ANALYSIS OF RESIDENTIAL PROPERTY VALUE BEFORE AND AFTER THE OPENING OF THE SKYTRAIN MILLENNIUM LINE

by

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ABSTRACT

This research investigates the impacts of the construction of the SkyTrain Millennium Line in Burnaby's Lougheed Town Centre area on residential property values. These price impacts are for three years, corresponding to a year during construction (2000), the completion date (2002) and three years after its opening (2005). A hedonic property price model shows that the distance from the SkyTrain station had a statistically significant negative impact on residential property values only prior to the SkyTrain's opening. The model also suggests that structural variables, such as floor space, age, and heating are more influential than the distance to SkyTrain in affecting the property values.

Keywords: SkyTrain, property value, light rail transit

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INTRODUCTION

There is little doubt, theoretically or practically, that the relationship between transportation and land use is significant. The most common empirical approach used to measure this relationship is to examine how property values vary with distance to a transportation facility (Ryan, 1999). This study investigates the impact of the construction of the Lower Mainland SkyTrain Millennium Line in the Lougheed Town Centre area of the City of Burnaby, British Columbia, on nearby residential property values. The case study relies on a hedonic property price model to analyze the relation between the SkyTrain and values of the existing residential high-rise condominiums in the Lougheed area. The model is represented by a linear regression equation, which is used to isolate and quantify the factors that affect the value of housing stock in the study area. The study area is defined as a compact area near the SkyTrain station, which is the Lougheed Town Centre Area. These price impacts are for three years, corresponding to a year during construction (2000), the completion date (2002) and three years after its opening (2005).

This research project has two major research questions:

- *What are the factors affecting residential property values?*
- *Why are the values of some properties more affected by the SkyTrain project than other properties?*

The research project has two major hypotheses:

- *During a construction year, if the distance between the property and the SkyTrain station decreases, the property values will decrease.*
- *After the SkyTrain opened, if the distance between the property and the SkyTrain station decreases, the property values will increase.*

Objectivist epistemology distinguishes the manner by which we can individually translate our perceptions concerning the relationship between proximity to the SkyTrain station and residential property values into concepts that we can store in our minds. While we can "know" that there are existing relationships between proximity to transit and property values by our perceptions, we can know what exists only by turning precepts into concepts. The social world exists externally to the researcher, and the properties can be measured directly through observation. This research project studied the facts (sold prices of properties, physical characteristics of the properties and actual measurable distance to amenities), but not with values. The results of this research would present as objective facts and establish truth. This research approaches knowledge by testing evidence in order to confirm or disconfirm previously held theories in other case studies or price-predicting models.

This topic was chosen because knowing the effect of new transportation facilities on property values is essential to the public. Transportation systems not only facilitate the movement of people and goods but also have potentially wide-ranging impacts on land use (Huang, 1996). Planners can and do use transportation as a policy instrument to guide growth (Huang, 1996).

Governments design mechanisms to internalize the external effects of transport projects, and investors make decisions on real estate investment based on these effects (Lin and Hwang, 2003). The decisions and investments of governments and investors will result in intensification or change in land use (Henneberry, 1997). Communities such as Toronto and Arlington County, Virginia have adopted intensified zoning around transit stations. Communities such as Baltimore and Maryland see the rail stations as nodes for new office and retail development. Knapp, Ding and Hopkins (2001) describe high-density, transportation-oriented development around light rail[1] transport nodes as one of the features of "New Urbanism". In recent years, there has been growing support for transit-oriented development, which results when a transit station provides a catalyst for mixed-use, walkable land use patterns, sometimes called an urban village. This type of land use pattern can provide many benefits to residents, business and society, including improved accessibility, reduced consumer transportation costs, reduced traffic congestion, reduced parking costs, reduced accidents, plus environmental health benefits (Smith and Gihring, 2006). Cities throughout North America continue to invest in light rail and other forms of public transportation with the intent of shaping the pattern of urban development (Knapp, Ding and Hopkins, 2001). Other communities have discouraged growth in areas served by rail stations, as demonstrated when residents around several suburban Bay Area Rapid Transit stations objected to the prospect of intensified growth, and local officials downzoned the station areas (Huang, 1996).

[1] Light Rail: An electric railway with a "light volume" traffic capacity compared to heavy rail. Light rail may use shared or exclusive rights-of-way, high or low platform loading and multi-car trains or single cars. Also known as "streetcar," "trolley car" and "tramway" (American Public Transportation Association, 2002).

Although the Vancouver SkyTrain system has been serving the Lower Mainland for 21 years, little research has been done to analyse the impact of the SkyTrain on residential property. The expected effects of the Lower Mainland SkyTrain Expo Line on property values has been studied in "The preservice impacts of the Vancouver Advanced Light Rail Transit System on single family property values" by Ferguson and colleagues in 1998. However, the influence of the Millennium Line on property values has not yet been empirically studied since its opening in 2002.

This research is a longitudinal study of price impacts for three years, corresponding to a year during construction (2000), the completion date (2002) and three years after its opening (2005). The study uses a hedonic property price model to analyze the relation between the SkyTrain and values of the existing residential high-rise condominiums in Lougheed. Etymologically, the term "hedonics" is derived from the Greek word *hedonikos*, which simply means pleasure. In an economic context, it refers to the utility or satisfaction one derives through the consumption of goods and services. A hedonic price model quantifies house price as a function of a set of locational and property-specific characteristics. Henneberry (1997) asserts that hedonic analysis is a well-established technique used to identify the influence on price of one factor among many. Property is conceptualized as a bundle of individual attributes each of which contributes to the full enjoyment of the accommodation (Henneberry, 1997). Therefore, the price paid for a particular property is the sum of the implicit prices that the market ascribes to the various attributes contained in the bundle.

With information on the prices of properties and their varying attributes, it is possible to derive through analysis the implicit equilibrium market price – the hedonic price – of each attribute (Henneberry, 1997). An effective use of the hedonic price model requires a large number of transactions and their corresponding housing attributes.

Bae, Jun and Park (2003) claim that the hedonic property price models had non-negligible conceptual problems due to an inadequate specification of demand and supply functions; they claim further that the hedonic property price approach has attained a wide degree of acceptance as a serviceable reduced-form model, despite its underlying theoretical weaknesses. The theoretical justification for using hedonic price functions has been provided by Rosen (1974). Rosen explains that the predominant studies used the hedonic property price model to analyze the impacts of transport infrastructure on housing values. For example, Bajic (1983) used the hedonic property price model to study the effects of a new subway line on housing prices in metropolitan Toronto. Bae, Jun and Park (2001) studied the impact of Seoul's subway Line 5 on residential property values for four years, corresponding to the announcement of the subway, a year during construction, the completion date, and three years after its opening. Strand and Vagnes (2001) used dual methods (hedonic prices and real estate brokers' appraisals) to study the relationship between property values and railroad proximity. The hedonic price study and the real estate broker study showed similar results: when considering housing units within a 100-meter range of the nearest railroad line, there was a significant and strong relationship

between the housing value and railroad proximity. These studies also imply that when designing the research methods, the hedonic price study and real estate broker study will generate similar results.

There are two reasons to justify the application of the regression model in this project. Firstly, Lin and Hwang (2003) suggest that when there is a sufficient and complete sample, regression analysis is generally recommended in an impact study, and experiment-control analysis should only be used when the sample is incomplete or insufficient. Since the public record of British Columbia Assessment (BC Assessment) contains transaction records of properties in British Columbia in Canada and the Building Department at the City of Burnaby contains the records of the buildings in Burnaby. Given that both sets of records are available to the public, the experiment-control analysis is not considered in this study. Secondly, changes in accessibility induced by new transport infrastructure are not the only influence on property values. Other factors, such as long-term social, technological and economic trends can change fundamentally the physical and locational attributes necessary to the efficient and effective functioning of accommodated activities. Their effects on property values can be equally profound. The structural trajectory and economic performance in the economic and business cycle can have a significant short-run impact on the value of property with a set of physical and locational attributes. Financial performance of actual or potential occupants can limit the effective demand for given property types. Such influences on value typically predominate. Therefore, the identification of the discrete impact on property values of a particular

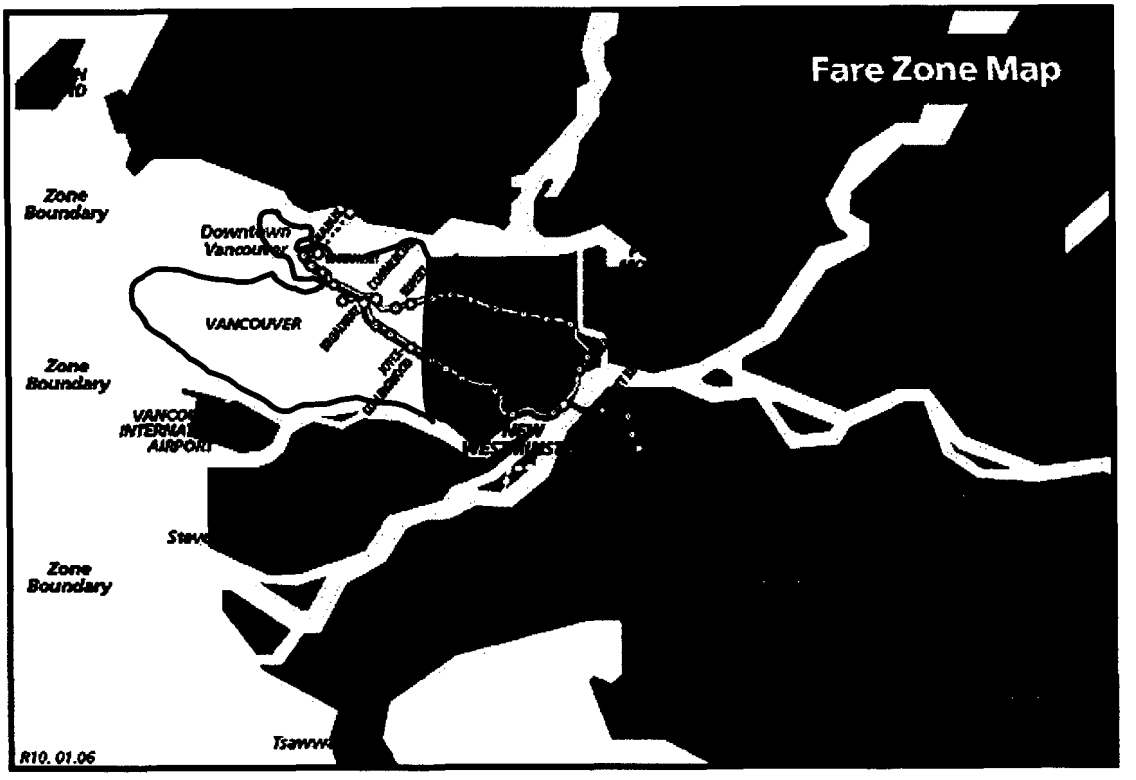
investment in new transport infrastructure can be problematic. Henneberry's (1997) assertion that hedonic analysis should be used to attack such problems led to the use of such an analysis here.

Description of the Vancouver SkyTrain

Background

The SkyTrain in Vancouver, British Columbia, Canada, is an advanced light rapid transit system (ALRT) operating fully automated trains on two lines: the Expo line and the Millennium line. The SkyTrain moves passengers across the region on the two lines along 49.5 kilometres and through 33 stations, which is the world's longest fully automated rapid transit system. (TransLink, 2007) Refer to Figure 1, the Fare Zone Map of the Lower Mainland, which shows the coverage of the two lines in the area.

Figure 1: Fare Zone Map of Lower Mainland SkyTrain



(Source: TransLink, 2007)

Serving the Vancouver metropolitan area since 1986, SkyTrain is operated by the British Columbia Rapid Transit Company Ltd. (BCRTC) which is an operating subsidiary of TransLink, the Greater Vancouver Transport Authority. BCRTC operates the Expo and Millennium SkyTrain lines which connect downtown Vancouver with the cities of Burnaby, New Westminster and Surrey, offering a vital link between the downtown core and nearby municipalities once not well served by public transit. The major objective of SkyTrain is to promote compact development, such as Burnaby's Metrotown and the New Westminster Quay. (TransLink, 2007)

History

The original SkyTrain was built for the Expo 86 World's Fair, and the Millennium Line route was first identified in the Greater Vancouver Regional District's (GVRD) Liveable Region Strategic Plan in 1986. After four years of public consultation, review and input, Broadway-Lougheed was identified as one corridor for rapid transit[2] development. In 1998, the provincial government announced that a new line would be built in the Broadway-Lougheed corridor. Meanwhile, a new company – Rapid Transit Project 2000 Ltd (RTP 2000 Ltd) – was formed to plan and build the new line. According to Rapid Transit Office (RTO), construction of the line officially began on October 14, 1998, and most of the construction work was finished by 2002. The Millennium Line entered revenue service in December 2001. The final station at Vancouver Community College was completed in December 2005 (RTO, 2007).

Technology

SkyTrain technology was chosen for the Millennium Line. As the Vancouver SkyTrain combines the features of both light and heavy rail systems, it is called Advanced Light Rapid Transit (ALRT). The system uses the same family of linear induction motor-driven trains as the Scarborough RT line in Toronto, the Putra LRT in Kuala Lumpur, Malaysia, and the JFK AirTrain in New York (BCRTC, 2007). SkyTrain represents a modern family of automated rapid transit systems, also known as Intermediate Capacity Transit System (ICTS). The technology comprises a blend of design principles and philosophies

[2] Rapid Transit: Rail or motorbus transit service operating completely separate from all modes of transportation on an exclusive right-of-way. (American Public Transportation Association, 2002)

of conventional rapid transit, Light Rapid Transit (LRT), and automated "people mover" systems. Like conventional "heavy" rail[3], SkyTrain operates entirely on segregated right-of-way, with no vehicular or pedestrian crossings. The system incorporates features of proven transit technology along with new applications of the linear induction motor (LIM), steerable axle truck, and moving block inductive train control system. (BCRTC, 2007)

Vehicles

A total of 114 ART Mk I vehicles were initially delivered to Vancouver for use on the SkyTrain Expo Line. (BCRTC, 2007) With increasing network coverage and rising passenger demand, the number of ART Mk I vehicles was increased to 170 in 2002. (BCRTC, 2007) 60 ART Mk II vehicles were ordered from Bombardier Transportation in 1998 and are now all in service. (BCRTC, 2007) They are wider than the Mk 1 vehicles and feature three larger doors on each car, plus climate control and easy access for wheelchairs and bicycles. In November 2006, 34 additional ART Mk II vehicles worth $99 million were ordered. (BCRTC, 2007)These vehicles will provide additional capacity on the current network. The Bombardier's production facilities at Sahagun, Mexico and Thunder Bay, Ontario built the vehicles, which will be delivered in 2009. (BCRTC, 2007)

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[3] Heavy Rail: An electric railway with the capacity for a "heavy volume" of traffic and characterized by exclusive rights-of-way, multi-car trains, high speed and rapid acceleration, sophisticated signaling and high platform loading. Also known as "rapid rail," "subway," "elevated (railway)" or "metropolitan railway (metro)." (American Public Transportation Association, 2002)

Features

SkyTrain runs every two to eight minutes, and travels above traffic on separated guideways. SkyTrain is an automated guideway[4] rail-transit system carrying over 160-180,000 passengers per day traveling at speeds of up to 90 kph, with a per-train capacity of approximately 260 people (BCRTC, 2007). According to BCRTC, prior to the Millennium Line extension in 2000, annual ridership of SkyTrain was 46.3 million, for an average of 146,000 per weekday. When the new line became fully operational in 2005, ridership reached 66 million, with an average of 210,000 per weekday, and with more than 20,000 boarding during the peak hour of the day. (BCRTC, 2007) In 2007, passenger volume into the downtown core (departing Broadway station) exceeds 10,000 in the peak 60 minutes, equivalent to 4.5 freeway lanes of private automobiles. (BCRTC, 2007) The peak 2-hour volume is about 17,000. (BCRTC, 2007) As the system runs on electricity, it is emission-free and energy efficient. It is quiet and produces less noise than diesel buses, and is considered an environmentally friendly means of transportation.

Vancouver's SkyTrain was studied in an eight-year survey of automated metro systems in Europe, North America, and Asia conducted by a working group of the International Union of Public Transport (UITP), headquartered in Brussels. (American Public Transportation Association, 2003) In 2007, the working group concluded that total automation allows the operator to provide exceptional service quality while reducing operating costs. (American Public

[4] Automated Guideway: An electric railway operating without vehicle operators or other crew on board the vehicle. (American Public Transportation Association, 2002)

Transportation Association, 2003) According to the UITP's study, automated systems result in lower waiting time for passengers and a higher level of cleanliness, information, and safety in both trains and stations. The study also identifies that full automation allows for very precise and rapid service adjustments. The automated systems with platform door service availability are rated as "excellent" at 99.7 percent. The rating is far superior to conventional metros. The report also notes that automated systems can reduce capital costs. It suggested that frequent and shorter trains can reduce the size and cost of stations, and attain larger capacities during rush hours. The working group also summarized the four traditional arguments against driverless systems: they reduce jobs, confine passengers in a threatening environment where they are left on their own in case of hazardous incidents, create fear and insecurity through the absence of drivers, and require a higher level of investment.

Stations

SkyTrain stations and trains have special features designed to make the system useable for bike users and passengers with physical disabilities. (TransLink, 2007) Figure 2 shows a platform inside Lougheed Town Centre SkyTrain Station. Station platforms are exclusively high level for passenger convenience and loading efficiency.

Figure 2: Station platform and SkyTrain at Lougheed Town Centre Station

(Source: Au, 2007)

Stations are monitored by closed-circuit TV during operation hours to provide control operators effective station surveillance and the opportunity to record suspicious activity or crime in progress, and to respond to system emergencies. On average, there are approximately 23 cameras per station (BCRTC, 2007). Also, all public areas are designed to provide sight lines offering visibility for users, SkyTrain staff and security personnel. According to "SkyTrain cops to carry guns", a news article from Canadian Broadcasting Corporation News, dated March 22, 2005, Vancouver's rapid-transit system became the first in the country to be patrolled by police who carry guns and have full police

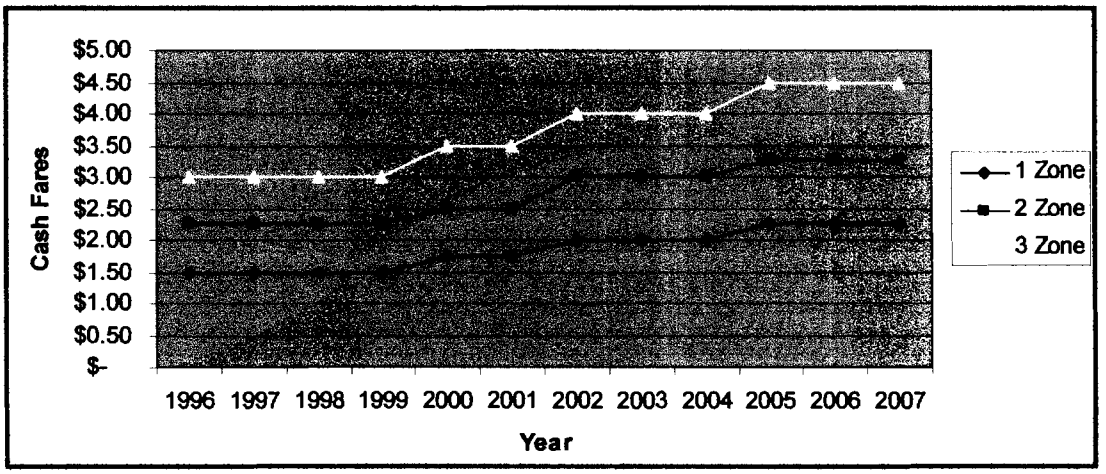
powers since 2005. TransLink introduced the new armed force to patrol the SkyTrain, Sea Bus and West Coast Express train (CBC News, 2005).

The UITP's study in 2007 notes that passengers give high marks to the automated, 'driverless' SkyTrain system in Lower Mainland and that initial apprehensions, such as confining passengers in a threatening environment where they are left on their own in case of hazardous incidents, creating fear and insecurity through the absence of drivers, regularly disappear after the first few weeks of operation.

Fare

According to TransLink, the existing fare structure is a zone system consisting of three zones, which is in effect until 6.30 p.m., Monday to Friday. (Figure 1 shows the fare zone map of the system). At all other times, riders can pay a one-zone fare to travel to any part of the region. Figure 3 shows the trend for adult cash fares for one-zone, two-zone and three zone trips during 1996 to 2007. There were fare increases in 2000, 2002 and 2005. Currently, the adult cash fares for one-zone is $2.25, for two-zone is $3.25 and for three-zone is $4.50.

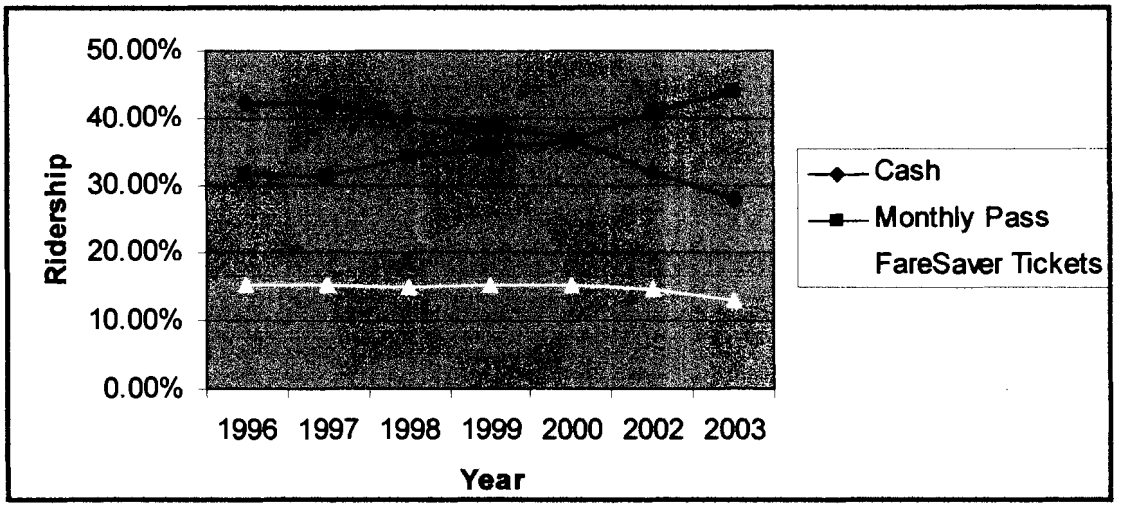
Figure 3 Adult Cash Fares, 1996 to 2007



(Source: TransLink, 2007)

Figure 4 illustrates the relative usage of the three main fare types in the period from 1996 to 2003. The trend shows a greater use of monthly passes, a declining use of cash fares, and a relatively stable use of FareSaver tickets (books of 10 tickets). This trend is indicative of the increasingly better value of monthly passes over cash fares and tickets during the period of 1996 to 2007. (TransLink, 2007) To encourage regular and greater use of the transit system, the price of the monthly passes was reduced, and the price of cash fares was increased in 2000. According to TransLink, this approach has been successful in increasing pass use and increasing overall transit ridership, which continues to show strong growth in 2004.

Figure 4 Percentage of Ridership by Cash Fare, Monthly Pass and FareSaver Tickets, 1996 to 2003



(Source: TransLink, 2007)

The Greater Vancouver Transport Authority (GVTA) implemented a U-Pass Program with the University of British Columbia (UBC) and Simon Fraser University (SFU) in September 2003. The monthly price for the pass paid to the GVTA was established at $23.00 for UBC and $25.00 for SFU. (U-Pass Review Final Report, 2005) U-Pass Review Final Report (2005) prepared by Urban Systems outlined the success of the program: the majority of students supported the program, most student used their U-Passes, transit ridership increased more than expected, U-Pass users reported significant benefits and transit service capacity increased by 27%.

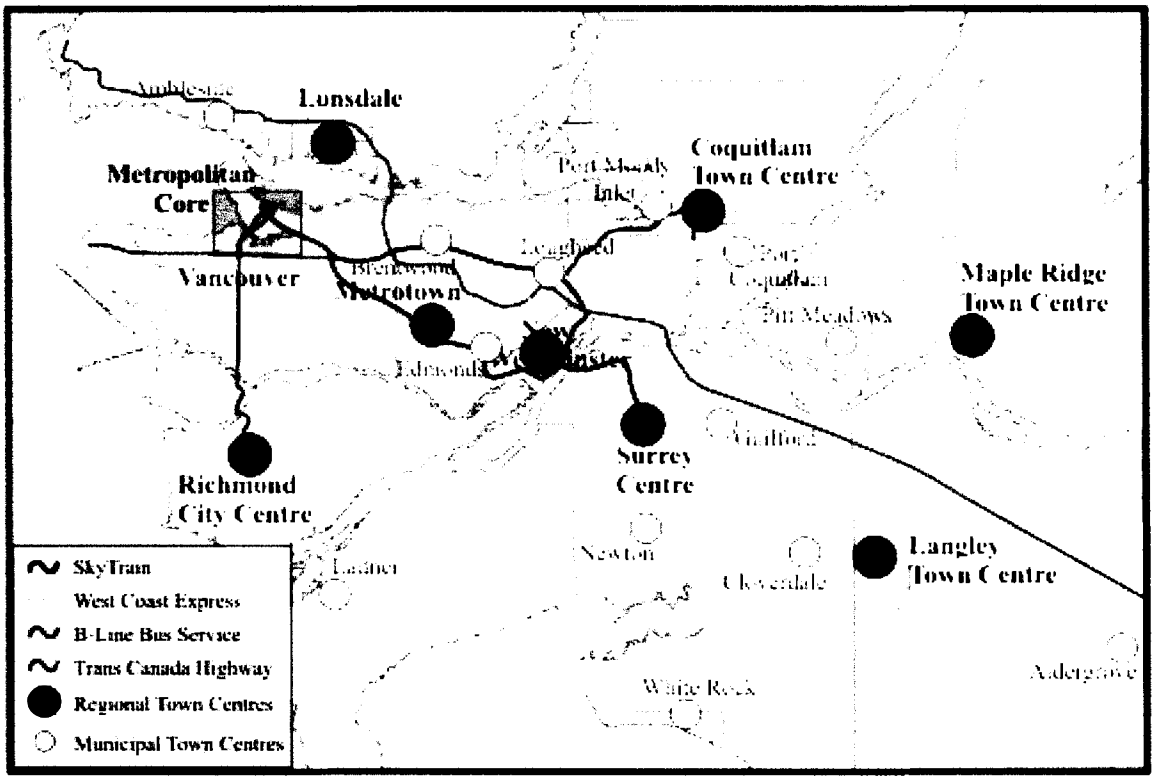
Description of the Lougheed Town Centre Area, Burnaby

The population of the GVRD is expected to reach 3 million over the next 20 to 25 years. The Livable Region Strategic Plan was adopted by the Greater Vancouver Regional District (GVRD) in 1996 to serve the needs of the

growing population (GVRD, 2007). The GVRD and its partner municipalities have been working to help create a compact, liveable metropolitan region, a healthy natural environment and complete communities. Also, they have been working to increase transportation choice. A key component of the plan is the ongoing development of the metropolitan core, eight interconnected Regional Town Centres and a number of smaller, local serving Municipal Town Centres (GVRD, 2007). Figure 5 shows the locations of the metropolitan core, the Regional Town Centres and the Municipal Town Centres. Along the SkyTrain Millennium Line, there were three municipal town centres in Burnaby: Brentwood, Lougheed and Edmonds.

At the regional level, Lougheed Town Centre is situated within the GVRD's Compact Metropolitan Area (Downtown Vancouver and Central Broadway) as defined in the Liveable Region Strategic Plan. At the city level, Lougheed is one of three municipal town centres in Burnaby and is identified as a centre of regional significance by the City of Burnaby. Located in the northeast quadrant of the city at the foot of Burnaby Mountain, Lougheed is planned as a complete community with a wide range of housing types and a strong retail core.

Figure 5: The Map of the Metropolitan Core, the Regional Town Centres and the Municipal Town Centres in Liveable Region Strategic Plan



(Source: GVRD, 1996)

Profile of the City of Burnaby

According to the Statistical Profile of School District 41 Burnaby, prepared by BC Stats, the population of the City of Burnaby in 2006 was 205,477, which was approximately 4.8% of that of British Columbia. The number of dwellings occupied by usual residents was 78,027 in 2006. The land area of the city in 2006 was approximately 90.1 square km. The population density of the city was slightly higher than that of the province, at 2,305.6 persons per square km, while that of British Columbia was 2,280.8 persons per square km. Over the past ten years, the annual average population change rate of the city has been 1.4% while that of the province is 1.1%. The 2001 census data showed that 48.6% of

the population in the city was identified as visible minorities, while that of the province was only 21.6%.

Burnaby's Real Estate Market

According to the Real Estate Board of Greater Vancouver (REBGV), the benchmark price of a condominium unit in Burnaby in December 2005 was $251,997, and the price index was 188.4 (all index equals to 100 in June 2001). Compared with 2004, 2002, and 2000 the condominium unit appreciated 21.5%, 64.4% and 90.0%, respectively. Table 1 shows the benchmark price, price range and price index for the condominium units in Greater Vancouver. The benchmark price of condominium in Burnaby was smaller than that of Greater Vancouver, but the price index of Burnaby was higher than that of Greater Vancouver. Condominium in Burnaby had the fourth highest benchmark in Greater Vancouver. Price indexes for Burnaby, North Vancouver, Richmond, Vancouver East, Vancouver West and West Vancouver were similar to that of Greater Vancouver. The price of condominiums in Port Moody and Port Coquitlam grew faster than Burnaby. Generally, the real estate market in Burnaby during 2000 to 2005 followed the trend of Greater Vancouver. Based on these figures, the opening of SkyTrain did not have a sharp impact in condominium value in Burnaby.

Table 1: Summary of residential property figures in Greater Vancouver as of December 2005

CONDOMINIUM							
AREA	BENCHMARK PRICE	PRICE RANGE	3 MTH AVG BENCHMARK	PRICE INDEX	1 YEAR CHANGE	3 YEAR CHANGE	5 YEAR CHANGE
Greater Vancouver	$282,079	0.80%	$281,559	183.5	19.7	58	90
Burnaby	$251,997	1.80%	$250,305	188.4	21.5	64.4	90
Coquitlam	$211,324	3.20%	$212,499	180.2	19.8	56.1	92.4
South Delta	$267,456	7.60%	$269,487	174.2	20.2	37.5	78.3
Maple Ridge & Pitt Meadows	$185,698	5.00%	$182,367	197.2	23	59.3	115.6
New Westminster	$215,032	2.90%	$209,699	174.7	19.3	57.5	84.5
North Vancouver	$292,518	2.70%	$295,096	186.1	18.8	69.1	80.8
Port Coquitlam	$190,303	3.00%	$186,067	222.9	28.2	81.9	147.3
Port Moody	$243,647	5.70%	$244,418	207.9	36.2	98.8	135
Richmond	$228,220	1.70%	$227,895	185.5	18.5	60.1	97
Vancouver East	$230,574	2.60%	$228,177	188.8	24.6	69	92.9
Vancouver West	$364,033	1.40%	$366,573	185.2	17.3	52.9	98.6
West Vancouver	$505,358	9.20%	$475,153	181.3	22.1	49	83.9

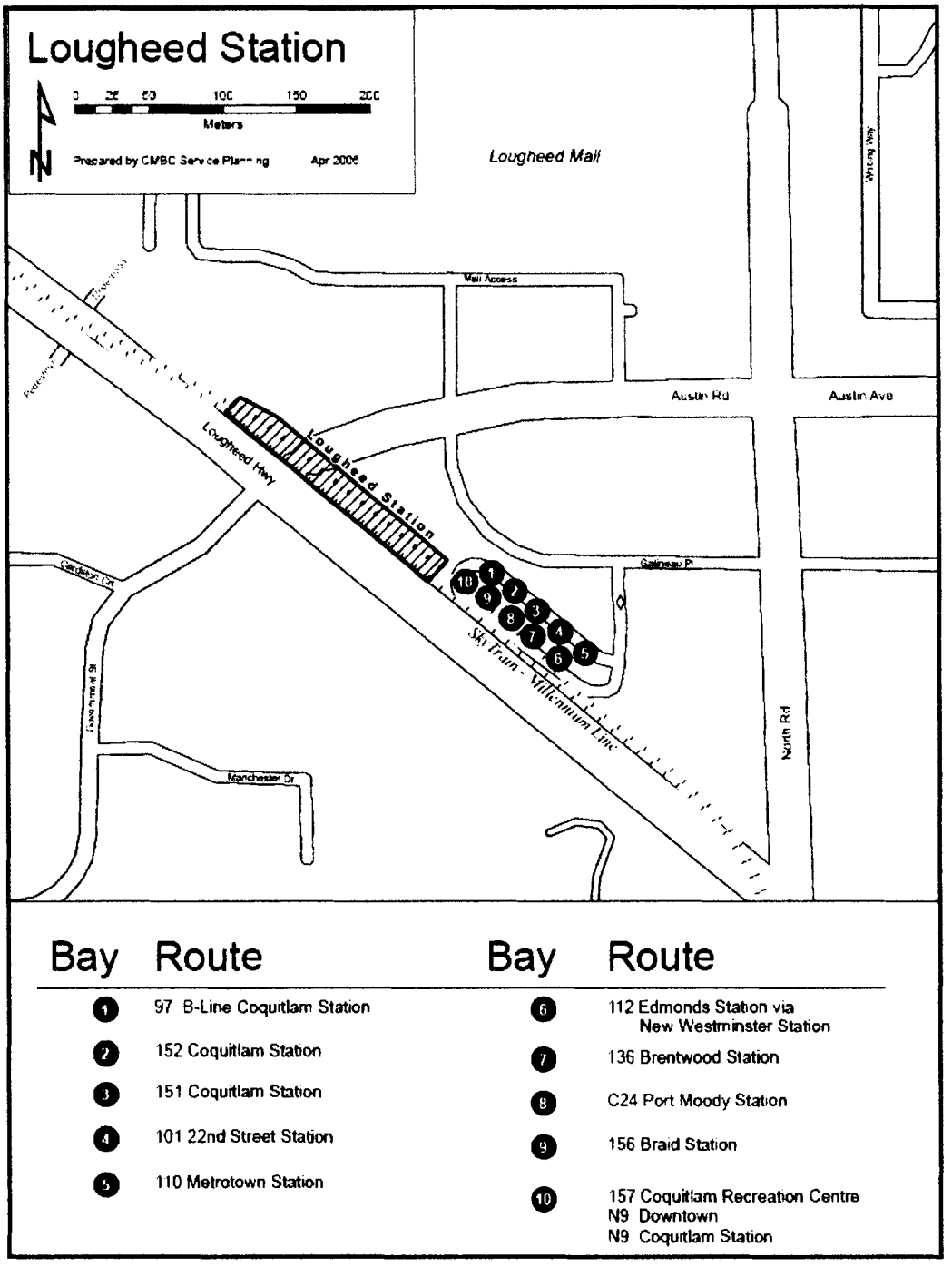
Estimated sale price of a benchmark property: Benchmarks represent a typical property within each market. Price range: Expressed as a + or - percentage of the benchmark price, there is a 90% probability the sale price of a benchmark house is within the interval. Price index: Index numbers estimate the percentage change in price on typical and constant quality properties over time. All figures are based on past sales. All indexes equal 100 in June 2001. (Source: REBGV, 2005)

Transportation

The town centre's major public transportation hub is located near the Lougheed Highway-Austin Road intersection. Currently, the Lougheed Town

Centre SkyTrain Station on the new Millennium Line connects passengers to downtown Vancouver, New Westminster, or Surrey in approximately 25 minutes (TransLink, 2007). In October 2004, the Evergreen light rail transit line was approved in principle by the TransLink Board (TransLink, 2007). The Evergreen Line is expected to serve the public by 2009, will feature ten stations over 11 kilometers linking neighbourhoods between Coquitlam, Port Moody and Lougheed Town Centre and connect with buses, SkyTrain, West Coast Express and points beyond (GVRD, 2007). As a result, the Lougheed Town Centre will be at the confluence of two major rail lines with vastly improved access to and from major portions of the regional area. The Advisory Committee of the Lougheed Town Centre Plan intended to change the Lougheed Town Centre Core Area from the suburban car-oriented shopping centre with surrounding residential and commercial uses to a more pedestrian and transit-oriented centre having a fuller and better integrated range of uses leading to a more complete and self-sufficient community for the Lougheed Town Centre. Figure 6 shows the location of the Lougheed Town Centre SkyTrain Station and the bus stations in the Lougheed area. The bus stations are adjacent to the SkyTrain Station, and the Lougheed Mall is located north of the SkyTrain Station. Currently, there are ten bus routes that converge at the Lougheed bus interchange and provide service to Burnaby's other town centres as well as to New Westminster, Coquitlam, and Port Moody (TransLink, 2007).

Figure 6: Map of Lougheed Station

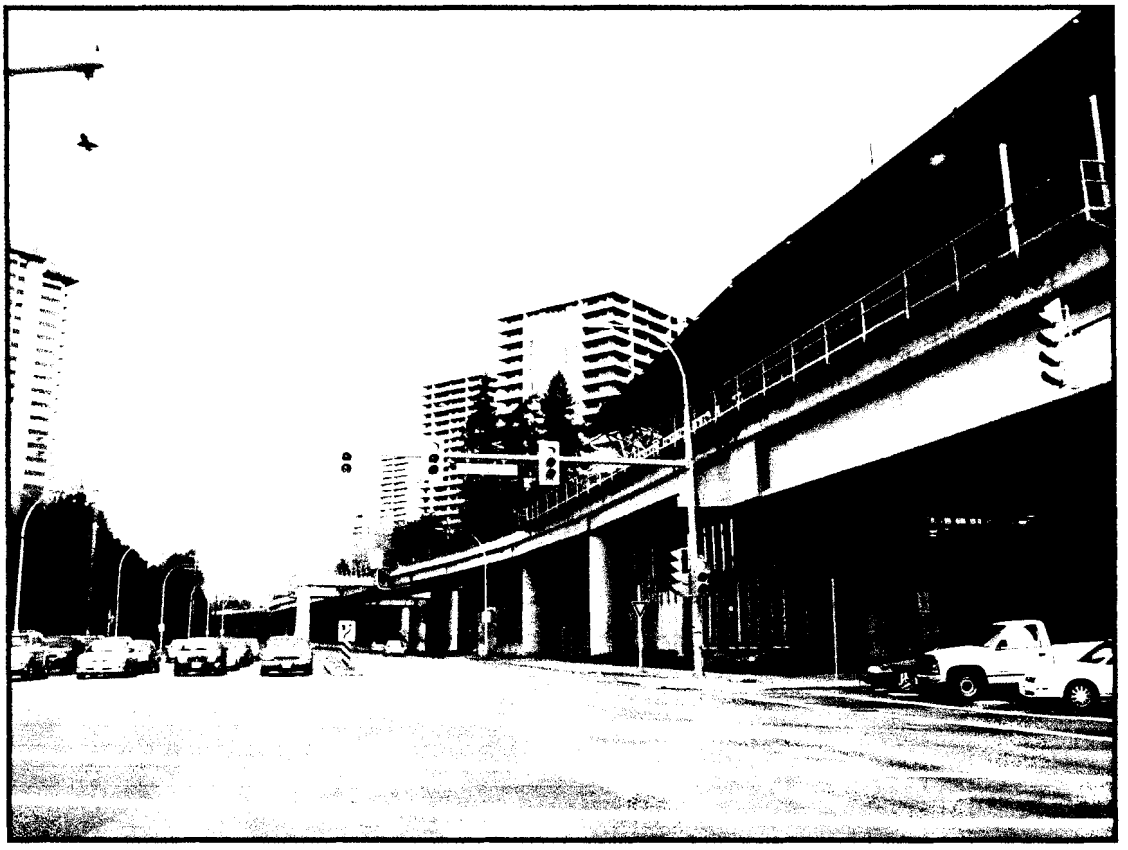


(Source: TransLink, 2007)

There are developed automobile connections to other parts of the region. Figure 7 is a photo showing the intersection of Lougheed Highway and

Austin Road in Burnaby, which shows both that Lougheed Highway is a busy street with heavy traffic flow in daytime and that high-rise condominium buildings are located near the SkyTrain Station.

Figure 7: Intersection of Lougheed Highway and Austin Road, Burnaby

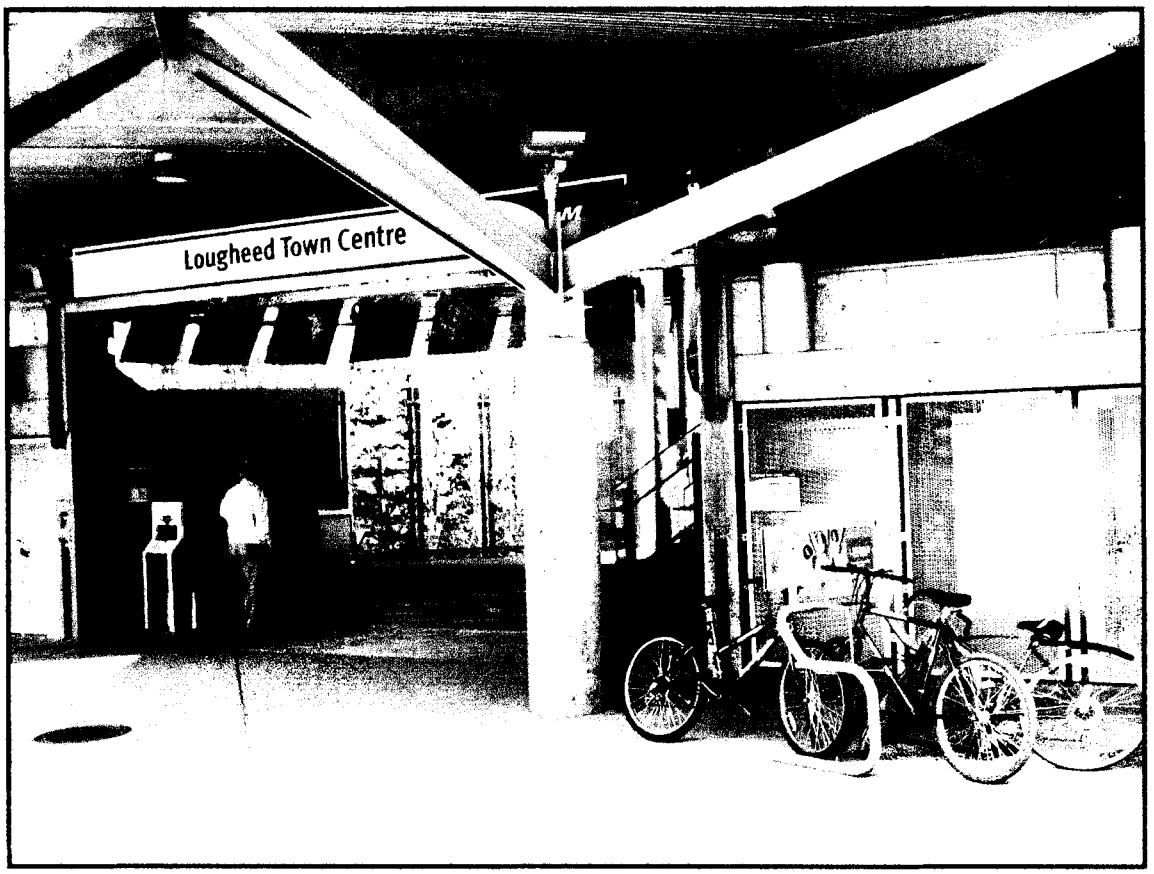


(Source: Au, 2007)

Gaglardi Way connects the Lougheed Highway to the Trans-Canada Highway, so that residents and employees in the Lougheed Town Centre can easily access other parts of the region. The Lougheed Highway also provides quick connections to the Tri-City area of Port Moody, Coquitlam, and Port Coquitlam. In addition, several cyclist routes and pedestrian walkways add to the range of transportation options in the Lougheed community. Figure 8, a photo of

the Lougheed Town Centre SkyTrain Station, shows a bicycle rack outside the station, and a pedestrian entering to the station.

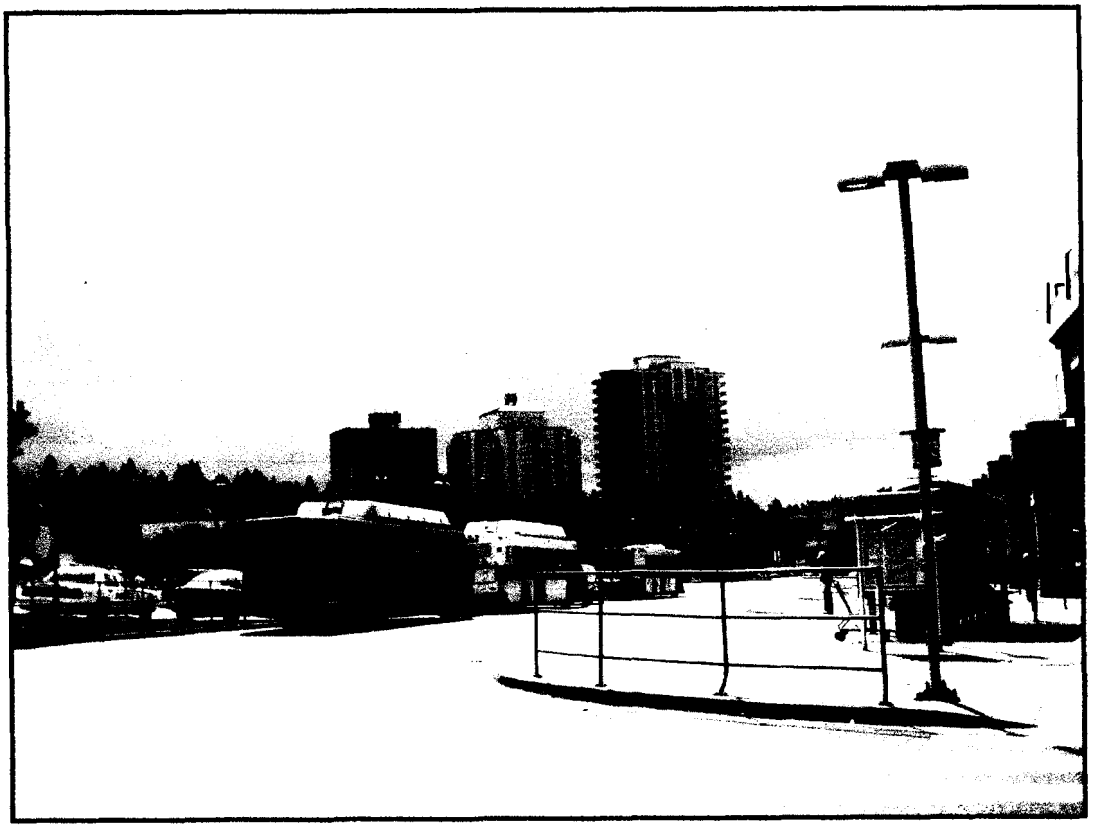
Figure 8: Lougheed Town Centre SkyTrain Station



(Source: Au, 2007)

The Lougheed Town Centre is bounded by North Road, which is Burnaby's easterly boundary. North Road serves as a major north-south arterial for the community. Figure 9 shows the bus stations located at the corner of North Road and Lougheed Highway. There are three high-rise condominiums located east of the North Road in Coquitlam; residents of these buildings can walk to the SkyTrain Station to access to the SkyTrain services.

Figure 9: Lougheed Town Centre Bus Interchange



(Source: Au, 2007)

Land Use

Burnaby Council initiated a citizen-based review of the community plan for the Lougheed Town Centre area in May 1995. Recommendations for a renewed Town Centre Plan for the Lougheed area were completed over a two-year period. The plan was the first step in the ongoing process of planning and guiding the future development of the Lougheed Town Centre in the next ten to twenty years. The Council's approval of the proposals confirmed the creation of a framework for the continued refinement and detailed implementation of the Plan. The Advisory Committee for the Lougheed Town Centre Plan identified that the

housing development near the Lougheed core area[5] would focus on medium to high density developments (City of Burnaby, 1997). Table 2 shows the land use allocations recommended in the Lougheed Town Centre Plan. The total town centre area is about 700 acres, with 281 acres of land planned for residential use. Table 3 is a summary of land use figures in the area in 1997 and in the plan. In 1997, there were no residential units in the core area. The plan proposed to add 2,400 residential units in the core area.

Table 2: Recommended land use allocations in Lougheed Town Centre Plan (1997)

Land Use Allocations	Area(Acres)
Core Area (excluding roads & park)	62
Residential	
High Rise	29
Mid Rise	9
Low Rise	42
Townhouse	101
Single Family	100
Total Residential	281
Parks and Open Spaces	160
Civic, Institutional & Other Uses	22
Roads and Rights of Way	175
Total Town Centre Area	700 Acres

(Source: City of Burnaby, 1997)

[5] The Core Area is defined as the 72 acre area bordered by the Lougheed Highway, North Road, Cameron Street and Bartlett Court. The area includes the Lougheed Mall, properties located in the Government Place 'triangle', and existing properties near North Road and Cameron Street. (City of Burnaby, 1997)

Table 3: Summary of land use figures in Lougheed Town Centre Plan (1997)

Land Uses	1997	Proposed additional	Total
Residential Units Core Area	0	2,400	2,400
Remainder of Town Centre High Rise (RM5)	1,855	815	2,670
Medium Rise (RM4)	850	0	850
Low Rise (RM3)	1,475	425	1,900
Townhousing (RM2/1)	1,585	85	1,670
Single Family (R2) – Review Area	440	-20	420
Total Residential Units	**6,205 Units**	**3,705 Units**	**9,910 Units**
Population Estimates	11,200 persons	6,600 persons	17,800 persons
Commercial Space Estimates	1,000,000 sq.ft.	2,000,000 sq.ft.	3,000,000 sq.ft.
Park and Open Spaces	142.5 Acres	17.5 Acres	160 Acres

(Source: City of Burnaby, 1997)

Currently, Lougheed Town Centre has a broad array of housing types. Figure 10 shows the Government Road area in the Lougheed Town Centre, which is adjacent to the SkyTrain Station and the Lougheed Mall, which is home to some older high-rise condominium buildings. Figure 10 shows the Sullivan Heights neighbourhood. Located north of the core area, it is a mature, single-family neighbourhood and a townhouse community. In Figure 11, we can see that the density of this neighbourhood is lower and the streets are less busy than the Government Road neighbourhood.

Figure 10: Government Road area in Lougheed Town Centre Area

(Source: Au, 2007)

Figure 11: Sullivan Heights area (North of Lougheed Highway) in Lougheed Town Centre Area

(Source: Au, 2007)

The Cariboo area is located south of Lougheed Highway. Figure 12 is a photo of the Cariboo area showing three high-rise condominiums. The density of this area is high and the buildings are newer than those in the Government Road area. Simon Fraser Hills, northwest of the core, is a well-established townhouse community. Currently, an established low, medium, and high-density multiple family housing area is found south of Lougheed Highway and within walking distance of the core and SkyTrain.

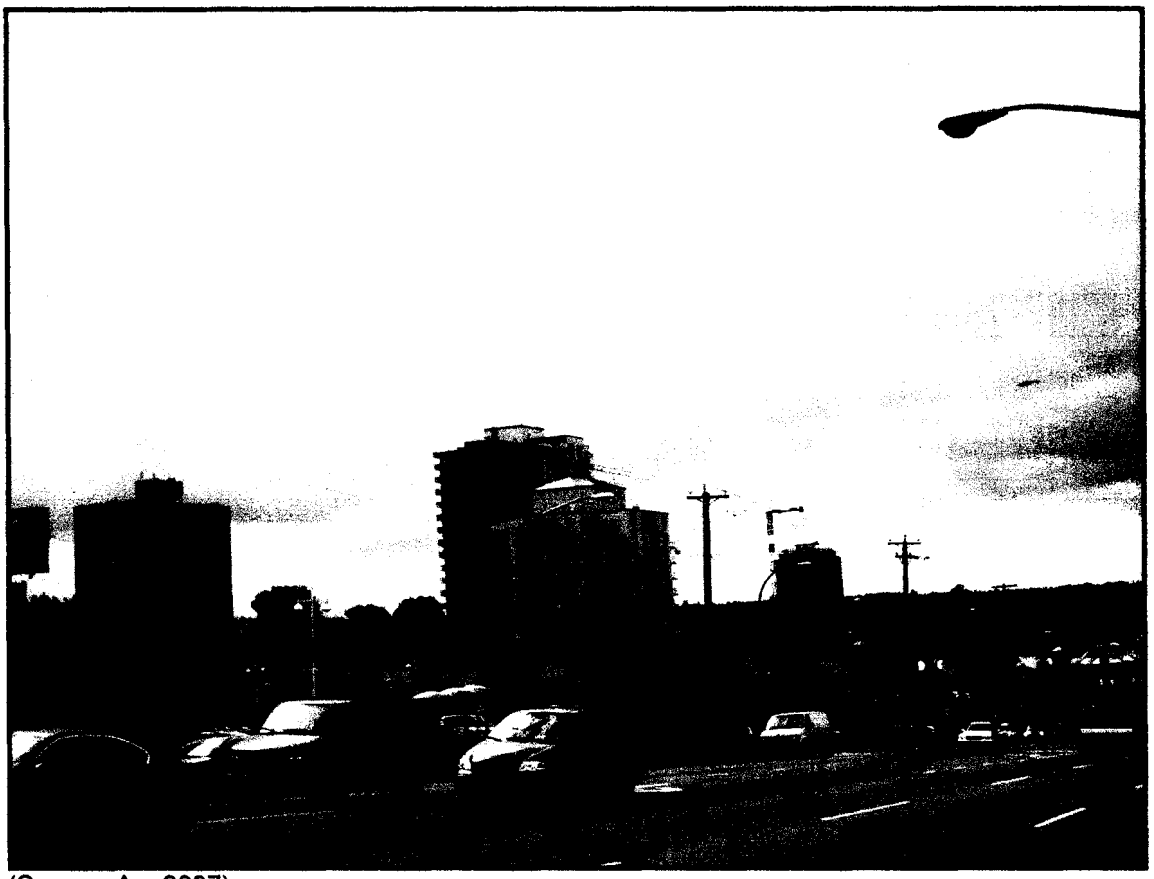
Figure 12: Cariboo area (South of Lougheed Highway) in Lougheed Town Centre Area

(Source: Au, 2007)

In addition to the city's Lougheed Town Centre Plan and the GVRD's Livable Region Strategic Plan, the development of the Lougheed area has been

affected by the Lougheed Neighbourhood Plan managed by the City of Coquitlam. The Lougheed Neighbourhood Plan of Coquitlam adopted in 2002 also aimed to create a transit-oriented and high density mixed land use neighbourhood that is a desirable place in which to live, work, shop and play. The Lougheed Neighbourhood Plan in Coquitlam intensified the development of the neighbourhood by changing land use regulations and controls. As seen in Figure 13, there are newer buildings on the east side of North Road. Although North Road is the artificial boundary of two municipalities, people who work or live in the Lougheed neighbourhood in Coquitlam can easily cross the road and access retail, transport or recreation facilities in Burnaby. The development of the Lougheed neighbourhood in Coquitlam also affects the Lougheed Town Centre area in Burnaby, because they are geographically adjacent to each other. Increasing population and job densities may bring more business opportunities to retail stores, increase the number of pedestrians and cyclists around the SkyTrain Station, and increase the use of public recreation facilities in Lougheed Town Centre area in Burnaby.

Figure 13: Street view of North Road

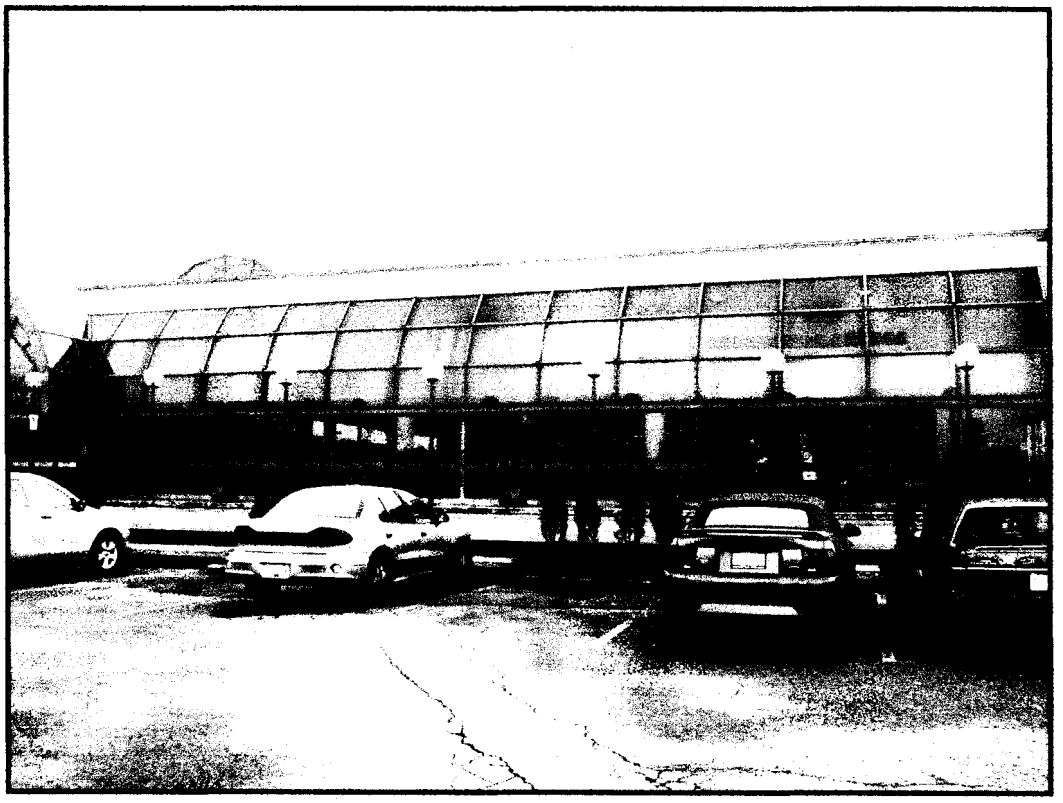


(Source: Au, 2007)

Lougheed Town Centre Mall serves as the core of retail activity in the community, offering a wide range of community services and amenities to the public. It underwent a $20 million renovation in 2003 and currently has over 649,000 sq.ft. of retail space, five major anchors and 175 stores (GVRD, 2007). The mall has been a catalyst for further retail and commercial development in the town centre (GVRD, 2007). In the Liveable Region Strategic Plan and the Lougheed Town Centre Plan, pedestrian-oriented street-front retail is proposed as part of a mixed-use development at North Road and Cameron Street. Currently, the North Road commercial corridor provides area residents with convenient access to the variety of retail commercial services along the west and

east (Coquitlam) sides of the road. Figure 14, 15 and 16 were taken outside Lougheed Mall. Retail stores such as Wal-Mart, the Bay, etc. are located inside the mall.

Figure 14: Lougheed Mall (east side entrance)



(Source: Au, 2007)

Figure 15: Lougheed Mall (east side, in front of the Bay)

(Source: Au, 2007)

Figure 16: Lougheed Mall (north side, in front of Wal-Mart)

(Source: Au, 2007)

The Cameron Recreation Complex has a public library, gymnasium, weight room, indoor cycling studio, seniors' centre, and indoor tennis and racquet courts. Figure 17 shows the recreation complex on Cameron Road with a sign promoting activities available to the community.

Figure 17: Cameron Recreation Complex (9523 Cameron Street, Burnaby, BC)

(Source: Au, 2007)

LITERATURE REVIEW

Land use and accessibility

The linkage between accessibility, property values and land use patterns preoccupied early theorists. The importance of transport costs to property prices was raised by von Thunen (1826), then Haig (1926), Alonso (1965), Muth (1969) and Evans (1973) further developed their own urban economic models (Yiu and Wong, 2005). Their models of urban rent predict that land values are derived from accessibility and transport (Yiu and Wong, 2005). Travel cost is traded-off against rents and population densities from the Central Business District (CBD) to the suburbs of a monocentric city. In addition, travel costs (money and time) increased with distance to CBD. The monocentric model assumes that the CBD is important to firms as an export node, a source of secondary services, and a place where managers can easily engage in face-to-face communication. Travel costs also increase when the distance between households and employment locations increase or when distance between firms and the places they need to conduct business increase. In a monocentric city, this generalization about the correlation between travel distance and travel costs is sensible (Ryan, 1999). In Miller's (1982) review of some of the earliest empirical tests on the effects of transport on housing values, there is a clearly negative relationship between transport costs and housing values (Yiu and Wong, 2005). However, the CBD has declined as the predominant location of employment and services in the

modern city as peripheral centres of activity grow and trips are made for employment and for a range of consumption purposes; accessibility has become a more complicated phenomenon requiring more complex treatment (Henneberry, 1997). Many recent studies on polycentric models have also stressed the importance of transport effects (Yiu and Wong, 2005). Bajic (1983) suggested that the benefits of living in the vicinity of subway stations in Toronto, Canada were capitalized into housing values. Cheshire and Sheppard (1995) showed that transport networks had a great impact on land prices in Darlington, United Kingdom.

Urban transport systems influence the property's location and value. A key aspect of location, physical accessibility is determined by the time and cost of travel to other locations and depends on the presence, efficiency and effectiveness of transport modes. Transport improvements will alter a location's relative accessibility, including both localized and more general changes in land values (Henneberry, 1997).

Improving transport in a certain district helps to enhance accessibility by reducing both transport costs and commuting time. It is commonly believed that better transport links will bring benefits to nearby residents so that a premium will be reflected in housing prices. Under market competition, homebuyers will evaluate property prices on the basis of rational expectations. All information will be taken into consideration, including the expectation of transport improvements. Bidders with higher expectations will outbid those with lower expectations, *ceteris paribus* (Yiu and Wong, 2004).

Divergence between empirical literature and theoretical expectations

People understand the value of property through the price or value of a home that they own or in the rent that they pay. However, most people working in an office building or purchasing goods in a retail store do not know what rents are charged for office space or retail space (Roderick, 1999). Comparatively, the amount of space devoted to residential property is generally greater than that devoted to other uses (Roderick, 1999). Given that the number of residential property owners or residential renters is greater than the number of consumers of other types of real estate, the effects of rail transit on property values are most acutely felt in the residential sector (Roderick, 1999). This explains why much of the research performed on the impact of rail transit on property values focuses on the impact on residential property values (Roderick, 1999).

Transport development has been commonly found to have an impact on property value. A potential positive effect for property value is that having one's house close to a railway station gives ready access to public transportation which can reduce transport costs and commuting time (Yiu and Wong, 2003). The introduction of a rail transit investment brings benefits to the transportation system and to the accessibility of the population to employment, retail and recreation activities (Roderick, 1999).

However, railway tracks can have a number of negative environmental effects set by the public, such as noise and vibrations associated with passing trains, an increase in crime rate, loss of views, and hazards for children, all of

which can negatively affect property value (Strand and Vagnes, 2001). Some studies identify negative externalities arising from pollution and congestion affecting the immediate vicinity of transport infrastructure (Henneberry, 1997).

There have been some studies examining the impact of transport infrastructure, especially rail systems on property values. Fewer studies have examined the impacts of light rail than have studied those of heavy rail, perhaps because the 'new start' light rail systems are more recent (Huang, 1996). Although many studies have confirmed that transport systems significantly influence property values, the influences vary among different cities. This is because the importance of public values, perceptions of transport and housing, and social norms of different cities are not identical. Ryan (1999) summarized that impact studies from the 1950s, 1960s, and 1970s generally showed positive property value effects associated with new transport facilities, but studies from 1980s and 1990s generally showed small property value effects.

The research results of previous studies proposed an important question to urban studies researchers: what are the reasons why no consensus emerged from the literature as to the property value impact of transport investments?

Knight and Trygg (1977) offer an explanation for the inconsistent and perplexingly weak evidence of the transport-property value relationship. They conclude that factors other than transportation investments, such as land use controls and economic growth, influence land-market responses. They suggest that controlling for land use policy and economic conditions would improve our

understanding of transportation effects. These conclusions were widely accepted and cited by researchers who find mixed or unexpected results (Ryan, 1999).

To address the questions, Guiliano (1986) identifies some problems with measuring the impact of transportation and property values. Firstly, many factors in addition to transit investment may be occurring at the same time. Secondly, the results of a transport improvement may only develop over a long period. Thirdly, relationships between developers, politicians, and transportation planners are difficult to determine, so that causality becomes even more difficult to determine. Guiliano's interpretation suggests that transportation facilities may no longer offer significant improvements in accessibility (Ryan, 1999).

Landis et al. (1995) suggest that a transportation technology noticeably influenced accessibility levels when the technology is new, but the technology's influence declines over time. Properties located in the area benefit from increased accessibility and are 'underpriced' in the period shortly after the introduction of the new transportation technology. However, over time, the values of the properties located in the areas increase, and new land-market equilibrium is reached. Once the economy of an urban area adjusts to the initial effects of a new transportation technology, additional transportation improvement will not generate equally strong property value effects. Under the interpretation of Landis et al. (1995), results from impact studies vary according to the extent to which urban land markets are adjusted to the travel cost savings brought about by the introduction of a particular transportation technology (Ryan, 1999). The explanation offered by Landis et al. also suggests that research should account

for the relative changes in accessibility that result from a particular transportation technology and the degree to which land markets are adjusted to that transportation technology (Ryan, 1999).

Although empirical literature seemed to have diverged from theoretical expectations, Henneberry (1997) asserts that the results of previous studies of transport improvements on property values can be used to inform and guide subsequent research. The applicability to other urban areas will be limited by the differences in context and approach; however, when the number of studies increase, our ability to assess possible impacts of new transportation infrastructure on house prices also increases (Henneberry, 1997).

Methods used in previous studies of transport investment and property values

In previous studies analyzing the impact of transport facilities on property values, several methods are identified such as with-and-without comparisons, experiment-control analysis, discrete choice models, the regression model and test control technique. Lin and Hwang (2003) note that most impact studies are conducted before transport systems opening using with-and-without comparisons, such as Lee (1988), Feng and Yang (1989), and Hsu (1989). Feng et al (1991) made a before-and-after comparison examining the influence of project announcement and construction on property values, but the influence of system operation remains unstudied.

Experiment-control analysis is another method for conducting an impact study (Ryan, 1999). This method analyses the statistical differences between experimental samples besides the subway system and control samples located elsewhere. According to Lin and Hwang (2003), this method should be applied only when the samples are difficult to reach.

A discrete choice model is an econometric model in which the actors are presumed to have made a choice from a discrete set. Lin and Hwang (2003) note that Feng and Yang (1989) and Chen and Anas (1994) apply discrete choice models in their studies and that this method is suitable for analyzing with-and-without comparisons before facility opening.

Ryan (1999) notes that VNI Rainbow Appraisal Service employed a test control technique to study the San Diego Light Rail System on property values in 1992. Ryan categorizes the impact studies as two generations, which roughly corresponds to the two waves of rail construction (heavy and light rail construction) in the United States. Ryan summarizes that first generation rail studies analyzed heavy rail systems built in the 1960s and 1970s, and the second generation studies examined the more recent light rail systems. Regression analysis was predominately used in both generations of rail studies to analyze the hedonic property price model.

METHODS

Overall methods

This is a longitudinal study of price impacts for three years, corresponding to a year during construction (2000), the completion date (2002) and three years after SkyTrain's opening (2005). The study aims to understand what the factors affecting property values in the selected area were, and tries to explain why the property values of some properties were more affected by the SkyTrain project than others. In this study, the hedonic property price model was used to identify the effects of SkyTrain on residential property values in Lougheed Town Centre. The model is represented by a linear regression equation, which is used to isolate and quantify the factors that affect the value of housing stock in the study area. Instead of focusing on the outcome of the model overall, it develops the most accurate possible values for the coefficient. Linear regression aims to find a linear relationship between a response variable and a possible predictor variable by the method of least squares. A regression equation allowed us to express the nature of the relationship between two or more variables algebraically. It indicates the extent to which we could predict some variables by knowing others, or the extent to which some were associated with others. The correlation coefficients (R) were calculated by the linear regression equations. A correlation coefficient, a number between -1 and 1, measured the degree to which two variables were linearly related. Stepwise regression was used in the next stage.

A list of twelve potential independent (explanatory) variables were available and this list was repeatedly searched for variables that should be included in the model. The best explanatory variable was used first, then the second best, and so on. Microsoft Excel and a statistical program, Minitab, were used in the study to perform the analysis.

Property type

According to the REBGV, overall sales in Greater Vancouver in 2000 decreased 7 per cent to 20,401 units from 22,040 units in 1999. The sales activity in 2000 decreased nearly 10 per cent, and the total sales of condominium units in 2000 decreased nearly 6 per cent to 6,033 units compared with 6,408 units in 1999. The benchmark price for a Greater Vancouver condominium unit in 2000 was $156,710, a decrease of nearly 3 per cent in comparison to 1999. The figures suggested that the sales volume and sold prices of condominium properties were both decreasing from 1999's level.

The REBGV reported that overall sales in Greater Vancouver for 2002 of detached, attached and apartment properties increased 21.4 per cent to 33,792 sales in 2002 from 27,825 in 2001. Moreover, the sales of condominium properties rose sharply in 2002, with a 36.2 per cent increase to 11,967 sales from 8,789 apartment sales in 2001. The data suggests that since the sales volume of condominium properties in 2002 is larger than 2000, it became more common to live in condominium units.

The REBGV reported that sales in Greater Vancouver of detached, attached and apartment properties increased by 10.8 per cent in 2005 compared to 36,593 sales in 2004. For the period between January 1 and December 31, 2005, sales of condominium properties increased 6.5 per cent to 17,061 sales, compared to 16,025 sales in 2004. The sales volume of condominium properties in 2005 is more than 2002, indicating an increase in homebuyers choosing the condominium unit.

This study focused on multi-level high-rise concrete buildings (usually about 10 to 15 storeys). The figures from REBGV suggest that multi-family condominium housing has become a more common and popular form of residential housing in Greater Vancouver. The studies sampled in this survey were existing groups of residential property (concrete high-rise condominiums), because GVRD and the City of Burnaby had focused the housing development on multi-family housing in the Livable Region Strategic Plan and the Lougheed Town Centre Plan of the 1990s.

Study area

This research project used the area near Lougheed Town Centre as the study area to analyze the price impact before and after the SkyTrain opened. In selecting the study area in Burnaby, three locations were considered – Lougheed, Brentwood and Edmonds. These locations were identified as municipal town centres in the GVRD's Liveable Region Strategic Plan. The aim of SkyTrain was to promote a compact community, while the Liveable Regional

Strategic Plan was intended to provide business and community facilities, together with opportunities for medium and higher-density residential development in both ground-oriented housing and apartments. The aims of the SkyTrain project and those of the Liveable Region Strategic Plan were thus strongly interrelated.

Use of the hedonic price model for this study's purposes requires a large number of transactions and their corresponding housing attributes. As Lin and Hwang (2003) note, regression analysis requires a sufficient and complete sample, so the volume of transaction records of the area was an important consideration in selecting the study area. The choice of the study area was limited by the research method which required a sufficient and complete sample.

In the Edmonds area, there are 20 existing high-rise buildings in the South Slope, Middle Gate and Edmonds neighbourhoods. Among all the buildings, eight of them were built before 2000. In the Brentwood area, there are 16 existing high-rise buildings. In the Brentwood, Willingdon Heights and Central Burnaby neighbourhoods, only four of them were built before 2000. In Lougheed area, there are 13 existing high-rise buildings in the Government Road, Cariboo and Sullivan Heights neighbourhoods. Among the 13 buildings, 12 of them were built before 2000. When comparing the figures, the Lougheed area was assumed to have the largest amount of transaction records among all the municipal town centres in Burnaby. The Lougheed area is located close to Simon Fraser University, and is a popular area for the students to find accommodations, so it attracts a lot of investors to buy residential properties in that area. Tables 4, 5

and 6 show the lists of high-rise condominiums in the Edmonds, Brentwood and Lougheed areas.

Table 4: List of high-rise condominiums in Edmonds Area in Burnaby

Area	Neighborhood	Address of Building	Year Built
Edmonds Area	Edmonds	7079 17th Ave	2007
		7088 18th Ave	2007
		7109 Edmonds St	1992
	Middle Gate	7288 Acorn Ave	1991
		7077 Beresford St	1996
		7108 Collier St	2006
		7138 Collier St	2005
		7178 Collier St	2005
		7063 Hall Ave	2007
		7235 Salisbury Dr	1983
		7275 Salisbury Dr	1982
		6611 Southoaks Cr	1999
		6659 Southoaks Cr	2003
	South Slope	7368 Sandborne Ave	2004
		7388 Sandborne Ave	2002
		6823 Station Hills Dr	2007
		6833 Station Hills Dr	2004
		6837 Station Hills Dr	2000
		6838 Station Hills Dr	1996
		6888 Station Hills Dr	1992

Total Number of Buildings = 20

Number of Buildings Built Before Year 2000 = 8

(Source: BC Assessment, 2007)

Table 5: List of High-rise condominiums in Brentwood Area in Burnaby

Area	Neighborhood	Address of Building	Year Built
Brentwood Area	Brentwood Park	2020 Bellwood Ave	1976
		2041 Bellwood Ave	1983
		2060 Bellwood Ave	1982
	Central Burnaby	4388 Buchanan St	2002
		4398 Buchanan St	2002
		4118 Dawson St	2007
		4178 Dawson St	2006
		4180 Dawson St	2007
		4182 Dawson St	2007
		4132 Halifax St	2003
		4353 Halifax St	1985
		4380 Halifax St	2004
		4425 Halifax St	2000
		2138 Madison Ave	2006
		2088 Madison Ave	2005
		2345 Madison Ave	2007
	Wellingdon Heights	Not records	

Total Number of Buildings = 16

Number of Buildings Built Before Year 2000 = 4

(Source: BC Assessment, 2007)

Table 6: List of High-rise condominiums in Lougheed Area in Burnaby

Area	Neighborhood	Address of Building	Year Built
Lougheed Area	Cariboo	9603 Manchester Dr	1994
		9623 Manchester Dr	1995
		9633 Manchester Dr	1993
	Government Rd	9521 Cardston Ct	1983
		3970 Carrigan Ct	1986
		3980 Carrigan Ct	1986
	Sullivan Heights	3737 Bartlett Ct	1975
		3755 Bartlett Ct	1976
		3771 Bartlett Ct	1977
		9888 Cameron St	2007
		9541 Erickson Dr	1982
		9595 Erickson Dr	1982
		9280 Salish Ct	1977

Total Number of Buildings = 13

Number of Buildings Built Before Year 2000 = 12

(Source: BC Assessment, 2007)

Ryan (1999) reviews several light rail studies of the 1990s, which included San Diego County, CA, South and East Lines, San Diego Light Rail System by VNI Rainbow Appraisal Services Inc (1992), Portland, OR MAX, East Burnside Line by Al-Mosaind et al (1993), California's Sacramento Light Rail System, San Diego Light Rail System and San Jose Light rail System by Landis et al (1995), California's San Diego Light Rail System by Lanis et al (1995, same study as above, using different dependent variables), San Francisco, CA, Pleasant Hill BART Station and Portland, OR, East Burnside Line by Workman and Brod (1997), and South Bay region of San Diego, CA, East County region of San Diego, CA, and Central City region of San Diego, CA San Diego Light Rail System by Ryan (1997). Ryan (1999) observes that three of five studies indicate

a positive correlation between access to light rail stations and residential property values. Ryan (1999) also summarizes that these light rail studies generally show that effects are focused within an area close (walkable distance for approximately not more than 3 km) to a transportation facility. The major aim of the SkyTrain project was to promote compact development near the stations. Meanwhile, the Lougheed Town Centre area was planned as a pedestrian and transit-oriented centre. Considering the conclusion of Ryan (1999) and the design of the Lougheed area, this study was narrowly focused on the Lougheed Town Centre as defined by the City of Burnaby and GVRD.

Data source

Data relating to 53 properties for 2000, 166 properties for 2002 and 159 properties for 2005 were obtained from the Lougheed area through the public records maintained by BC Assessment and the Building Department at City of Burnaby. The data for each hedonic property price model were randomly drawn from the public records. The total varied over time according to the location of properties offered for sale. The data was not the price of individual property but the average price of the same models (condominiums with similar floor space, heating type, number of bathrooms, and other characteristics) sold within a particular complex in each of the 3 years. 2000 was a year during the SkyTrain construction, 2002 was the year when SkyTrain started to operate and 2005 was three years after the SkyTrain opened. Therefore, the housing stock built after 2000 was not covered in the analysis.

Variables

In our study, we have one dependent variable and twelve independent variables at the beginning. These variables were selected after a review of the second generation studies which examined the more recent light rail systems. There were several measures of property value, such as the transaction price, the asking price and the assessed value by professional valuers. Overwhelmingly, previous studies have used transaction prices (Henneberry, 1998). Henneberry (1998) explains that when sufficient data are to be assembled then it is necessary to use transaction prices spanning significant periods, and to employ deflators to express prices in constant money terms. In this study, the sold price of properties was used, and the house price indexes from Statistics Canada for 2000, 2002 and 2005 were employed in the study. Separate hedonic equations for each year were calculated. An equation for the pooled data was also calculated. The pooled data resulted in aggregating the three years, thereby tripling the sample size. By adopting this approach, we could compare the difference in the relative impact of various influences on property values for three separate years.

Independent variables were intended to reflect those factors that influence the variability in the sales price of property. In our hedonic property price model, the independent variables were organized into structural and accessibility variables. Issues that should be considered when selecting a set of independent variables include the effects of excluding relevant variables, correlation among variables (multicollinearity), correct specification of the variables, and controlling

for variables that are correlated with the key variables of interest. The light rail studies of the 1990s were reviewed to assist the selection of independent variables in the study.

For structural variables, a number of features which previous studies considered important in determining property values were collected. The structural variables included floor space, number of bedrooms, number of bathrooms, total number of units in the building, age and type of heating system. In the study, all variables were quantitative, except that heating was qualitative. According to a newspaper article from Vancouver Sun, "Cities show a better way" dated February 17, 2007, in the Lower Mainland an electrical heating system is a newer but more expensive heating system compared with a gas heating system. The ranking for gas was '1' (less expensive, older form of heating system) and for electricity was '2' (more expensive, newer form of heating system).

Three neighborhoods were chosen in the study. Accessibility variables define the ease with which local amenities can be reached from the property: its distance to the elementary school, the secondary school, the recreation centre, Lougheed SkyTrain Station, Lougheed Mall and Downtown Vancouver (dropped out from the model eventually due to multicollinearity with the distance to the SkyTrain station). Schools in Burnaby are organized into district zones which are based on geographical attendance areas (Burnaby School District 41, 2007). The buildings sampled in the study belong to the Cariboo-Lougheed Zone as defined by Burnaby School District 41. Students living in these buildings were assigned to Cameron Elementary School and Burnaby Mountain Secondary School.

Figure 20 shows the exterior of the elementary school and Figure 21 shows the exterior of the secondary school. Cameron Recreation Complex is the major public recreation centre in the Lougheed area. These were straight-line distances estimated using the online Burnaby map provided by the City of Burnaby website.

Figure 20: Cameron Elementary School (9540 Erickson Drive, Burnaby, BC)

(Source: Au, 2007)

Figure 21: Burnaby Mountain Secondary School (8800 Eastlake Drive, Burnaby, BC)

(Source: Au, 2007)

Neighbourhood variables are included in many impact studies of a transport system on property values. Although there were three neighborhoods (Cariboo area, Sullivan Heigthts area and Government Road area) in our study, the neighbourhood variables were not included in the analysis. The homogenous nature of these neighbourhoods meant that such variables would not severely affect the decisions of the buyers; job and population in the neighbourhoods were planned as similar densities, students in these neighbourhoods were assigned to the same elementary school and secondary school, and residents in the neighbourhoods were served by the same transport, recreation and shopping facilities.

Table 7 is a summary of variables used in the model. These data were mainly collected from BC Assessment, Building Department of City of Burnaby, and a Burnaby map provided by the City of Burnaby.

Table 7: Summary of variables in the model

Variable label	Description of measure	Data Source
Price	Sold Price of Property	BC Assessment
Structural variables		
Fspace	Floor space	Building Dept
Nbedroom	Number of bedrooms	Building Dept
Nbathroom	Number of bathrooms	Building Dept
Nunits	Number of units in the building	Building Dept
Age	Age of the building at sold date	Building Dept
Heating	Heating system (gas: 1, electricity: 2)	Building Dept
Accessibility variables		
DCamSchool	Shortest Straight Line Distance to Elementary School	Burnaby Map
DMounSe	Shortest Straight Line Distance to Secondary School	Burnaby Map
DCamRecr	Shortest Straight Line Distance to Recreation Centre	Burnaby Map
DLoStation	Shortest Straight Line Distance to Lougheed SkyTrain Station	Burnaby Map
DLoMall	Shortest Straight Line Distance to Lougheed Mall	Burnaby Map
Ddowntown	Shortest Straight Line Distance to Downtown Vancouver	Burnaby Map

Note: All variables are quantitative, except that 'heating' is qualitative

Relating to 53 properties in 2000, 166 properties in 2002 and 159 properties in 2005

FINDINGS

In this section, the correlation coefficient analysis of the variables will be discussed, and the different models generated by the linear regression analysis and stepwise regression analysis will be developed. There are several points to be noted in the models. Firstly, the level of confidence in the study is 95%. Secondly, the overall performance of the model analyzed by stepwise regression analysis is good: R square adjusted in the 84.79 to 94.26 range. Thirdly, the correlation coefficient of distance to Downtown Vancouver is highly correlated with other independent variables in all study years. To avoid multicollinearity, distance to Downtown Vancouver was taken out from the analysis in all sets of data. Finally, the correlation coefficient of distance to the SkyTrain station and distance to Lougheed Mall is highly correlated in all study years, due to the reality that the station is geographically closely located to the mall. As a result, one of the variables (distance to Lougheed Mall) had to be taken out from the model.

Year 2000 – a year during construction of the SkyTrain

Generally, the structural variables appeared to be more correlated to the property value than the accessibility variables. Before the SkyTrain opened in 2000, correlation coefficient analysis suggested that most variables, except the number of units in the building and heating, were highly correlated to the property value. The model suggested that floor space was the most influential factor in the

model, followed by the number of bathrooms, number of bedrooms, distance to station (also implied distance to mall), distance to the secondary school, age, distance to the recreation centre and finally distance to the elementary school.

Linear regression analysis indicated that property value was a function of floor space, number of bedrooms, number of bathrooms, number of units in the building, age, heating type, distance to the elementary school, distance to the secondary school and distance to the recreation centre. The R square adjusted is 88.5. The linear regression analysis generated the following equation:

Price = 234692 + 68.6 FSpace + 8507 NBedr + 12218 NBathr + 336 NofUnits
- 5206 Age - 36978 Heating - 230093 DCamSchool - 75804 DMounSe
+ 274299 DCamRecr

Stepwise regression analysis took four steps to conclude a simplified version of the equation. The R square adjusted was 87.64 in the model for 2000. It suggested that the most important influential independent variables in affecting the property value were floor space, age, number of bedrooms and number of bathrooms. It indicated that only some of the structural variables were significant in the model, and all of the accessibility variables were insignificant in 2000.

Year 2002 – the completion date of the SkyTrain

When the SkyTrain started to serve the Lougheed area in 2002, the correlation coefficient analysis suggested a totally different model from 2000 (before the SkyTrain operated). Only one structural variable (floor space) was

identified as an influential factor in affecting the property values. Among all the variables, only floor space was identified as a variable which was highly correlated to property value. The correlation of the remaining variables in the structural and accessibility categories with the property values was considered insignificant.

Linear regression analysis indicated that property value in 2002 was a function of floor space, number of bedrooms, number of bathrooms, number of units in the building, age, heating type, distance to the elementary school, distance to the secondary school and distance to the recreation centre. With the R square adjusted as 93.2, the equation for 2002 was:

Price = 172674 + 119 FSpace - 531 NBedr + 1699 NBathr + 123 NUnits
- 4763 Age - 20647 Heating - 25748 DElemSc - 29003 DMountSe
+ 33047 DRecr

Stepwise regression took three steps to generate that floor space, age and heating type were the most important variables in affecting the property value in the Lougheed area in 2002. The R square adjusted was 94.26 in the stepwise regression equation in 2002. The analysis suggested that only structural variables were significant in affecting the property value in the study area. Again, the accessibility variables were not identified as influential variables in the model in 2002 when the SkyTrain started to provide service to the area.

Year 2005 – three years after the SkyTrain opened

The correlation coefficient analysis suggested a similar conclusion as the previous 2002 analysis. One structural variable was identified as an influential factor in affecting the property values. No accessibility variables were identified as influential factors in affecting the property values. Only floor space was identified as a variable that was highly correlated to the property values in 2005.

Linear regression analysis indicated that the property value in 2005 was a function of floor space, number of bedrooms, number of bathrooms, number of units in the building, age, heating type, distance to the elementary school and distance to the secondary school. The R square adjusted was 84.5. The regression equation is as follows:

Price = 175773 + 190 FSpace - 7304 Nbedr + 11537 NBathr + 164 NUnits
- 4832 Age - 35463 Heating + 343 DElemCam - 9026 DMountSe

Stepwise regression analysis took two steps to simplify the regression equation. Floor space and age were identified as influential variables in affecting the property value. The R square adjusted was 84.79. Similar to the previous results, none of the accessibility variables were considered influential in this impact study.

Pooled data for 2000, 2002 and 2005

In the pooled data, the correlation coefficient analysis suggested a similar model as that for 2002 and 2005. One structural variable was identified as an

influential factor in affecting the property values. Only floor space was identified as an influential variable in affecting the property value. No accessibility variables were identified as an influential factor in affecting the property values.

Linear regression analysis generated the conclusion that the deflated property value generated by the house price index was a function of floor space, number of bedrooms, number of bathrooms, number of units in the building, age, heating type, distance to the elementary school, distance to the secondary school, distance to the recreation centre, and distance to the station. The R square adjusted was 73.5 for the pooled data set. The equation is generated as follows:

Deflated Price = - 332990 + 144 FSpace + 4403 NBedr + 7686 NBath
- 998 NUnits + 10272 Age + 90972 Heating
+ 110721 DElemSc - 6555 DMounSe - 5506 DRecr
+ 45356 DLoSt

Stepwise regression analysis indicated that floor space, distance to the elementary school, number of units, age, and heating type were significant factors affecting the property value in all years (after the house price index was applied to deflate the property value). Distance to the elementary school was the first and the only accessibility variable identified as a significant independent variable in the model by stepwise regression analysis. R square adjusted for the pooled data set was 73.84.

Summary of findings and analysis

Distance to the SkyTrain Station was positively correlated to property values in 2000. During the construction stage of the SkyTrain, the property values decreased when the distance to the station increased. The effect disappeared in 2002 and 2005, when distance to the station did not affect the property values. The result of 2000 was similar to Henneberry's study in 1998. When Henneberry (1998) studied the Supertram in Sheffield, England, he interpreted that anticipation of the construction of the railway acted to reduce house prices, possibly due to the disturbance during the building of the system. During the construction stage, local residents had to suffer the noise, disruption and pollution of construction work itself. Noise and air pollution and other externalities tend to decrease property values of residential properties. The construction work altered the visual appearance of the immediate area, and local residents might find that the views from their properties had been impaired so homes that had once have the benefit of water and mountain views may have then faced the station and rail tracks. The flow of traffic along the road during the construction work may have made it more time consuming, difficult and dangerous for pedestrians and cyclists to cross the road to local facilities, such as retail shops, community centre, etc (barrier effect). Moreover, local residents had to cope with a series of externalities produced by the construction work, such as noise and air pollution, dust from the construction site, smells from vehicle and machine fumes, polluted water run-off and vibration. Both Supertram and

SkyTrain demonstrated that the inconvenience, noise and congestion during the construction would adversely affect the housing values.

To understand the different impacts of light rail and heavy rail on property values, our research results on light rail transit could be compared with a study of heavy rail transit on property value carried out in Seoul, Korea. The Korean case study is the most recent impact study of rail transit on property values and the research methods are similar to our study. Using a hedonic property price regression model, Bae, Jun and Park (2003) studied the impact of Seoul's subway Line 5 on property values for four years (1989,1995, 1997 and 2000), corresponding to the announcement of the subway, a year during construction, the completion date, and three years after its opening. Similarly, the sampling units in the survey were high-rise condominiums. In their study, they concluded that after the line began operation, property prices increased modestly, and in some distance ranges fell slightly. Compared to our study of Vancouver SkyTrain, distance to the SkyTrain Station had minimal effects on property value after the SkyTrain opened in 2002 and three years after the SkyTrain opened in 2005. What are the reasons to explain the contrasting results in our study with the Seoul's study? Ryan (1999) asserts that light rail should have less effect on property values than heavy rail transit because light rail systems have lower average speeds and capacities, resulting in more modest time savings than heavy rail transit. SkyTrain has a capacity of approximately 260 people per train (BCRTP, 2007) and offers a vital link between Vancouver's downtown core and nearby municipalities. However, the capacity of a light rail system (SkyTrain in

our study) is much smaller than that of a heavy rail system (Subway Line 5 in Seoul). The current daily ridership of the Vancouver SkyTrain is approximately 160-180,000 (BCRTP, 2007), while that of Seoul's subway Line 5 is about 795,000 (Bae, Jun and Park, 2003). Henneberry (1997) argues that the development of a light rail system would not offer particularly significant gains in accessibility to the population. Thus, little effect on house prices should be expected in the impact study of light rail system on property values.

Local transport and planning policies affect car dependence in specific cities; these factors may help to explain the different impacts of rail transit on property values in Korea and Canada. The transportation market is heavily skewed by the free public road network, which provides trips for car owners at such a low marginal cost that no common carrier can sustainably compete on price alone. In Korea, the government in Seoul introduced policies to expand the metro system and reduce car dependence in the city. Since 1996, private cars with less than three occupants crossing the two tunnels which connect southern and northern Seoul must to pay a toll of 2000 won (about USD$2) (Pucher, Park, Kim, Song 2005). The implementation of the toll successfully reduced traffic volume by 12%, increased travel speed by 84%, raised the number of users carried per car and increased the ridership of the public transport system (Pucher, Park, Kim, Song 2005). Secondly, the government increased taxes on petrol and diesel fuels to discourage driving and generate needed revenues for improving public transport infrastructure. Thirdly, the government raised the parking fees for public parking facilities almost every year and cut the required

amount of parking included in newly built commercial and office buildings in the city centre. These measures made parking less available as well as more expensive in order to discourage private car driving. Finally, the City of Seoul implemented a range of measures to encourage walking, cycling and using public transport by prohibiting motor vehicles on some streets. Rail and bus services carried 65% of all trips in Seoul after the implementation of the transport policies, which allowed Seoul to become one of the world's highest market shares for public transport (Pucher, Park, Kim, Song 2005).

In Canada, Tomalty evaluated the planning policies of the Vancouver region in 2002. The Transport 2021 plan called for the use of policy instruments to reduce automobile dependence in the region and reverse urban sprawl (Tomalty, 2002). The plan proposed a variety of instruments, such as tolls on bridges coming into Vancouver, a much higher gas tax, increased parking charges, and disincentives to employers who offer free parking. However, almost no demand management programs to discourage single occupancy vehicle use has been put in place since the plan was adopted in 1991 (Tomalty, 2002). The transport system has not responded as foreseen in Transport 2021 because of the lack of implementation measures. In contrast to Seoul, car ownership in the Lower Mainland grew at a much faster rate than population throughout the 1970s and 1980s, with serious consequences on the rate of traffic growth. Per capita ownership levelled off in the 1990s at about 580 cars for every 1000 people or about 1.5 cars per household, usually considered a saturation level (Tomalty, 2002). By 1999, transit's share stood more or less where it had been in the early

1970s when the Livable Region Plan was being formulated – about ten percent of trips in the region (Tomalty, 2002). The report suggested that the vision of "compact, transit-supportive urban structure with high-quality transit links between urban centres and a shift away from car dependency" in the region had been realized only in a very limited form. Even with the operation of SkyTrain in Lower Mainland, car dependency in our study area was still higher than that in Seoul.

Generally, floor space was identified as the most important structural variable in all the years and in the pooled data set as floor space and property values were positively correlated. When the floor space of the property increased, it was logical to expect that the property value would be higher.

Age was another important structural variable in affecting the property value in the study area. Age and property value were negatively correlated. The value of improvements would decrease over time as a result of wear and tear or change in taste (Real Estate Trading Service Licensing Course Manual, 2006).

The type of heating system was not identified as influential factor in affecting the property values in 2000 and 2005, but it was recognized as an influential factor in affecting the property value in 2002. In 2002, experts forecasted that deregulation would increase the use of natural gas, increase the carbon dioxide emission from the electricity sector and bring about harmful environmental damages. British Columbia Citizens for Public Power Society (2002) asserted that British Columbians had a high level of anxiety about the

break-up, sell-off and deregulation of BC Hydro in 2002. Deregulation of electricity markets in California and Alberta had resulted in brown-outs, huge price increases for electricity users, and possibilities of future shortages that could send prices sky-high (Cohen, 2001). The issue of the deregulation of BC Hydro possibly affected the significance of the heating system on property value in the 2002 model because it could have direct impact on the utility expenses for the owners and renters.

Distance to the elementary school and distance to the secondary school were not identified as influential factors in affecting the property value before and after the SkyTrain operated. According to the Report Card on British Columbia's Elementary Schools 2006 Edition by Peter Cowley and Stephen Easton, published by Fraser Institute, Vancouver, British Columbia, Cameron Elementary School was ranked 418 among 1007 elementary schools in British Columbia during 2004-2005, and its average ranking in the past five year was 313 out of 1007 elementary schools. According to the Report Card on Secondary Schools in British Columbia and Yukon 2006 Edition, the overall academic ranking of Burnaby Mountain Secondary School in 2004-2005 was 118 among 281 secondary schools. The overall rating decreased from 7.0 out of 10 in 2002, to 6.5 out of 10 in 2003, to 6.0 out of 10 in 2004 and increased to 6.6 out of 10 in 2005. Research by Professors Paul Cheshire and Stephen Sheppard (2004) analyzes the relationship between quality of schools and property values. The study focuses on houses and schools around Reading in United Kingdom, where nearly all children went to the primary and secondary schools assigned on the

basis of where they live. They conclude that people paid higher house prices to live in the right spot to get into a high quality school. In our study, students living in the Lougheed area were assigned to Cameron Elementary School and Burnaby Mountain Secondary School, a situation similar to the students in Reading being assigned to particular schools. Base on the figures in the Report Cards, Cameron Elementary School and Burnaby Mountain Secondary School were not top ranking schools in British Columbia. In the light of the study in Reading, only high quality schools could affect property values. The quality of the schools could be a possible explanation to interpret that distance to the elementary school and distance to the secondary school were not influential factors in affecting the property value in the Lougheed area. Secondly, after the SkyTrain had completed in 2002, the accessibility of residents became higher; some parents could arrange for students to go to private schools with higher ranking and academic rating located outside the Lougheed area.

This study demonstrated the impact of SkyTrain on nearby residential property values. It aimed to understand what were the factors affecting the property values in the selected area, and tried to explain why were the property values of some property more affected by the SkyTrain project than others. To sum up, the model identified that the structural variables were more significant than the accessibility variables in affecting the property values in the study area. Floor space and age were the most important variables in the structural category to affect the property values. Type of heating was identified as a significant factor in 2002 due to the public's presumed high level of anxiety about the break-up,

sell-off and deregulation of BC Hydro in that particular year. Distance to the elementary school, distance to the secondary school and distance to the recreation centre, significantly correlated with the property value before the SkyTrain operated, were considered insignificant factors after the SkyTrain opened in 2002. After the SkyTrain opened, the accessibility of parents and students increased and they may have had more choices to go to schools with higher academic qualities outside the study area. The results in the study were consistent with study results in Reading, in which only high quality schools affected property values. During the construction year, distance to SkyTrain station had a significant negative impact on property values. The results were inconsistent with the anticipatory effect observed in other studies. Negative externalities discouraged people from living too close to the SkyTrain station, and anticipation of the construction of the railway acted to reduce house prices, possibly due to the disturbance during the building of the system. After the SkyTrain opened in 2002, the negative impacts of distance to the SkyTrain station on property values disappeared. The research results were different from those of the study in Seoul due to the difference of local policies, different population and job densities, and different perceptions on public transport, which possibly affected ridership and car dependency in different cities.

QUALIFICATIONS AND LIMITATIONS

The study used a separate model for each study year, which aimed to show that the impacts of the SkyTrain on property values are not constant. The purpose of this study is to evaluate the relationship between the SkyTrain and property values. In the absence of a control area, the results roughly sketch an explanation as to why some property values are more affected by the SkyTrain than others.

The research results generated by our case study are similar to those generated by a study funded by Canadian Mortgage and Housing Corporation (CMHC) in 2003, titled "UniverCity: Assessing Consumer Demand for Sustainable Development in Greater Vancouver". The study was conducted by Pollara, which studied 150 members of the general population of British Columbia. It used Burnaby Mountain, an adjacent area of Lougheed Town Centre area, as a case study and analyzed the housing decisions made by residents within Greater Vancouver. They used a 10-point ranking system to identify twelve key decision-making factors considered by consumers when buying a home. "Proximity to transportation options such as SkyTrain, buses, etc" scored 6.0, while "Quality of construction" scored 9.3, "Privacy from neighbours and traffic" scored 8.2, "Proximity to amenities such as schools, grocery stores and shops" scored 7.6, "Proximity to work" scored 6.6 and "View" scored 6.5. (Resource Rethinking Inc, 2007) The CMHC study suggests that when

consumers are buying a home, they do not think that living closer to the transportation facilities is the most important factor.

This study focused on residential condominium units that were built before the construction of the Vancouver SkyTrain Millennium Line in 2000. Since 2000, there had been many high-rise condominium construction projects along the Millennium Line, such as in the Brentwood and Edmonds areas. As the affordability of single family houses decreases, more people are choosing to live in condominiums. Vancouver Sun reported that condominiums were the most saleable new home type in the GVRD in the first six months of 2007. The impact after the SkyTrain's opening will be a separate research study that should be addressed in the future.

Transaction records and twelve variables were used in building the models, but the issues of travel cost or travel time were not explicitly studied. Ryan (1999) suggested that the impact study should return to the fundamental question of how new or existing transportation facilities influence regional and local travel times for various populations of users, because property changes should be more directly correlated with changes in travel time than with the distance of residents and employers from a transportation facility. Improving transport in a certain district helps to enhance accessibility by reducing both transport costs and commuting time (Yiu and Wong, 2004).

The research design could be improved by manipulating the sold price of the condominium units into the sold price per square feet. Using the sold price

per square feet as the dependent variable simplifies the hedonic property price model because the size of the condominium units and the number of bedrooms could be highly correlated and could complicate the research results.

Although the SkyTrain did not show any effects on the property values after its opening, we cannot conclude that it is a failure to reduce auto-dependency or to promote a transit-oriented community. The development of high-rise condominiums east of North Road (Coquitlam) provides more housing options to home buyers and renters. Also, the cost of driving (parking, energy and auto insurance) is becoming more expensive, and so people's perceptions on public transit may change over time. The effects of SkyTrain on residential property values during high a period seeing high driving costs may be very different from the situation in 2002 or 2005. Therefore, further research should consider other variables such as number of parking stalls, oil and gas price or premium price of auto insurance.

The choice of the study area was limited by the research method and the volume of transaction records of residential properties. Due to the insufficient transaction records in the Brentwood and Edmonds areas, the study only narrowly focused on the area near Lougheed SkyTrain Station. In the absence of a comparative area, we could not test that whether the distance to downtown Vancouver was an important factor in affecting the property values. In order to test this variable, a separate area with similar characteristics in Lower Mainland should be identified and further study carried out.

Insufficient transaction records can be addressed by using market rent and the hedonic property price model to indicate the property value. Market rent is an important indicator that reflects the values of residential properties. Job opportunities draw more people from other provinces or abroad to the Lower Mainland and thus the demand for rental units in Lower Mainland has been increasing in recent years. Many people relocating to the Lower Mainland have to rent before buying because the cost of home-ownership is high. High home prices in the region are keeping many potential first time buyers renting. CMHC's Spring Rental Market Survey found that all the major centres in British Columbia posted a vacancy rate below one per cent as the province's increasing population and the continued relatively high home-ownership costs have propped up rental demand. (The Province, 2007)

Finally, other impacts of the SkyTrain were not examined in the study, such as the expansion of retail trade, personal services, and neighborhood activities in the study area, and resulting increased population and job densities around the station.

POLICY IMPLICATIONS

This study provides useful information for planning the future rail transit system. An automated Canada Line is currently under construction between downtown Vancouver and central Richmond, with a branch to Vancouver International (YVR) airport. Neighbourhoods along the Cambie corridor are being adversely affected by the construction work of the Canada Line. The city reduced the width of the sidewalk in the 3300 block of Cambie and closed two lanes for the construction work for the new rapid transit line. (Vancouver Sun, 2007) Pedestrians, cyclists and drivers are taking a longer time to arrive at their destinations and business owners experience loss in business revenue (Vancouver Sun, 2007). This study demonstrated that before the SkyTrain opened, property value was negatively affected by traffic disturbance, noise and air pollution during the construction stage. It is crucial for transportation engineers and planners to design systems that avoid disturbance and nuisance to the neighbourhoods.

Smith and Gihring (2006) identify that in recent years, there has been growing support for transit-oriented development, which results when a transit station provides a catalyst for mixed-use, walkable land use patterns, sometimes called an urban village. The type of land use pattern can provide many benefits to residents, business and society, including improved accessibility, reduced consumer transportation costs, reduced traffic congestion, reduced parking

costs, reduced accidents, plus environmental health benefits (Smith and Gihring, 2006). The results of the study suggested that the implementation of transport policies was important to reduce car dependency and to increase the ridership of the rail system. It is crucial for policy makers to combine transport measures and development plans together when there are plans for new transit-oriented development.

CONCLUSION

This study used a case study to demonstrate the impact of the construction of the SkyTrain Millennium Line on residential property values for the years 2000, 2002 and 2005. The area near Lougheed Town Centre was chosen as the study location, and high-rise condominium units were studied in the research. Limited by the amount of transaction records in other town centres, no control area was chosen in the study. The study aimed to understand the factors affecting the property values in the selected area, and to explain why the property values of some property more affected by the SkyTrain project than others. In this study, the hedonic property price model was used to identify the effects of SkyTrain on residential property values in Lougheed Town Centre. The hedonic property price model indicated that distance to SkyTrain Station was negatively correlated to property values in 2000, during the construction stage of the SkyTrain, and that property values decreased when the distance to station increases. The effect disappeared in 2002 and 2005, when distance to the station did not affect the property values. Distance to SkyTrain station negatively affected the property value in the study area during the construction stage of the SkyTrain, but compared with the structural variables in the study, it was not an influential factor affecting property value after the SkyTrain opened. The result contradicted a recent heavy rail study in Seoul. This difference is the result of the difference in capacity and ridership between a light rail system and a heavy rail

system, the degree of changes in accessibility, and the different amount of population being affected. This study also offered an explanation of the effects of the type of heating system and locations of schools on property values. Heating type was identified as a significant factor in 2002 due to the public's presumed high level of anxiety about the deregulation of BC Hydro in that particular year. Distance to the elementary school, distance to the secondary school and distance to the recreation centre significantly correlated with the property value before the SkyTrain operated. To sum up, accessibility variables in the model had less impact on residential property values than the structural variables, such as floor space, age and heating. The study offered some policy implications to transport engineers, planners and policy makers. It suggested that disturbance and nuisance to the neighbourhoods should be avoided during the construction process of transport infrastructure, and transport measures might be combined with development plans for new transit oriented development.

APPENDICES

APPENDIXA RESULTS FOR CORRELATION COEFFICIENT ANALYSIS (2000)

	Price	FSpace	NBedr	NBathr	NofUnits	Age	Heating	DCamSchool	DMounSe	DCamRecr
FSpace	0.820									
	0.000									
NBedr	0.790	0.714								
	0.000	0.000								
NBathr	0.798	0.600	0.638							
	0.000	0.001	0.000							
NofUnits	0.284	0.350	0.152	0.179						
	0.143	0.068	0.442	0.363						
Age	-0.622	-0.248	-0.414	-0.641	-0.034					
	0.000	0.202	0.029	0.000	0.862					
Heating	0.516	0.316	0.359	0.412	0.424	-0.747				
	0.005	0.102	0.061	0.029	0.025	0.000				
DCamSchool	0.614	0.374	0.358	0.643	0.627	-0.719	0.617			
	0.001	0.050	0.061	0.000	0.000	0.000	0.000			
DMounSe	0.635	0.401	0.415	0.645	0.598	-0.784	0.733	0.963		
	0.000	0.034	0.028	0.000	0.001	0.000	0.000	0.000		
DCamRecr	0.621	0.379	0.368	0.643	0.625	-0.739	0.653	0.999	0.974	
	0.000	0.047	0.054	0.000	0.000	0.000	0.000	0.000	0.000	
DLoStation	-0.658	-0.448	-0.405	-0.688	-0.664	0.703	-0.740	-0.944	-0.925	-0.949
	0.000	0.017	0.033	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Cell Contents: Pearson correlation
P-Value

APPENDIXB RESULTS FOR LINEAR REGRESSION ANALYSIS (2000)

The regression equation is
Price = 234692 + 68.6 FSpace + 8507 NBedr + 12218 NBathr + 336 NofUnits
- 5206 Age - 36978 Heating - 230093 DCamSchool - 75804 DMounSe
+ 274299 DCamRecr

Predictor	Coef	SE Coef	T	P
Constant	234692	139532	1.68	0.110
FSpace	68.65	15.34	4.48	0.000
NBedr	8507	4651	1.83	0.084
NBathr	12218	8059	1.52	0.147
NofUnits	336.3	161.6	2.08	0.052
Age	-5206	2022	-2.57	0.019
Heating	-36978	33782	-1.09	0.288
DCamSchool	-230093	444297	-0.52	0.611
DMounSe	-75804	72892	-1.04	0.312
DCamRecr	274299	543533	0.50	0.620

S = 8147.62 R-Sq = 92.3% R-Sq(adj) = 88.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	9	14407952293	1600883588	24.12	.000
Residual Error	18	1194906790	66383711		
Total	27	15602859083			

Source	DF	Seq SS
FSpace	1	10498975121
NBedr	1	1327348320
NBathr	1	1362715381
NofUnits	1	20801423
Age	1	776227714
Heating	1	44200518
DCamSchool	1	85409100
DMounSe	1	275368057
DCamRecr	1	16906659

Unusual Observations

Obs	FSpace	Price	Fit	SE Fit	Residual	St Resid
13	928	122000	106062	4154	15938	2.27R
25	779	115000	97597	4402	17403	2.54R

R denotes an observation with a large standardized residual.

APPENDIX C RESULTS FOR STEPWISE REGRESSION ANALYSIS (2000)

Alpha-to-Enter: 0.15 Alpha-to-Remove: 0.15

Response is Price on 10 predictors, with N = 28

Step	1	2	3	4
Constant	8861	53368	51762	42292
FSpace	117	102	80	71
T-Value	7.31	9.17	5.58	4.78
P-Value	0.000	0.000	0.000	0.000
Age	-1828	-1591	-1232	
T-Value	-5.77	-5.03	-3.29	
P-Value	0.000	0.000	0.003	
NBedr	10031	8425		
T-Value	2.15	1.83		
P-Value	0.042	0.081		
NBathr		9626		
T-Value		1.65		
P-Value		0.112		
S	14011	9361	8750	8451
R-Sq	67.29	85.96	88.22	89.47
R-Sq(adj)	66.03	84.84	86.75	87.64

APPENDIX D RESULTS FOR CORRELATION COEFFICIENT ANALYSIS (2002)

	Price	FSpace	NBedr	NBathr	NUnits	Age	Heating	DCamSchool	DMounSe	DCamRecr
FSpace	0.804									
	0.000									
NBedr	0.338	0.385								
	0.063	0.033								
NBathr	0.478	0.398	0.554							
	0.007	0.027	0.001							
NUnits	-0.377	-0.183	0.149	0.030						
	0.037	0.324	0.424	0.874						
Age	-0.510	0.029	-0.120	-0.275	0.237					
	0.003	0.878	0.522	0.134	0.200					
Heating	0.108	-0.212	0.220	0.128	0.358	-0.702				
	0.564	0.251	0.234	0.491	0.048	0.000				
DElemSc	0.226	-0.114	0.120	0.318	0.443	-0.687	0.686			
	0.223	0.543	0.521	0.081	0.013	0.000	0.000			
DMountSe	0.144	-0.248	0.145	0.240	0.398	-0.775	0.858	0.930		
	0.440	0.179	0.436	0.194	0.027	0.000	0.000	0.000		
DRecr	0.226	-0.129	0.141	0.301	0.438	-0.726	0.763	0.993	0.960	
	0.222	0.490	0.449	0.099	0.014	0.000	0.000	0.000	0.000	
DLoSt	-0.115	0.166	-0.141	-0.283	-0.534	0.594	-0.755	-0.924	-0.871	-0.926
	0.537	0.372	0.449	0.123	0.002	0.000	0.000	0.000	0.000	0.000

Cell Contents: Pearson correlation
P-Value

APPENDIX E RESULTS FOR LINEAR REGRESSION ANALYSIS (2002)

The regression equation is
Price = 172674 + 119 FSpace - 531 NBedr + 1699 NBathr + 123 NUnits - 4763 Age
- 20647 Heating - 25748 DElemSc - 29003 DMountSe + 33047 DRecr

Predictor	Coef	SE Coef	T	P
Constant	172674	67025	2.58	0.018
FSpace	119.14	12.36	9.64	0.000
NBedr	-531	2839	-0.19	0.853
NBathr	1699	3953	0.43	0.672
NUnits	123.4	119.4	1.03	0.313
Age	-4763	1578	-3.02	0.007
Heating	-20647	20116	-1.03	0.316
DElemSc	-25748	72213	-0.36	0.725
DMountSe	-29003	24726	-1.17	0.254
DRecr	33047	95875	0.34	0.734

S = 6976.90 R-Sq = 95.3% R-Sq(adj) = 93.2%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	9	20573867214	2285985246	46.96	0.000
Residual Error	21	1022221013	48677191		
Total	30	21596088227			

Source	DF	Seq SS
FSpace	1	13950855474
NBedr	1	21569752
NBathr	1	689366246
NUnits	1	1330503209
Age	1	4368359115
Heating	1	123512848
DElemSc	1	19193793
DMountSe	1	64723391
DRecr	1	5783386

Unusual Observations

Obs	FSpace	Price	Fit	SE Fit	Residual	St Resid
7	704	104233	91750	4211	12483	2.24R
14	1569	199000	206332	6110	-7332	-2.18R

R denotes an observation with a large standardized residual.

APPENDIX F RESULTS FOR STEPWISE REGRESSION ANALYSIS (2002)

Alpha-to-Enter: 0.15 Alpha-to-Remove: 0.15

Response is Price on 10 predictors, with N = 31

Step	1	2	3
Constant	16978	55494	95482
FSpace	132.7	135.2	128.9
T-Value	7.27	16.37	17.18
P-Value	0.000	0.000	0.000
Age	-2422	-3047	
T-Value	-10.66	-10.75	
P-Value	0.000	0.000	
Heating	-13192		
T-Value	-3.09		
P-Value	0.005		
S	16237	7348	6429
R-Sq	64.60	93.00	94.83
R-Sq(adj)	63.38	92.50	94.26

APPENDIX G RESULTS FOR CORRELATION COEFFICIENT ANALYSIS (2005)

	Price	FSpace	Nbedr	NBathr	NUnits	Age	Heating	DElemCam	DMountSe	DRecr
FSpace	0.839									
	0.000									
Nbedr	0.438	0.531								
	0.022	0.004								
NBathr	0.549	0.426	0.336							
	0.003	0.027	0.087							
NUnits	-0.248	-0.002	0.132	-0.039						
	0.212	0.993	0.511	0.846						
Age	-0.273	0.140	-0.098	-0.192	0.432					
	0.168	0.486	0.626	0.338	0.024					
Heating	0.022	-0.238	0.104	0.110	0.232	-0.754				
	0.912	0.233	0.604	0.583	0.245	0.000				
DElemCam	0.129	-0.135	0.145	0.155	0.193	-0.769	0.966			
	0.522	0.502	0.470	0.441	0.336	0.000	0.000			
DMountSe	0.044	-0.235	0.141	0.129	0.166	-0.794	0.984	0.960		
	0.826	0.237	0.483	0.523	0.408	0.000	0.000	0.000		
DRecr	0.118	-0.149	0.145	0.152	0.190	-0.776	0.973	0.999	0.970	
	0.558	0.457	0.469	0.450	0.343	0.000	0.000	0.000	0.000	
DLoStation	-0.016	0.194	-0.047	-0.086	-0.319	0.640	-0.953	-0.926	-0.886	-0.925
	0.935	0.333	0.814	0.669	0.105	0.000	0.000	0.000	0.000	0.000

Cell Contents: Pearson correlation
P-Value

APPENDIX H RESULTS FOR LINEAR REGRESSION ANALYSIS (2005)

The regression equation is
Price = 175773 + 190 FSpace - 7304 Nbedr + 11537 NBathr + 164 NUnits - 4832 Age
- 35463 Heating + 343 DElemCam - 9026 DMountSe

Predictor	Coef	SE Coef	T	P
Constant	175773	103863	1.69	0.108
FSpace	190.04	25.33	7.50	0.000
Nbedr	-7304	6362	-1.15	0.266
NBathr	11537	8219	1.40	0.177
NUnits	163.6	228.2	0.72	0.483
Age	-4832	2809	-1.72	0.103
Heating	-35463	58206	-0.61	0.550
DElemCam	343	28802	0.01	0.991
DMountSe	-9026	55701	-0.16	0.873

S = 15728.1 R-Sq = 89.2% R-Sq(adj) = 84.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	8	36908935692	4613616962	18.65	0.000
Residual Error	18	4452723818	247373545		
Total	26	41361659511			

Source	DF	Seq SS
FSpace	1	29115641200
Nbedr	1	3335033
NBathr	1	1918581847
NUnits	1	2270805802
Age	1	3322193294
Heating	1	271869194
DElemCam	1	13575
DMountSe	1	6495748

Unusual Observations

Obs	FSpace	Price	Fit	SE Fit	Residual	St Resid
9	673	168454	146064	11550	22390	2.10R
10	928	170640	193030	11550	-22390	-2.10R
12	864	260450	230818	7610	29632	2.15R

R denotes an observation with a large standardized residual.

APPENDIX I RESULTS FOR STEPWISE REGRESSION ANALYSIS (2005)

Alpha-to-Enter: 0.15 Alpha-to-Remove: 0.15

Response is Price on 10 predictors, with N = 27

Step	1	2
Constant	43057	74428
FSpace	186	198
T-Value	7.71	11.59
P-Value	0.000	0.000
Age	-2395	
T-Value	-5.16	
P-Value	0.000	
S	22132	15553
R-Sq	70.39	85.96
R-Sq(adj)	69.21	84.79

APPENDIX J RESULTS FOR CORRELATION COEFFICIENT ANALYSIS (POOLED DATA)

	Deflated Pri	FSpace	NBedr	NBath	NUnits	Age	Heating	DElemSc	DMounSe	DRecr
FSpace	0.561									
	0.000									
NBedr	0.359	0.519								
	0.001	0.000								
NBath	0.419	0.464	0.501							
	0.000	0.000	0.000							
NUnits	-0.106	0.052	0.147	0.054						
	0.332	0.636	0.176	0.622						
Age	-0.259	-0.016	-0.191	-0.360	0.211					
	0.016	0.882	0.078	0.001	0.052					
Heating	0.218	-0.032	0.230	0.225	0.343	-0.717				
	0.044	0.771	0.033	0.038	0.001	0.000				
DElemSc	0.401	0.067	0.213	0.391	0.428	-0.657	0.714			
	0.000	0.542	0.049	0.000	0.000	0.000	0.000			
DMounSe	0.323	-0.014	0.235	0.347	0.389	-0.742	0.841	0.948		
	0.002	0.895	0.030	0.001	0.000	0.000	0.000	0.000		
DRecr	0.397	0.059	0.224	0.383	0.424	-0.683	0.759	0.997	0.966	
	0.000	0.587	0.038	0.000	0.000	0.000	0.000	0.000	0.000	
DLoSt	-0.320	-0.055	-0.208	-0.377	-0.511	0.605	-0.794	-0.934	-0.899	-0.937
	0.003	0.616	0.054	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Cell Contents: Pearson correlation
P-Value

APPENDIX K RESULTS FOR LINEAR REGRESSION ANALYSIS (POOLED DATA)

The regression equation is
Deflated Price = - 332990 + 144 FSpace + 4403 NBedr + 7686 NBath - 998 NUnits
+ 10272 Age + 90972 Heating + 110721 DElemSc - 6555 DMounSe
- 5506 DRecr + 45356 DLoSt

Predictor	Coef	SE Coef	T	P
Constant	-332990	92141	-3.	0.001
FSpace	144.36	20.69	6.98	0.000
NBedr	4403	5654	0.78	0.439
NBath	7686	7949	0.97	0.337
NUnits	-998.3	106.3	-9.39	0.000
Age	10272	1295	7.93	0.000
Heating	90972	25454	3.57	0.001
DElemSc	110721	113350	0.98	0.332
DMounSe	-6555	39629	-0.17	0.869
DRecr	-5506	134724	-0.04	0.968
DLoS`t	45356	34705	1.31	0.195

S = 23805.5 R-Sq = 76.6% R-Sq(adj) = 73.5%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	10	1.39428E+11	13942760830	24.60	0.000
Residual Error	75	42502699625	566702662		
Total	85	1.81930E+11			

Source	DF	Seq SS
FSpace	1	57175955186
NBedr	1	1150233587
NBath	1	4770421388
NUnits	1	3835150581
Age	1	4756989229
Heating	1	9555842843
DElemSc	1	57026046164
DMounSe	1	94895528
DRecr	1	94179726
DLoSt	1	967894066

Unusual Observations

Obs	Deflated FSpace	Price	Fit	SE Fit	Residual	St Resid
9	971	135614	187774	5835	-52160	-2.26R
33	838	122164	125963	16981	-3799	-0.23 X
34	1054	160944	157145	16981	3799	0.23 X
35	704	11838	100650	7617	-88812	-3.94R
68	673	159824	113724	8387	46100	2.07R
71	864	247106	178186	5211	68920	2.97R

R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large influence

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APPENDIX L RESULTS FOR STEPWISE REGRESSION ANALYSIS (POOLED DATA)

Alpha-to-Enter: 0.15 Alpha-to-Remove: 0.15

Response is Deflated Price on 10 predictors, with N = 86

Step	1	2	3	4	5
Constant	15189	-14760	17413	-62758	-253401
FSpace	155	148	151	148	161
T-Value	6.20	6.56	7.33	8.12	10.37
P-Value	0.000	0.000	0.000	0.000	0.000
DElemSc		26374	37316	77124	87564
T-Value		4.47	6.30	7.82	10.30
P-Value		0.000	0.000	0.000	0.000
NUnits			-306	-619	-1006
T-Value			-4.33	-6.82	-9.94
P-Value			0.000	0.000	0.000
Age				4585	9835
T-Value				4.77	8.13
P-Value				0.000	0.000
Heating					77250
T-Value					5.84
P-Value					0.000
S	38538	34812	31592	28082	23662
R-Sq	31.43	44.71	55.02	64.89	75.38
R-Sq(adj)	30.61	43.38	53.37	63.16	73.84
Mallows C-p	138.1	97.5	66.4	36.7	5.0

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