is for buses. This group of transit agencies does not have any rail infrastructure. Approximately three-quarters of the bus needs identified have already been planned and budgeted. The fact that this gap exists for replacement and rehabilitation needs indicates that these communities are having difficulty keeping up with their existing needs. While some of them are able to accommodate expansion of service, the gap in this area indicates that the agencies feel they could do more if new sources of funding were available.

4.8 Future Pressure Points

Through the analysis and discussion presented in this chapter, a number of issues, or pressure points, for the Canadian transit industry are evident:

1. There is a significant gap between current capital funding and future needs to accommodate significant growth in transit ridership, as set out in the National Vision of almost $1.4 billion annually;

2. Significant positive progress must be made by all governments, transit agencies and industries on the elements that influence transit ridership;

3. The best opportunities for reducing operating costs in real terms will require investment in a wide variety of information technologies that provide more information and better service at a lower per passenger cost;

4. The incentive for transit agencies to implement so-called "green" technologies on a large scale is limited because of the added cost and the fact that improved conventional technologies meet environmental standards. The most effective strategy in reducing green house gases is for all governments to pull together in programs which will see people shift from their private cars to public transit;

5. All transit agencies, regardless of size need financial assistance (new funding) for the rehabilitation and replacement of their fleets;

6. All transit agencies in Canada need new sources of funding to meet the requirements for new and expanded service as set out in the National Vision:

7. The twelve largest urban regions in Canada need financial assistance (new funding) in order to implement transit infrastructure to accommodate growth in ridership, improve reliability and maintain or improve running speed.

5.0 PRESSURE POINTS

The information and analysis presented in the previous chapters clearly describes the current transit industry and illustrates the challenges in achieving a National Vision for transit in Canada. This chapter summarizes the comparison between the present and the future and discusses the significant implications or "pressure points" of achieving the future vision.

Exhibit 5.1 compares the current transit industry with the National Vision for transit that was described in Chapter 4. This exhibit is referred to throughout the following sections of this chapter.

Exhibit 5.1

Canadian Transit - Present and Future

Point of Comparison	Current (1999)	Increasing Modal Share Scenario (2021)
Population of Canada	30.5 million	35.4 million
Annual Transit Ridership in Canada	1.4 billion	2.2 billion
Annual Rides per Capita	80 - 85	105 – 110
24 Hour Weekday Work Trip Transit Modal Share	10%	12%
Total Bus Fleet	11,548	18.477
Total Rail Fleet	2,444	3910
Total Fleet Capital Needs	$7.9 billion	$16.9 billion
Annual Fleet Capital Needs	$395 million	$766 million
Annual Total Service Hours	35.3 million	51.2 million
Operating Cost Per Hour	$77.12	$74.81
Total Annual Operating Costs	$2.92 billion	$4.11 billion
Average Fare	$1.23	$1.23
Total Passenger Revenue	$1.8 billion	$2.7 billion
Revenue to Cost Ratio	62%	66%

Pressure Point #1 – Demand Management

The National Vision calls for a 50% increase in transit over the next 20 years, with demand for transit growing faster than the Canadian population (forecast to increase by 16% over this period). This would represent a tremendous challenge for all concerned.
To even make the attempt would require a systematic assessment of the factors that influence transit demand and a concerted effort to improve and adjust practices and policies related to these factors. For example:

- Policies that recognize and support transit's integral role in creating a sustainable transportation system would be needed at all levels of government;
- Transit priority measures (tools to improve the mobility and "on-time" performance of transit vehicles through congested urban streets) would need to be the standard rather than the exception;
- Policies that allow flexibility of zoning requirements with respect to parking and development intensity adjacent to transit facilities would need to be established by urban municipalities;
- Policies that facilitate increased urban density would need to be researched, developed and implemented;
- Policies to integrate transit efficiency and service considerations into land use decisions would be needed at the municipal level;
- Improvements would be needed to transit service availability and reliability to a level as yet not obtained in Canada;
- Rapid Transit infrastructure development would be needed to ensure that transit could be competitive, particularly in a congested traffic environment;
- Policies that provide for increased charges for car use such as road tolls, complementary congestion charges, license surcharges and parking surcharges would be needed.

Pressure Point #2 – Access to Capital for Infrastructure Investments

Canadian transit agencies currently spend approximately $1 billion annually on capital projects, 25% of which relies on debt financing. With their municipal partners, capital spending grows to more than $1.3 billion annually. Lack of access to capital funding would constrain the ability of transit properties to support the desired growth in demand. Extrapolating from the list of projects that municipalities across Canada identified in the CUTA survey, new capital expenditures of almost $1.4 billion annually would be required.

Two basic types of programs to address the gap would be needed:

- Large-scale infrastructure programs geared to the needs of the large transit agencies and residents of the urban areas they serve. Over 70% of capital funding would likely be for rapid transit projects in the three largest urban regions and the nine mid-to-large sized transit systems
- Programs to assist with vehicle purchase and small infrastructure projects for all transit agencies.

Pressure Point #3– Access to Operating Funding

If all of the projects put forward by municipalities in the CUTA survey were implemented (a rough proxy for the transit capacity which would be needed under the National Vision), annual operating expenditures by the transit industry would increase by 40% to $4.11 billion (from $2.92 billion today). This amount assumes a decline in per hour operating costs of the industry, as it takes advantage of new technologies and economies of scale. However, it is unlikely, under the present taxing powers, that revenues for municipalities (the main agencies that pay for net operating costs) will grow at this rate given the expected 16% increase in the Canadian population. Thus, approximately half of the funding for the increase in operating costs would not likely be accounted for without a new source of funding being available.

Fare revenue from transit users in the National Vision scenario is assumed to grow from an annual amount of $1.8 billion today to $2.7 billion in the future. The difference between this future revenue and the future total annual operating costs of $4.11 billion is $1.41 billion (compared with a gap of $1.1 billion today). Thus, the potential gap in operating cost funding under the National Vision, would be approximately $300 million annually. This operating funding gap essentially reflects the additional funds that would be required to pay for the extra peak period service necessary to allow transit to compete effectively with the automobile. It would apply mainly to the larger transit systems, as their peak hour services are operating at capacity now.

Pressure Point #4 – Fleet Availability and Durability

When considering fleet expansion to support the substantial increase in transit demand envisioned, it is important to consider the capacity of the transit manufacturing industry. The three Canadian transit bus manufacturers have all experienced significant change over the past several years and have products that can generally meet the requirements of the transit systems. However, they are structured to serve the current Canadian market as well as compete in the U.S. market and they would face a challenge to quickly increase their manufacturing capacity to meet an ongoing expanded market. To address this, they would have to invest and grow based on the future vision, and/or other manufacturers from the U.S. or elsewhere would have to become active in the Canadian market.

The U.S. transit bus market is much larger than Canada. Because the Canadian bus manufacturers compete in both markets, they naturally design their products to meet the needs of the largest market. Since U.S. transit systems typically replace their bus fleet after twelve years of life, the vehicles accommodate this and do not always meet the needs of Canadian agencies that traditionally keep their buses longer. Ensuring that buses purchased in Canada can meet the unique requirements of the Canadian environment for the desired time frame is a key issue.

The availability of long-term sustained and guaranteed funding support for transit agencies would provide the agencies with the ability to plan and commit to vehicle purchases in a stable and predictable environment. This would in turn, allow the equipment manufacturers to invest in their production capability to meet the needs of an expanded market.

Summary of Pressure Points

To summarize, there are four main pressure points that need to be addressed if the transit industry is to achieve the National Vision:

1. Demand management measures and comprehensive plans, policies and service standards which are supportive of transit are necessary to achieve the National Vision;

2. In order to achieve the ridership levels of the Vision, new sources of capital funding are required. The gap between what is available and what is needed is in the order of $1.4 billion annually for both fleet and infrastructure;

3. The transit vehicle manufacturing industry in Canada will have to expand or new entrants are required into the market to meet the vehicle needs resulting from the National Vision;

4. In order to meet the ridership targets of the National Vision transit agencies will need new sources of funding for net annual operating costs. The funding gap between what is available and what will be needed is in the order of $300 million annually.

6.0 SUMMARY AND CONCLUSIONS

The purpose of this "Taking Stock" study was to describe and assess the current state of the Canadian transit industry, compare it with other places internationally, project the current industry into the future based on targets outlined in the "National Vision" study and identify the pressure points and resource gaps related to achieving this future vision.

There is a great deal of historical and current information available about transit in Canada through the Canadian Urban Transit Association (CUTA). CUTA represents transit systems whose vehicles comprise 98% of the fleet in Canada. The Association surveys its members annually and collects a wide variety of statistics about ridership, revenues and costs. Highlights of this information along with additional research presented in Chapter two include:

- Annual transit ridership in Canada in 2000 was 1.5 billion, with service available to approximately 95% of urban residents and 61% of the 30 million residents of Canada.
- Canadian cities provide the full compliment of public transit modes including subways, bus rapid transit, light rail transit, heavy rail transit, and a variety of buses from low floor articulated, to small community buses.
- There are 14,335 active transit vehicles in operation in Canada, the average age of which is 10.7 years old.
- Transit vehicles consume almost 400 million litres of diesel, 600,000 litres of gasoline, 26 million cubic metres of natural gas and over 700 million kilowatt-hours of electricity annually.
- Public transit employs almost 40,000 people across Canada.
- About $3.5 billion is expended annually to cover operating costs, about 63 percent of which is funded by fares. The remaining 37% is covered primarily by municipal funding, and a decreasing trend in provincial funding.
- Between 1992 and 2000, the Canadian average revenue to cost ratio (passenger fares to operating costs), has steadily increased from 53% to 63%.
- Provincial government contributions to capital funding of transit is also in decline, from 87% in 1992 to 14% of total funding in 2000.
- Expenditures on for transit capital projects reached almost $1 billion annually in 2000.
- To account for declining provincial funding, revenues have covered a larger portion of expenses, and innovative funding sources such as regional gas taxes are making a significant contribution to funding.

Compared with other parts of the world, Canadian transit service and results are similar to Australia, better than the United States and not as good as in Europe. Some of the more interesting results of the international review presented in Chapter three are listed below:

- Boardings per capita in Canada is in general similar to Australia, much higher than in the US, and significantly lower than in Europe.
- Transit's mode share in Canada, as with boardings per capita, are similar to Australia, higher than the US and lower than Europe for the higher population cities. Smaller cities are closer in mode share to the US, in accordance to the population density.
- Larger Canadian cities have a higher revenue to cost (R/C) ratio than most other cities in the comparison groups, including the European cities. As the cities decrease in size, their R/C performance decreases.

Three possible futures for transit in Canada were described in Chapter four. One considered the future if the industry were to not grow and remain at the current level of ridership, a second looked at the future if the current state of the industry were increased by the expected change in Canada's population over the next twenty years and the third took the targets outlined in the National Vision Study and assessed the impact on the transit industry. If the future vision for transit is achieved by 2021, then the following milestones will be reached:

- Annual transit ridership will have increased by 50%;
- Annual per capita ridership will have increased by 25 – 30%;
- Transit modal share for work trips will have increased by 20%;
- Fleet size will have increased by 66%;
- Service provided will have increased by 45%;
- Revenue to cost ratio will have increased by 6.5%.

Exhibit 6.1 summarizes the three scenarios and provides the detailed comparative information for them.

Exhibit 6.1

Comparison of Current and Future Transit Scenarios

Point of Comparison	Current (1999)	Declining Modal Share Scenario (2021)	Stable Modal Share Scenario (2021)	Increasing Modal Share Scenario (2021)
Annual Transit Ridership in Canada	1.4 billion	1.4 billion	1.7 billion	2.2 billion
Annual Rides per Capita	80 - 85	< 70	80 – 85	105 – 110
24 Hour Weekday Work Trip Transit Modal Share	10%	8.5%	10%	12%
Total Bus Fleet	11,548	11,548	13,396	18,477
Total Rail Fleet	2,444	2,444	2,835	3,910
Total Fleet Capital	N/A	$7.9 billion	$9.7 billion	$16.9 billion
Annual Fleet Capital	N/A	$395 million	$440 million	$766 million
Annual Total Service Hours	35.3 million	35.3 million	40.9 million	51.2 million
Operating Cost Per Hour	$77.12	$77.12	$77.12	$74.81
Total Annual Operating Costs	$2.92 billion	$2.92 billion	$3.39 billion	$4.11 billion
Average Fare	$1.23	$1.23	$1.23	$1.23
Total Passenger Revenue	$1.8 billion	$1.8 billion	$2.1 billion	$2.7 billion
Revenue to Cost Ratio	62%	62%	62%	66%

Chapter four also describes the 2001 CUTA Transit Infrastructure Needs Survey. Seventy-three percent of capital funding needs are in the three largest urban areas, Montreal, Toronto and Vancouver. An additional twenty five percent of the requirements have been identified by the next nine largest transit systems. Approximately $1 billion of the $1.4 billion capital funding gap is for improving, extending or constructing new rapid transit facilities in the large and medium sized urban areas, while $200 million relates to rolling stock requirements at all sizes of transit systems throughout Canada.

Chapter five reviews the material presented in the previous three chapters and identifies issues and pressure points that will impede the achievement of the future transit vision. The key pressure points identified are:

- Demand management measures and comprehensive plans, policies and service standards which are supportive of transit are necessary to achieve the National Vision;
- In order to achieve the ridership levels of the Vision, new sources of capital funding is required. The gap between what is available and what is needed is in the order of $1.4 billion annually for both fleet and infrastructure;
- The transit vehicle manufacturing industry in Canada will have to expand, or new entrants are required into the market to meet the vehicle needs resulting from the National Vision.

- In order to meet the ridership targets of the National Vision transit agencies will need new sources of funding for net annual operating costs. The funding gap between what is available and what will be needed is in the order of $300 million annually;

The transit industry in Canada has evolved to its current state based on the combination of past financing, planning and service policies and practices, and it is clear that the way of doing business in the past will not be sufficient to allow Canada to achieve the future vision for transit outlined in the National Vision study.

The real question is, should efforts be made and funding provided in order that the future vision for transit can be achieved? To answer this question, it must be asked what the alternatives are? Is the future of transportation in urban Canada an extrapolation of today or will it include an enhanced transit component? Most researchers and observers agree that transit will need to play an expanded role in urban transportation if economic growth, congestion, sustainability and environmental issues are going to be tackled with a positive outcome. To do this will require work to begin on closing the resource gaps identified in this study. To accomplish this, governments at the municipal, provincial and federal level will need to work together to identify resources and programs that can be used to close the capital and operating funding gaps. All levels of government should work together because economic growth, sustainability, air quality, etc are all regional and national issues in scope and affect individual Canadians. Municipal agencies are generally responsible for delivering the service, however to do so they need the committed and sustained support from other levels of government in order to meet the goals of the National Vision.

Bibliography

Air Improvement Resource, Inc. and SENES Consultants Limited. Updated Estimate of Canadian On-Road Vehicle Emissions for the Years 1995-2020. 11 July 2001.

American Public Transportation Association (APTA). 2000 Public Transportation Fact Book. Washington, USA: APTA, 2000.

Annells, Bob, Executive Chairman of Melbourne Transport Enterprises (CONNEX). "Privatisation in Victoria – A Franchisee's Perspective". Speech presented at the Urban Rail 2001 Conference, Sydney, 4 April 2001.

Au, Joe. Economic and Social Costs of Private Urban Transportation by Automobile. Canadian Urban Transportation Association: Toronto, Canada, September 1994.

Calgary Transit. Calgary Transit Technical Information. www.calgarytransit.com/html/technical_information.html. 2001.

Cambridge Systematics, Inc. and Glen Weisbrod Associates, Inc. Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact.

Camph, Donald, Aldaron, Inc. Dolllars and Sense: The Economic Case for Public Transportation in America. June 1997.

Canada Transportation Act Review, Urban Transportation. Chapter 12: The National Interest in Urban Transportation.

Canadian Transit Heritage Foundation. The Street Side Guide to Urban Transit Fleets in Canada, 2000 Edition. Toronto, Canada: CUTA, 2000.

Canadian Urban Transit Association (CUTA). Transit Infrastructure Needs 2002-2006. October 2001.

Canadian Urban Transit Association (CUTA). "A Review of Canadian Transit Service Standards." Toronto, Canada: CUTA, March 2001: p.1-9.

Canadian Urban Transit Association (CUTA). "Provincial and Territorial Funding of Urban Transit: A Cross-Jurisdictional Comparison". Toronto, Canada: CUTA, November 2000.

Canadian Urban Transit Association (CUTA). Green Transit: Environmental Innovation Benefiting all Canadians (Draft 1.0). November 13, 2000.

Canadian Urban Transit Association (CUTA). "Better Transit: An Essential Economic Strategy for Canada". Presented at Transit Summit 2000 in Toronto and Ottawa. 10 April 2000.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1999 Operating Data. Toronto, Canada: CUTA, 2000.

Canadian Urban Transit Association (CUTA). Transit Infrastructure Needs, Report on a Survey of Infrastructure Needs. Toronto, Canada: CUTA, 1999.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1997 Operating Data. Toronto, Canada: CUTA, 1998.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1996 Operating Data. Toronto, Canada: CUTA, 1997.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1995 Operating Data. Toronto, Canada: CUTA, 1996.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1994 Operating Data. Toronto, Canada: CUTA, 1995.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1993 Operating Data. Toronto, Canada: CUTA, 1994.

Canadian Urban Transit Association. Specialized Transit Services Fact Book 1994 Operating Data. CUTA: Toronto, Canada, February 1994.

Canadian Urban Transit Association (CUTA). Canadian Transit Fact Book: 1992 Operating Data. Toronto, Canada: CUTA, 1993.

Canadian Urban Transit Association (CUTA). Urban Transit Facts In Canada: 1989 Data. Toronto, Canada: CUTA, 1991.

Canadian Urban Transit Association (CUTA). Urban Transit Facts In Canada: 1987 Data. Toronto, Canada: CUTA, 1988.

Canadian Urban Transit Association (CUTA). Urban Transit Facts In Canada: 1986 Data. Toronto, Canada: CUTA, 1987.

Centre for Sustainable Transportation in cooperation with Learning for a Sustainable Future. "Sustainable Transportation – Reflections on the Movement of People and of Freight with Special Attention to the Role of the Private Automobile." Toronto, Canada, April 1998.

Centre for Sustainable Transportation. "Definition and Vision of Sustainable Transportation". September 1997.

City of Calgary. 1999 City of Calgary Civic Census Travel to Work Survey. City of Calgary: Calgary, Canada, 2000.

Cole, Sherman & Associates Limited. Report Title Unknown. p.13-24.

Dauby, Laurent. "The Choice of Fuel – A Complex Debate." Public Transport International 4 April 2000: 24-28.

Department of Transport and Regional Services, Government of Australia. "Land Transport: Rail Policy and Programs – Urban Public Transport". http://www.dotrs.gov.au/land/Rail/urban.htm. 9 March 2001.

Dillon Consulting Limited. Regional Municipality of Ottawa Carleton Transportation Master Plan: Mass Transit. Toronto, Canada, January 1996.

EKOS Research Associates Inc. Findings of Citizens Working Groups: Climate Change (Draft Report). Ottawa, Canada, April 2001.

Environics Research Group Limited. "Focus Ontario – GTA – 2001-1". 2001.

Environics Research Group Limited. Focus Canada, Flash Report 1999-4. Toronto, Canada.

European Environment Agency. "Indicator 21: Specific Emissions". http://reports.eea.eu.int/ENVISSUENo12/en/page028.htm

Floeting, Holger. German Institute for Urban Affairs. Transport and Communication in Germany. www.unchs.org/unchs/english/transpor/germany.htm.

Hagler Bailly, Inc. Basic Study of Measures and Strategies to Reduce GHG Emissions in Urban Canada. p. 10-13.

Gilbert, Richard. Potential Users and Uses of Sustainable Transportation Performance (STPI) Indicators – Final Report on Phase 2 of the STPI Project. Toronto, Canada, May 2001.

Gilbert, Richard and Helen Tanguay, The Centre for Sustainable Transportation. Sustainable Transportation Performance Indicators Project: Brief Review of Some Relevant Worldwide Activity and Development of an Initial Long List of Indicators. Toronto, Canada, June 2000.

Grand River Transit Alternative Fuels Investigation. September 2001.

HLB Decision Economics Ind. Economic Study to Establish a Cost-Benefit Framework for the Evaluation of Various Types of Transit Investments. Chapter 3: Transit Comparative Analysis. 3 October 2001.

HLB Decision Economics Inc. Canada Transportation Act Review: The Value Proposition for Transit Investment, Subsidy and Federal Involvement (Draft Report). Ottawa, Canada, 5 April 2001.

IBI Group and Richard M. Soberman. National Vision for Urban Transit to 2020 – Draft Report. 10 September 2001.

IBI Group. The Regional Municipality of Ottawa-Carleton: Environmental Review of the Regional Official Plan – Background Paper on Environment, Transportation and Land Use. February 1993.

IBI Group and Richard M. Soberman. National Vision for Urban Transit to 2020 (Draft Report). 10 September 2001.

Institute of Transportation Engineers. Transportation and Traffic Engineering Handbook: Second Edition. Toronto, Canada: Prentice-Hall of Canada, Ltd., 1982.

Institute of Transportation Studies, University of Sydney. 1999 Fact Sheet: The Private Bus and Coach Industry in Australia. Sydney, Australia, 2000.

Ipsos Reid. Strategic Transportation Plan Resident Survey. Vancouver, Canada, October 2000.

Jacobsen, Pat, TransLink. Remarks by Pat Jacobsen, Chief Executive Officer for TransLink - Greater Vancouver Transportation Authority, to the Greater Vancouver Regional District Councils. 8 September 2001.

Kenworthy, J. and Laube F., UITP (International Association of Public Transport) & ISTP (Institute for Sustainability and Technology Policy). The Millennium Cities Database for Sustainable Transport. 2001.

M.J. Bradley & Associates, Inc. Hybrid-Electric Drive Heavy-Duty Vehicle Testing Project: Final Emissions Report. 15 February 2000.

McCormick Rankin Corporation. Region of Waterloo, Central Transit Corridor – Description of Candidate Rapid Transit Technologies. July 2001.

McCormick Rankin Corporation. “W.O. 4683: Urban Transit in Canada – Taking Stock, Steering Committee Meeting No.2.” 26 July 2001.

MacKinnon, Mark. “GLOBE/CTV/IPSOS-REID POLL: Majority Supports Restricting Use of Cars to Cut Smog; New Taxes for Transit Unpopular, Poll Finds.” Globe and Mail July 2001. (website)

Metropolitan Transportation Commission. Statistical Summary of Bay Area Transit Operations: Fiscal Years 1994-1995 Through 1998-99. Metropolitan Transportation Commission: Oakland, USA, September 2000.

Ministry of Transportation (Ontario), Municipal Office Transportation Policy Branch. Jurisdictional Review Municipal Transit Funding. June 1999.

Newman, Peter and Jeffrey Kenworthy. Sustainability and Cities: Overcoming Automobile Dependence. Island Press: Washington, USA, 1999.

OC Transpo. Attitude Survey 1997. Ottawa, Canada.

OC Transpo. Transit Priority, Getting Most Out of Your Investment. Ottawa, Canada.

Ontario Urban Transit Association, Centre for Transit Improvement and CUTA Competitiveness of Urban Transit – Public or Private Operation. June 1996.

Perl, Anthony and John Pucher. "Transit in Trouble? The Policy Challenge Posed by Canada's Changing Urban Mobility." CUTA Forum 5 June 1995: 22-24.

Planning Division, OC Transpo. Operating Statistics August 1999. Ottawa, Canada, August 1999.

Pollution Data Branch, Environment Canada. Updated Estimate of Canadian On-Road Vehicle Emissions for the Years 1995-2020. July 2001.

"Public transit tops urban transportation investment needs." http://www.newswire.ca/releases/November1999/30/c9335.html.

Queensland Transport. Integrated Regional Transport Plan for South East Queensland. Queensland Government: Brisbane, Australia, 1997.

Research Edge, The. 2000 Calgary Transit Customer Satisfaction Survey – Users. April 2000.

Roschlau, Michael, Canadian Urban Transit Association (CUTA). "Municipal Infrastructure Program." Memo, 7 March 2000.

Soberman, Richard M, and Brendon Hemily. Public Transportation in Canadian Municipalities: Implications for the Canada Transport Act and the Federal Role in Transit (Draft Report). March 2001.

Statistics Canada. "Canadian Statistics - Population and Growth Components." www.statcan.ca/english/Pgdb/People/Population/demo03.htm. 19 September 2001.

Statistics Canada. "Canadian Statistics - Population by Age Group, Canada, the Provinces and Territories." 19 September 2001. www.statcan.ca/english/Pgdb/People/Population/demo31a&b.htm.

Statistics Canada. "Canadian Statistics - Population by Sex and Age." www.statcan.ca/english/Pgdb/People/Population/demo10a.htm. 19 September 2001.

Statistics Canada. "Canadian Statistics - Population Canada, the Provinces and Territories." www.statcan.ca/english/Pgdb/People/Population/demo02.htm. 19 September 2001.

Statistics Canada. "Canadian Statistics - Population of Census Metropolitan Areas." www.statcan.ca/english/Pgdb/People/Population/demo05.htm. 19 September 2001.

Statistics Canada. "Canadian Statistics - Population estimates for 1996 and projections for the years 2001, 2006, 2011, 2021 and 2026, July 1." www.statcan.ca/english/Pgdb/People/Population/demo23a,b&c.htm. 19 September 2001.

Statistics Canada. "Canadian Statistics – Recent Immigrants by Country of Last Residence." www.statcan.ca/english/Pgdb/People/Population/demo08.htm. 19 September 2001.

Statistics Canada, Transportation Division. "Canadian Vehicle Survey. Quarter 4, 2000." Minister of Industry: Ottawa, Canada, 2001.

Strategic Transit Research Program (STRP), Canadian Urban Transit Association (CUTA). "STRP Report #1-1: The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada: Phase 1, Trends and Applications." CUTA: Toronto, Canada, December 1991.

Strategic Transit Research Program (STRP), Canadian Urban Transit Association (CUTA). "STRP Report #1-2: The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada: Phase 2, Potential Strategies". CUTA: Toronto, Canada, December 1991.

Strategic Transit Research Program (STRP), Canadian Urban Transit Association (CUTA). "STRP Report #1-3: The Implications of Demographic and Socioeconomic Trends for Urban Transit in Canada: Phase 3, Case Studies Technical Appendix". CUTA: Toronto, Canada, December 1991.

Transplan Associates. "STRP Synthesis S1: Profiling Transit Ridership". CUTA: Toronto, Canada, 2000.

Transport Canada. Performance of Transit Systems. (unpublished)

Transport Canada. POR Roll Up on Smog, Congestion and Urban Transit Issues, June 1998-June 2001. (unpublished)

Transport Canada. Sustainable Transportation: The Canadian Context. 2001. www.tc.gc.ca/envaffairs/english/UNCSD9_April23_01.htm.

Transport Canada. ITS Initiatives by Jurisdiction. May 2000.

Transport Canada. "Appendix A: Intelligent Transportation Systems: A Primer." An Intelligent Transportation Systems (ITS) Plan for Canada: En Route to Intelligent Mobility. November 1999.
www.its-sti.gc.ca/en/download/its_plan.htm

Transport Canada. Performance of Transit Systems: Summary Results, Detailed Tables, Methodology and Data Source.

Transportation Association of Canada (TAC). Urban Transportation Indicators – 1996 Survey 2. TAC: Ottawa, Canada, 1999.

Transportation Association of Canada (TAC). "Financing Urban Transportation." Briefing February 1997.

Transportation Association of Canada (TAC). Urban Transportation Indicators in Eight Canadian Urban Areas. TAC: Ottawa, Canada, 1996.

Transportation Association of Canada (TAC). "A New Vison for Urban Transport." Briefing March 1993.

Transportation Research Board, National Research Council. Making Transit Work: Insight from Western Europe, Canada, and the United States. Special Report 257. Washington, USA: National Academy of Sciences, 2001.

Transportation Research Board, National Research Council. "International Transit Studies Program: Report on the Spring 1998 Mission – Private Uran Transit Systems and Low-Cost Mobility Solutions in Major Latin American Cities." Research Results Digest April 1999: 1-40.

Transportation Research Board, National Research Council. Using Public Transportation to Reduce the Economic, Social, and Human Costs of Personal Immobility. TCRP Report 49. Washington, USA: National Academy Press, 1999.

Transportation Research Board, National Research Council. The Costs of Sprawl – Revisited. TCRP Report 39. Washington, USA: National Academy Press, 1998.

Transportation Research Board, National Research Council. Funding Impact Analysis of Transit Investments: Guidebook for Practitioners. TCRP Report 35. Washington, USA: National Academy Press, 1998.

Transportation Research Board, National Research Council. Funding Strategies for Public Transportation. Vol. 1: Final Report. Washington, USA: National Academy Press, 1998.

Transportation Research Board, National Research Council. Report 16: Transit and Urban Form. Vol. 1 and 2. Washington, USA: National Academy Press, 1996.

Urban Development Services, City of Toronto. City of Toronto Cordon Count 1998. Toronto, Canada, June 2000.

Vivier, Jean, UITP (International Association of Public Transport) & ISTP (Institute for Sustainability and Technology Policy). The Millennium Cities Database for Sustainable Transport, Analysis and Recommendations. 2001

Winfree, Tracy and Penny Puskarich, City of Boulder. The HOP & SKIP: A Formula for Success in Community Transit Systems. 1999.

APPENDIX