The Metro Vancouver Car Share Study

Technical Report

Metro Vancouver
November 2014

Executive Summary

Car share has emerged as a popular and growing mobility option in parts of the Metro Vancouver region. Car sharing allows individuals and businesses, through a membership, to access a network of vehicles on a short-term basis. Three car share providers operate in the region today. Modo and Zipcar require users to return the shared vehicle to the original pick-up location (two-way sharing); car2go allow users to complete a booking and park the vehicle in a different location (one-way sharing). Car share appeals to a broad range of households – from young urban professionals to families – who want a lifestyle that is not tied to owning and maintaining a private vehicle, but also want to retain the option to drive for primarily non-work trip purposes. Currently, the region has over 65,000 members[1] and close to 1,000 car share vehicles[2].

Municipalities are increasingly interested in the provision of car share vehicles in their communities in large part to support local policies around mobility choices, transit-oriented development, and housing affordability. Developers recognize the market demand for car share and the possible construction cost savings for new multi-residential developments if municipalities grant reductions in residential parking spaces for car share vehicles and parking stalls.

Car share providers are actively seeking to establish new markets in communities outside of the established urban neighbourhoods of the City of Vancouver. In particular, car share providers are seeking opportunities close to rapid transit stations in Urban Centres and Frequent Transit Development Areas that are undergoing significant redevelopment and intensification. The high-growth areas are envisioned in *Metro Vancouver 2040: Shaping Our Future* – the regional growth strategy. The regional growth strategy places a high priority on supporting sustainable transportation choices and reductions in private vehicular use and associated transportation and pollution effects. TransLink's *Regional Transportation Strategy Framework* includes a policy supporting car share and a performance target to reduce driving by one-third.

In order to establish an evidence base that municipal planners and engineers can refer to when contemplating accommodating or expanding car share in their communities, Metro Vancouver undertook a region-wide car share study, the first in the region[3]. The study findings can be used by the development industry and car share providers to further their respective and shared objectives. The study also helps to situate car share within the regional growth management framework.

The study involved surveying 3,405 car share households (Modo, car2go, and Zipcar) and 2,054 households residing in 110 apartment sites in the region. The key study findings are described next.

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[1] Based on publicly available information from Modo and car2go.

[2] Modo, car2go, and Zipcar.

[3] This work builds on the *2012 Metro Vancouver Apartment Parking Study*

Key Findings

Vehicle Holdings (Own/Lease): On average, up to three private personal vehicles were shed per car share vehicle. When the avoidance of acquiring private personal vehicles was included, each car share vehicle removed between 5 and 11 private personal vehicles from the use of current car share households. Unlike vehicle avoidance, not all vehicles that were shed would have been taken off the road, as some would have been sold or transferred to other owners in the region or outside.

Vehicle Kilometres Travelled (VKT): About one-half of car share households with no vehicles prior to joining car share reported driving more after joining a program. In contrast, one-third of car share households with vehicles prior to joining a car share program reported reductions in driving after joining. Over two-thirds of car share households that shed one or more vehicles also reduced their VKT. Further investigation is needed to understand the magnitude of the net change in vehicle kilometres travelled and implications for air emissions and related issues.

Availability of Car Share Vehicles in the Neighbourhood: The number of car share vehicles within walking distance from home has a small but statistically significant relationship with apartment household vehicle holdings. This evidence points to the importance of counting the number of available car share vehicles within a neighbourhood (whether parked on-street or off-street) when contemplating opportunities to promote reductions in household vehicle holdings and possible adjustments to parking supply in new apartment developments.

Motivation for Joining Car Share: Survey respondents were asked to select their top 3 reasons for joining car share. Amongst all households surveyed, the four most frequently cited reasons (each cited more than 1,000 times) were related to financial and mobility benefits:

- cost savings compared to owning or leasing a vehicle
- convenience of car share compared to transit
- additional mobility provided by car share
- availability of a car share vehicle near home.

Other reasons for joining car share, such as reducing air emissions and fuel consumption, and being drawn to the philosophy of sharing, varied between Modo and car2go households, between longer-term households (3 years or more) and more recent households, and whether a household had a private personal vehicle prior to joining. Zipcar-only households were not examined separately due to a small sample size. Also, car share programs enjoy a very high level of satisfaction amongst member households, with 9 out of 10 households saying they were somewhat or very satisfied with their car share program(s).

Considerations for Regional Growth Management and Community Planning: There is great interest throughout the region to see car share expand and provide additional transportation choices for residents. Where car share services operate today, they are popular and have become a fixture in neighbourhoods. While car share is not the remedy for all of the region's transportation problems, it can confer benefits in certain contexts and with appropriate public policy and private industry support.

Some of the strategic and operational considerations around the role of car sharing in regional growth management and community planning are described below.

Strategic Considerations

1. **Complexity of Household Decisions:** Transportation demand management measures have long been identified as ways to reduce auto dependence. These measures, whether investments in transportation services or infrastructure, implicitly assume households will respond accordingly and change travel behaviour. This study presents additional evidence to support these ongoing policy efforts.

   According to the study findings, households that shed a vehicle or reduced the amount of driving both cited "reduce pollution and fuel consumption" and "cost savings of car share compared to owning/leasing a vehicle" more frequently as top reasons for joining car share. The former reason is a personal belief or preference, and the latter is to some degree a circumstance of a household's economic situation (income and expenses). So, whether or not this combination of personal belief and household circumstance must be present in order to actualize vehicle shedding or VKT reduction, illustrates the latent complexity of public policy efforts to lessen our collective dependence on private personal vehicles. It also remains to be determined whether such personal beliefs change with duration of car share membership and different household stages; and the role, if any, that car share may play in reinforcing or changing these and other personal beliefs.

   The implication is that it may be difficult to project out or extrapolate the transportation choices and behaviour of future car share households without first having a better understanding of the role that personal beliefs, in conjunction with other household circumstances, play in travel behaviour. What this study shows is that consideration should be made to personal beliefs and recognition must be made to household financial burden, in addition to aspects of the built environment and transportation services and infrastructure.

2. **Relationship with Transit:** The relationship that car share has with transit deserves further investigation. The study findings suggests that car share could in certain cases be an alternative to taking transit. When households were asked what they would do if car share programs were discontinued permanently, one of the most frequently cited response was "use transit more".

   The study findings also point to car share as an additional mobility choice. The most commonly cited trips made with car share were discretionary, non-work trips. These trips are generally the most difficult to serve by transit in a cost-effective manner given the wide distribution of activity destinations throughout the region and travel demand throughout the day. The majority of transit trips (61%) today serve work or post-secondary purpose. In contrast, the majority of auto trips (68%) serve non-work purposes. Also, trips that require carrying heavy or large items, such as groceries, furniture, building supplies, limit the utility of transit. Further investigation is warranted on how people use car share to connect to the transit system, or how car share is used to connect transit to first or final destinations (the "first kilometre" or "last kilometre" link). This research

would be timely as car share expands into transit station areas in the more suburban parts of the region.

3. **Suburban Expansion:** The near-term potential utilization and benefits of car share in lower density areas are unlikely to approach the levels seen in higher density urban areas today. In suburban areas, walkability and the abundance of transit remain short of the levels seen in the Metro Core (downtown Vancouver, including Central Broadway) and its adjoining neighbourhoods. For these reasons, the redevelopment and intensification of established frequent transit corridors and new rapid transit station areas in suburban municipalities represent some of the best opportunities to create the built environment conditions for car share to thrive as a complement to transit, walking, cycling, and carpooling. Developers can play a role in supporting the marketing of car share vehicles in the first few years to improve utilization and affect travel behaviour, whether those vehicles are on-site or on nearby streets.

4. **Affordability:** Car share confers affordability benefits to member households directly and potentially to residents of apartment sites with on-site car share and reduced parking. The first set of affordability benefits is achieved when private personal vehicles are shed and payments for fixed costs (insurance, depreciation, and financing expense) and variable costs (gasoline and maintenance) are eliminated. Carless households also avoid having to make payments to buy or lease a car. The cost of using car share is the fee charged per kilometre or per unit of time by the car share provider, plus one-time registration fees.

   The second set of affordability benefits, associated with any developer savings in construction costs from not having to build the full complement of apartment residential parking stalls, is only achieved if the cost savings are returned to consumers in the form of price or rent reductions, or to municipalities for reinvestment in expanded mobility options or housing affordability initiatives in the immediate neighbourhood or broader community. One possibility is for the developer to fund the provision of on-site car share vehicles, or discounted car share memberships to all new residents of the apartment site for the duration of the car share and strata agreement (typically three years), or to fund any revenue shortfall. These actions may help to establish and sustain the demand for the on-site car share and encourage reductions in vehicle holdings and driving.

5. **Better Information to Manage Uncertainty and Risk:** Car sharing is a relatively young and dynamic industry. A great deal about car sharing and transportation decisions remain to be explored. For example, the introduction of one-way sharing in the region has complemented the established two-way sharing services. Further investigation is warranted on the longer term correlations between these two different sharing models with household decisions on trip purposes, vehicle shedding and avoidance, and changes in VKT.

   Rapid advancements in technology can abruptly make current models of practice obsolete, and bring forth new or adapted models. The next stage of car sharing may be peer-to-peer sharing, whereby an individual owner makes his or her vehicle available for others to rent for short periods

of time. In this dynamic environment, where private enterprises are competing to service the travel demand of residents and workers, new players may enter the market, while others may exit.

It is important to ensure that car share vehicles, in particular those that are located in neighbourhoods and apartment buildings in transit-oriented locations, remain stable over a long period of time. If the car share market becomes unstable and service types change or service levels are reduced, then the gains in mobility, affordability, and environment performance may regress. Car share providers, developers, and municipalities should jointly contemplate these risks and appropriate measures.

These discussions can be informed by third party assessments of car share household travel patterns, preferably surveying the same households and/or neighbourhoods over a number of years. In addition, methods to forecast car share utilization and feasibility should be developed and shared amongst local governments, just like acceptable methods have been established to forecast local and regional demand for driving, carpooling, and transit. Metro Vancouver could help facilitate these dialogues and/or provide updated data as appropriate.

Operational Considerations

6. **Parking Allocation and Fees:** As car share expands across the region, municipalities and TransLink will establish related policies, regulations, and fee structures to manage car share and the demand for parking spaces. To a large degree, it comes down to managing the supply of parking – a scarce good – from competing demands by multiple car share providers and other users (e.g., resident and visitor vehicles, taxi vehicles, loading trucks, etc.) through parking allocation and fees.

   Considerations should be made whether designated car share parking spaces should be capped, and/or allocated on a first come-first serve basis to providers, and whether to allow car share vehicles to park on streets with established parking restrictions, such as residents-only streets. The duration of such permits or agreements is another consideration. In existing and new rapid transit station areas or park-and-ride lots owned or managed by TransLink, TransLink may wish to make similar planning decisions on the allocation of car share vehicles and providers. If so, consideration should be made, in conjunction with municipalities, to incorporate parking capacity for car share vehicles at these public transit sites at the facility design stage.

   Municipalities and TransLink can consider levying fees on car share providers for the right to use reserved/designated spaces on public streets and parkades based on a cost recovery model or reduced/waived fees. Ultimately, the relative benefits and costs of aiding a private service provider, whether for profit or non-profit, based on assumed and demonstrated community benefits (social, economic, and environmental) must be weighed against the equitable and efficient management of public assets (street spaces and public lots).

7. **Access:** The successful utilization of car share is in part dependent on good visibility and ease of access to the vehicles. Many car share households cited the availability of a car share vehicle on a

nearby street as a reason for joining a program. Car share providers prefer to have their vehicles located on streets or on private or public surface lots. However, whether in Vancouver or other municipalities in the region, the demand for street parking spaces can be high. In some cases, it will be a challenge to convince local residents of the merits of reserving street parking spaces for car share vehicles only or allowing car share vehicles to be parked in 'resident parking only' or 'resident permit parking' street areas. Also, neighbourhoods near major destinations (e.g., hospitals, fairgrounds, and sporting venues) may experience significantly higher flows of general traffic and car share vehicles entering than are leaving the neighbourhoods.

The provision of car share vehicles within new or existing apartment sites (on a surface lot or in a parkade) may be the most acceptable way to introduce car share into a neighbourhood, but limited visibility and barriers to access may adversely affect recruitment and utilization rates, and long-term financial sustainability. These issues could potentially be addressed and resolved by the involvement of car share providers early on during the development design stage of new apartment projects.

8. **Apartment Parking Reductions:** Decisions to reduce minimum parking requirements for new apartment developments in return for the provision of one or more car share vehicles and dedicated car share parking stalls should ideally be made based on a consideration of two factors. First, parking supply should be rationalized relative to expected demand, in particular for sites close to the Frequent Transit Network. Second, the potential vehicle reduction effect within a building must account for both the on-site car share vehicle and the availability of nearby car share vehicles, whether in other apartment sites or on nearby streets. In the absence of considering these two factors fully, parking reductions granted to developers may not truly reflect the anticipated demand for parking. Hence, parking may still be oversupplied, or parking may be undersupplied.

   Municipalities may stipulate that developers provide more than one new car share vehicle, one to be placed on-site, and a second or third vehicle to be made available on nearby streets in order to qualify for parking reductions. Alternatively, rather than use car share as a tool for negotiating variances to parking supply, municipalities could add car share to the list of potential "amenities" required in new apartment developments. Another possibility is to link the provision of car share with "parking unbundling", whereby a prospective apartment customer is provided the option to buy/rent an apartment unit without a parking stall (and the option to have a stall for an extra fee).

Acknowledgements

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Table of Contents

1.0 Introduction

The emergence of car sharing is changing the way people move around in parts of Metro Vancouver. Car sharing allows individuals and businesses, through a membership, to access a network of vehicles on a short-term basis. The demonstrated demand for car sharing in the urban core of the region shows that many households can enhance their mobility and reduce the number of vehicles they have or forgo acquiring one. Car share could help many households in the region optimize their expenditures on transportation without significantly degrading their mobility, and could help municipalities, with confidence, reduce the number of parking stalls in new multi-unit residential developments, thereby supporting sustainable transportation and housing affordability objectives. Each kilometre driven in a car share vehicle (with improved emissions-control systems and fuel economy), and not driven in an older private personal vehicle, will have an environmental benefit. As car sharing expands beyond the urban core to suburban areas, changing people's attitudes and behaviour around personal mobility, there must also be consideration of the implications on public policy and, in turn, the effect that public policy can have on shaping positive outcomes.

One of the key policy documents is Metro Vancouver's regional growth strategy, *Metro Vancouver 2040: Shaping our Future (Metro 2040)*. *Metro 2040* sets out the vision and actions to shape land use development, conservation, and transportation considerations for the next three decades. Within the context of a physically constrained land base, the growth management priorities include making efficient use of lands, promoting transportation choices beyond the single-occupant vehicle, and lessening the region's contribution to greenhouse gas emissions and air contaminants. Should car share be advanced or promoted as an effective growth management tactic, a better understanding of car sharing will be needed. Metro Vancouver's *Integrated Air Quality and Greenhouse Gas Management Plan* recognizes the car share as a potential low carbon transportation choice.

To establish this evidence base, Metro Vancouver undertook the first region-wide car share study. The objectives were to:

1. **Establish a baseline understanding of the current car share market profile in Metro Vancouver;**
2. **Understand the relationship, if any, between car share and household vehicle holdings and driving; and,**
3. **Provide an informed perspective on the role of car share in regional growth management and community planning.**

The study comprises the following components:

- a review of the car share market globally and regionally;
- a review of municipal practices related to multi-unit residential developments and street parking;
- key informant interviews with the three main car share providers in the region; and,
- two online surveys conducted in Fall 2013.

The report will be made available on the Metro Vancouver website.

2.0 Study Context: The Metro Vancouver 2012 Apartment Parking Study

The motivation for the Metro Vancouver Car Share Study came from the 2012 Metro Vancouver Apartment Parking Study. The 2012 study established a comprehensive evidence base of current municipal parking practices, in the region and outside, observed parking supply and demand in 80 apartment sites throughout the region, and the parking habits of residents in these apartments.

Metro Vancouver identified a list of "opportunities" for new apartment developments near the Frequent Transit Network[4]. One of these opportunities was to encourage the expansion of car share programs where feasible. The study found that households with car share memberships have, on average, fewer vehicles compared to non-member households.

But because correlation does not equal causation, further investigation was necessary to delve into the car share phenomenon and to understand the role of car share programs in helping local governments meet their public policy objectives. These objectives include expanding transportation choices and reducing automobile dependence, fuel consumption/emissions, and housing and transportation costs.

The increasing popularity and acceptance of car share programs in Metro Vancouver could yield long-lasting benefits for residents, businesses, municipalities, car share providers, and developers. Many municipalities are either already, or are in the beginning stages of, integrating car share into land use and transportation planning. Several municipalities allow developers to provide car share vehicles and car share parking stalls in lieu of some regular parking stalls in multi-unit residential developments. Developers can save on development costs by reducing the total number of parking stalls and these savings could potentially be passed on to consumers or returned to the municipality for reinvestment. Car share provides residents one additional mobility option and could help reduce expenditures on transportation; and surrounding neighbourhoods could potentially experience less congestion and demand for on-street parking.

The environmental benefits could also be measurable[5]. Car share could allow households to get rid of one or more private personal vehicles, reduce unnecessary trips and excessive driving, and eliminate the use of older vehicles that may be less fuel-efficient and emit more pollutants. Car share also exposes a wider audience to different vehicle types, such as hybrids and electric vehicles, which may help dispel anxieties about the reliability of the technologies and even influence future purchase decisions towards more fuel-efficient and less polluting vehicles.

For these reasons, this study was undertaken by Metro Vancouver to advance the collective understanding of car share in relation to regional growth management and community planning.

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[4] High density communities with a robust network of frequent transit services offer the best opportunities to put the study findings into practice. For suburban communities lacking the coverage of frequent transit services, the opportunities identified in the study may be treated as longer-term objectives.

[5] Martin, E., and Shaheen, S.A. (2011). Greenhouse Gas Emissions Impacts of Carsharing in North America. *IEEE Transactions on Intelligent Transportation Systems*, December 2011.

3.0 Backgrounder on Car Share

This section provides an overview of the evolution of car share services, the global and regional markets, and specific trends and forecasts that lend support to car share being a durable feature of the regional transportation system.

3.1 The Car Share Market

3.1.1 The Evolution of Car Share Services

Car share programs provide a network of passenger vehicles to members who can access them on an as-needed basis. Car share members gain the benefits of private personal vehicle use without the costs and responsibilities of ownership. Car sharing differs from the traditional car rental model by offering more locations to pick up vehicles and eliminating the hassle of having to go into a branch office to pick up and drop off a vehicle. For two-way sharing services, such as Modo and Zipcar, vehicles must still be booked in advance and returned to the same pick-up location.

In 2008, one-way sharing was introduced in Germany by car2go, whereby members could pick up a vehicle without a reservation, and drop off vehicles in different locations. This model allowed for greater spontaneity and flexibility in trip-making. As of 2012, one-way car sharing was available in seven countries (Austria, France, Germany, the Netherlands, Great Britain, Canada, and the United States).

Table 1. Comparison of Car Share and Car Rental Services

Attributes	Car Share Service	Traditional Car Rental Service
Vehicle Locations	Network of "hubs" distributed widely throughout a city or multiple cities, with each hub comprising up to 10 vehicles for a given provider. Vehicles are also parked on streets, surface lots, or parkades.	Retail storefronts comprising a larger fleet of vehicles, such as in airports and central business districts. Truck rental companies (e.g. U-Haul) have storefronts that may be more distributed across a municipality.
Vehicle Booking	Either booking or spontaneous access using GPS-enabled smartphone app to locate available nearby vehicles.	Booking typically required.
Vehicle Access	For two-way services, vehicles must be picked up and dropped off at the same location. For one-way services, vehicles can be picked up and dropped off anywhere within a geographic area.	Vehicles can sometimes be dropped off a different retail storefront.
Membership Fees	Typically an application fee plus either an annual or monthly fee.	No fee.
Usage Fees	Per km and/or per unit of time billing. Zipcar offers the first 200 kilometres free (over which a distance-based charge is assessed). Gasoline is paid for by the provider.	Flat daily rates (either unlimited or limited kilometres), varying by size of vehicle. Users pay for gasoline, and usually must fill up the tank before returning the vehicle.
Insurance	Car share company covers insurance.	Rental company covers insurance, and actively sells additional optional insurance policies to customers.

The next evolution of car sharing appears to be peer-to-peer sharing, whereby an individual owner makes his or her vehicle available for others to rent for short periods of time. This model does away with the centrally managed and owned fleet synonymous with car sharing and car rental operations to date. A company provides the brokerage service via the Internet and a smartphone app to match an owner and customer. These "personal vehicle sharing programs" are legally allowed to operate in BC. According to ICBC, people can rent or lend their vehicles to others, but the vehicles must be insured in the appropriate rate class, and the owner of the vehicle is still responsible for injuries or damage caused by people using the vehicle.

A second version of peer-to-peer sharing is ridesharing where a broker links a passenger and a driver having a private vehicle to complete a ride. Uber, Lyft, and Sidecar are three such companies originating from the United States that are also facing scrutiny from regulators and the taxicab industry. As a sign of things to come, on October 14, 2014, San Francisco International Airport granted a permit to Sidecar to provide service to and from the airport – the first arrangement in California.

3.1.2 The Growth of the Global Car Share Market

The car share market has grown exponentially around the world in the past decade. Car sharing has its origins in Switzerland in the late 1940's, but did not enter the North America market until the 1990's. One of the first car share programs in North America started in Vancouver in 1997. In 2013, there were 20 providers in Canada, 25 in the United States, and one in Mexico. As of January 2013, there were about one million members sharing 15,600 car share vehicles in North America. Globally, an estimated 1.8 million members share 44,000 vehicles, administered by 33 operators, in 27 countries and five continents.

Table 2. Growth in Car Share Membership (UC Berkeley, Transportation Sustainability Research Centre)

Region	Average Annual Growth Rate 2006-2008	Average Annual Growth Rate 2008-2010	Average Annual Growth Rate 2010-2012
Asia	-11%	155%	40%
Australia	115%	56%	41%
Europe	26%	29%	12%
North America	64%	27%	33%
South America	Operations started 2009		269%
Worldwide	39%	37%	20%

According to data compiled from the UC Berkeley Transportation Sustainability Research Centre, North America is the largest car sharing region, accounting for 51 percent of global membership, followed by Europe at 39 percent.

A scan of cities with car share services in Canada and United States reveals a market landscape that is similar to the one in Metro Vancouver. Typically, at least two car share providers operate in each city-region, with Zipcar and car2go the dominant players. A lack of published data on specific provider

membership and fleets precludes comparisons between city-regions. As noted above, peer-to-peer car share is gaining a market foothold in the United States.

Table 3. Comparison of Cities with Car Share Services

City	Population (2011 Canada, 2012 U.S.)	Major Two-Way Car Share Providers	Major One-way Car Share Providers	Peer-to-Peer Car Share Services
Toronto	2.6 million	Zipcar, AutoShare	car2go	--
Calgary	1.1 million	Calgary Carshare	car2go	--
Montreal	1.7 million	Communauto	car2go, Auto-Mobile	Communauto (pilot)
Seattle	0.6 million	Zipcar, Hertz 24/7	car2go	RelayRides
Portland	0.6 million	Zipcar, Uhaulcarshare	car2go	Getaround, RelayRides
San Francisco	0.8 million	Zipcar, City CarShare, DriveNow	--	Getaround, RelayRides
Los Angeles	3.9 million	Zipcar	--	RelayRides
Denver	0.6 million	Zipcar	car2go	RelayRides
San Diego	1.3 million	Zipcar	car2go	Getaround, RelayRides

3.1.3 The Metro Vancouver Car Share Market

Three car share companies dominate the market in Metro Vancouver. Modo is the longest established car share provider, and the only car share co-op, in the region (Modo was founded in 1997 as the Co-operative Auto Network). Zipcar (owned by Avis Budget Group) entered the Metro Vancouver market in 2007. The one-way sharing service, car2go (owned by Daimler AG), which began operations in 2008 in Germany, entered the regional market in 2011.

Table 4. The Major Car Share Providers in Metro Vancouver (as of November 2013)

	Modo	Zipcar	car2go
Locations and Vehicles	303 vehicles, 245 locations	128 vehicles, 53 locations	550 vehicles, no fixed locations
Operating Areas	Vehicles located in Vancouver, UBC, City of North Vancouver, West Vancouver, Richmond, Burnaby, New Westminster, Coquitlam, Surrey	Vehicles located in Vancouver, UBC, City of North Vancouver, Richmond, SFU Burnaby	Most of Vancouver, UBC, City of North Vancouver, parts of District of North Vancouver, Kwantlen University campuses in Richmond, Surrey, and Langley City
Membership	7,897 individual drivers; 1,667 business-only drivers	Not disclosed	7,400 (interpolated from disclosed data in May 2013, January 2014, and April 2014)
Individual Membership Fees	Co-op membership: One-time $500 refundable shares purchase and $20 registration fee Casual membership: $5 monthly fee and $20 registration fee	Occasional Driving Plan: $25 one-time non-refundable application fee and $65 annual fee Monthly Driving Plan and Extra Value Plan: $25 one-time non-refundable application fee	$35 one-time registration fee

The geographic arrangement of car share vehicles and operating areas still suggests a niche service focused primarily within the City of Vancouver, and specifically the Metro Core (downtown Vancouver and central Broadway) and the immediate neighbourhoods within 5 km of downtown Vancouver. In the past few years, the car share providers have begun to enter markets in North Vancouver City and District, Richmond, Burnaby, New Westminster, Surrey, UBC Point Grey Campus, and SFU Burnaby Campus. In most of these new locations, vehicles have been placed near SkyTrain stations. More recently, car2go made an arrangement with Kwantlen University to dedicate some vehicles at satellite campuses in Richmond, Surrey, and Langley.

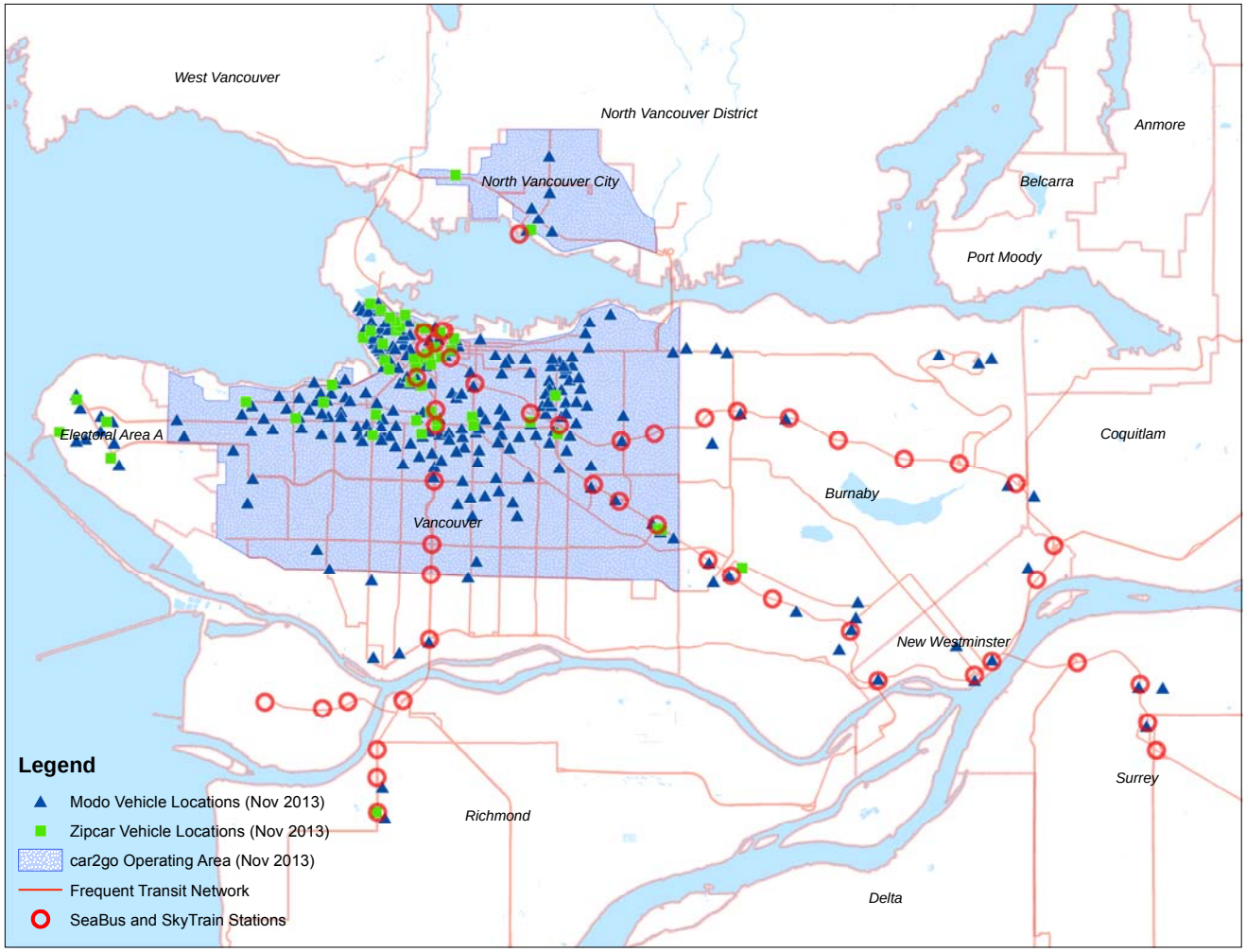

Figure 1. Car Share Locations as of November 2013

3.2 Established Directions in Regional Policy

The opportunity exists in the upcoming five-year review of *Metro 2040* to consider elevating the role of car sharing as a sustainable transportation choice. Acknowledgement in regional policy is contingent in part on demonstrable evidence that car share is helping to address regional interests around land use/transportation, affordability, and the environment. The evidence presented in this technical report helps to lay the foundation for such a policy dialogue. The clearest indication to date of support in the region for car share comes from TransLink's *Regional Transportation Strategy Framework*, adopted in 2013, which commits TransLink to supporting car sharing[6]; and, Metro Vancouver's *Integrated Air Quality and Greenhouse Gas Management Plan*, which contains a commitment for Metro Vancouver to work with municipalities and TransLink to develop model bylaws that facilitate low carbon transportation choices, such as car sharing. *Metro 2040* has a goal to support sustainable transportation choices, which are defined as transit, multiple-occupancy vehicles, cycling, and walking.

A legacy of regional planning work has affirmed time and again the concept of providing transportation choices to residents so that the private personal vehicle is not the default choice for trip making. As the region continues to add more residents and jobs, the amount of travel will increase. Uncontrolled growth in travel using the private personal automobile would lead to worsening traffic congestion, air quality, and greenhouse gas emissions. If a greater proportion of these trips could instead be made by public transit, carpooling, cycling, and walking, then growth and economic development are less prone to compromising livability and mobility.

With the link between transportation, land use, and housing affordability now firmly established in *Metro 2040,* car share could in the future be considered for inclusion in regional policy as a distinctive form of sustainable transportation choice. To get to that point will depend in part on the evidence.

Table 5. Regional Policies and Plans

Regional Planning Document	Select Transportation Element
1976 Livable Region Proposals	Provide a transit-oriented transportation system and coordinating transportation with growth management.
1993 Transport 2021	Increase the choice of modes available, use transportation demand management to restrain growth in travel by the single occupant automobile, and maximize transit investment
1996 Livable Region Strategic Plan	Increase transportation choice
2011 Metro 2040 Regional Growth Strategy	Coordinate land use and transportation to encourage transit, multiple-occupancy vehicles, cycling, and walking
2011 Metro Integrated Air Quality and Greenhouse Gas Management Plan	Reduce the carbon footprint of the region's transportation system; develop model bylaws that facilitate low carbon transportation choices, such as car sharing.
2013 TransLink Regional Transportation Strategy Framework and 2014 Mayors' Council Vision	Reduce total driving distances by one-third, and make half of all trips by walking, cycling, and transit.

[6] TransLink's 2013 *Regional Transportation Strategy Framework* commits the regional transportation authority to "supporting carsharing, ridesharing, bikesharing and taxis including undertaking research on how best to increase trips by multiple-occupancy vehicle trips."

3.3 Supportive Regional Trends and Patterns in Metro Vancouver

Supportive trends and patterns in fuel prices, travel choices, and land use development point to synergies with car share.

3.3.1 Fuel Price Trend

Fuel prices have been rising for the past 15 years, in part from market fundamentals and geopolitics, and in part from increases in motor fuel taxes. The average monthly retail price of gasoline in the region has nearly doubled in real terms since the 1990's. The dip in retail price associated with the global economic recession lasted only a few years and has rebounded to pre-recession levels.[7]

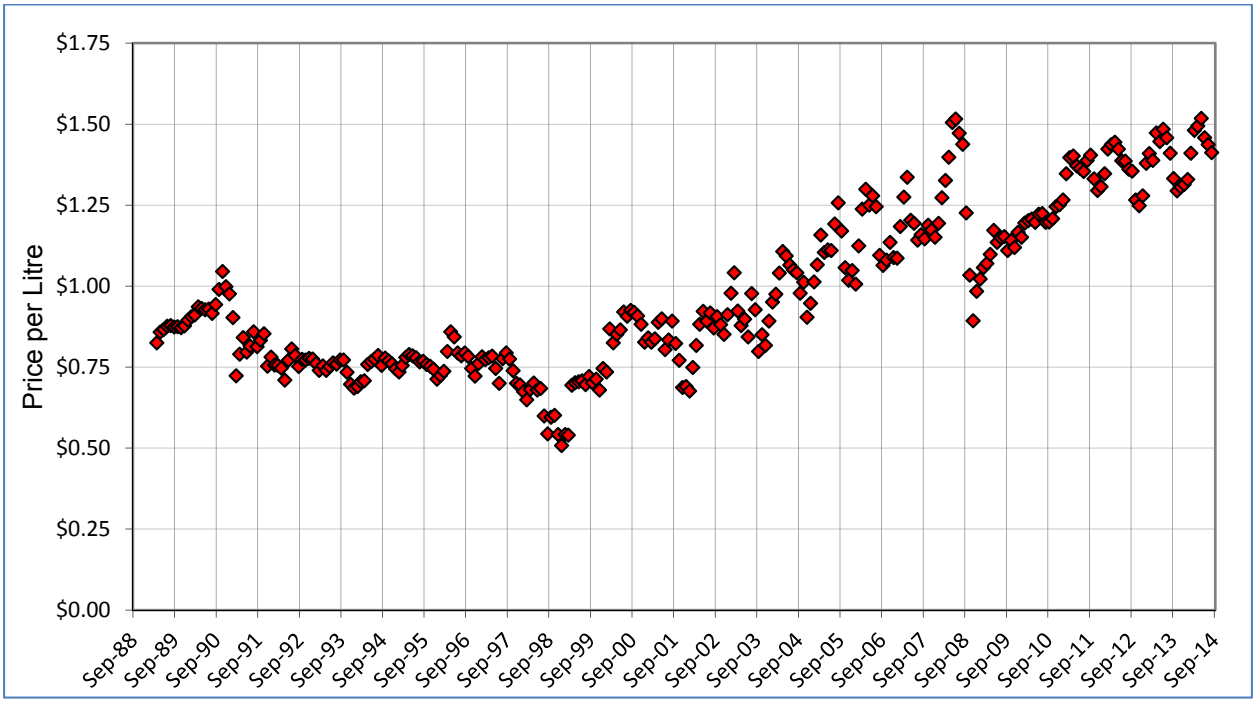

Figure 2. 25-Year Trend in Average Retail Price of Gasoline in Metro Vancouver, 1989-2014 (2014$) (Source: Natural Resources Canada)

The total cost of living in Metro Vancouver can be attributed in part to both the cost of housing and the cost of transportation. The rising cost of private vehicle ownership is likely causing some households to reconsider getting a second or third vehicle, and perhaps even to sell an older, inefficient model[8]. The emergence of car share has allowed these decisions to be made more easily than before. Car share eliminates the fixed cost of ownership and changes the way operating costs are paid out by the user. Expenditures on cars comprise vehicle ownership costs (insurance, licensing and registration,

[7] As of October 15, 2014, retail gas prices across Canada are at multi-year lows and are projected to decline further. The decline in retail prices is associated with rising production and supply of crude oil amid tepid global demand (http://www.cbc.ca/news/business/gas-prices-at-5-year-low-and-dropping-1.2799300).

[8] Improvements in vehicle fuel economy will mitigate in part the out-of-pocket costs of rising fuel prices. However, the psychological impact of seeing media reports of higher and higher gas prices at the pump could have a disproportionate effect on changing transportation behaviour. In the U.S., $4 per gallon is often cited as a psychological barrier above which discretionary income is perceived to be threatened. In Canada, $1.50 per Litre has been cited as the psychological barrier (http://www.surreyleader.com/news/253407021.html).

depreciation, financing) and operating costs (fuel, maintenance, and tires). The only cost item that is truly a variable is fuel, which can be responsible for up to 70 percent of operating costs (and 25 percent of total costs).

3.3.2 Non-Work Trips

Current travel patterns provide inferential evidence that car share programs can serve an immense market. Car share providers have been successful in targeting discretionary non-commute trips, which make up the 66% of the 6 million trips generated by Metro Vancouver residents on a typical fall weekday[9]. About two-thirds of auto trips serve non-work purposes. In contrast, the majority of transit trips (61%) today serve work or post-secondary purposes. Further, non-work trips are significantly shorter in distance, which make car share that much more economically attractive as a mobility option[10]. A comparison of 2008 and 2011 travel patterns suggest a relatively stable market for these non-work trips. If per capita trip generation remains steady as the region's population continues to grow, then the market for public and private transportation services will continue to expand.

Table 6. Weekday Trip Purpose and Average One-Way Trip Distance by Metro Vancouver Residents (TransLink 2011 Regional Trip Diary Survey)

Trip Purpose	Share of Trips (All Modes) 2008	Share of Trips (All Modes) 2011	Trip Distance (km) 2008	Trip Distance (km) 2011
Work or post-secondary	35.0%	34.5%	13.3	13.2
Shopping or personal business	24.7%	22.9%	6.5	7.1
Social, recreational, or dining	17.0%	19.5%	7.7	7.7
Drop-off or pick-up	12.8%	14.2%	5.7	6.0
Grade school	10.5%	8.9%	3.4	3.4
Total	**100% (5.6 million)**	**100% (6.1 million)**	--	--

3.3.3 Actively Licensed Vehicle Trend

The 2012 Metro Vancouver Apartment Parking Study remarked that the region was experiencing a decline in the annual growth rate of passenger vehicles between 2006 and 2012. This trend has been updated to July 2014. The number of actively licensed passenger vehicles is increasing on an absolute basis year-over-year (as of July 31 of each year). However, the annual rate of growth remains one-half of what it was prior to the global economic recession. The annual growth rate in the past six years is tracking below the regional population growth rate of 1.6 percent. This trend, perhaps catalyzed by the recession and ongoing economic conditions in the region and province, appears to be durable.

At the subregional level, the regional pattern persists: current vehicle growth rates range from one-third to one-half of what they were prior to the recession. Most subregions are tracking at or below the regional average. For the municipalities south of the Fraser (Surrey, White Rock, Langley City, and

[9] TransLink's 2011 Metro Vancouver Regional Trip Diary Survey – Analysis Report.

[10] Trip distances for different trip purposes can vary from municipality to municipality. Moreover, Modo and Zipcar are better suited than car2go for longer distance non-work trips because their vehicles have larger carrying capacities and they charge lower hourly and distance rates, and lower maximum daily rates.

Langley Township), their growth rates are tracking above the regional trend, even though current rates are less than half of pre-recession rates. In general, these trends should bolster the confidence for those municipalities that have reduced their parking provisions in recent years. For other municipalities that are contemplating reviews of residential parking policies and regulations, these trends could lend additional support for new policy proposals.

The implications for car share are clear. If evidence could be found that shows that car share can enable households to shed a car, or to postpone getting one, and possibly shape the amount of driving, then a cogent case could be made to confirm car share is a low carbon transportation choice and one way to encourage a less auto-dependent region.

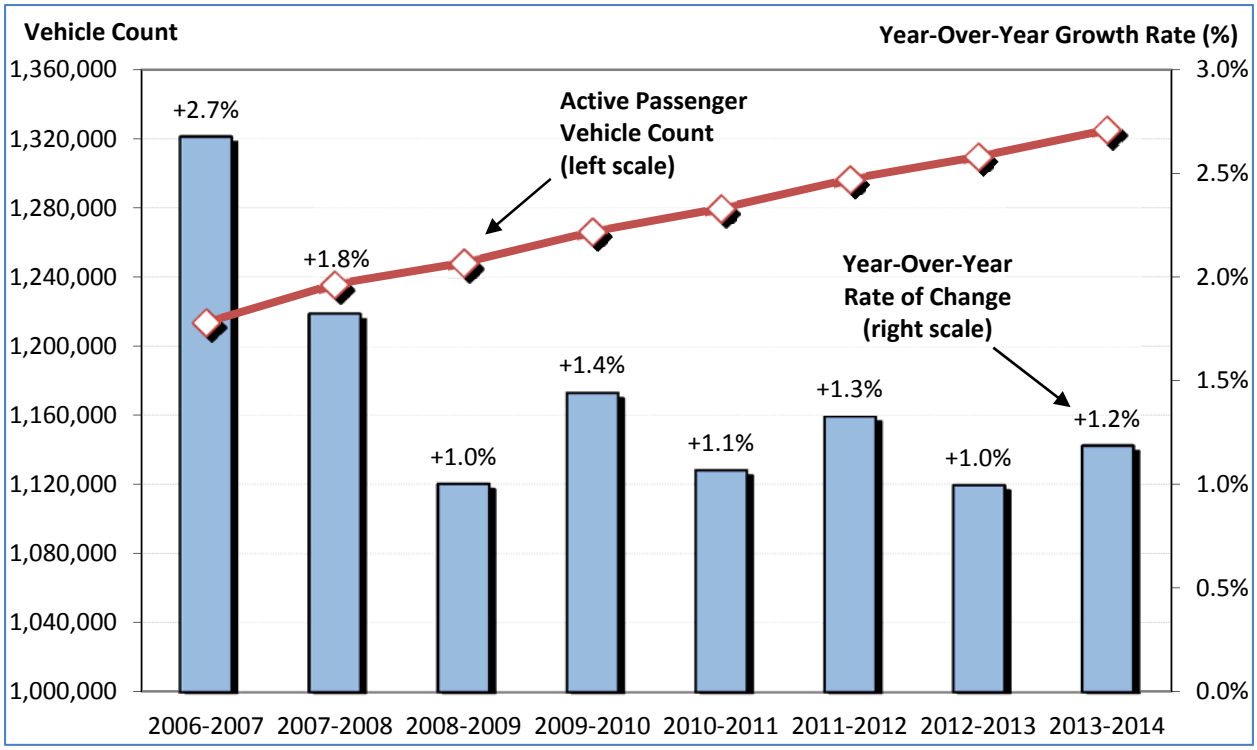

Figure 3. Actively Licensed Passenger Vehicles (July 31st of each year, source: ICBC)

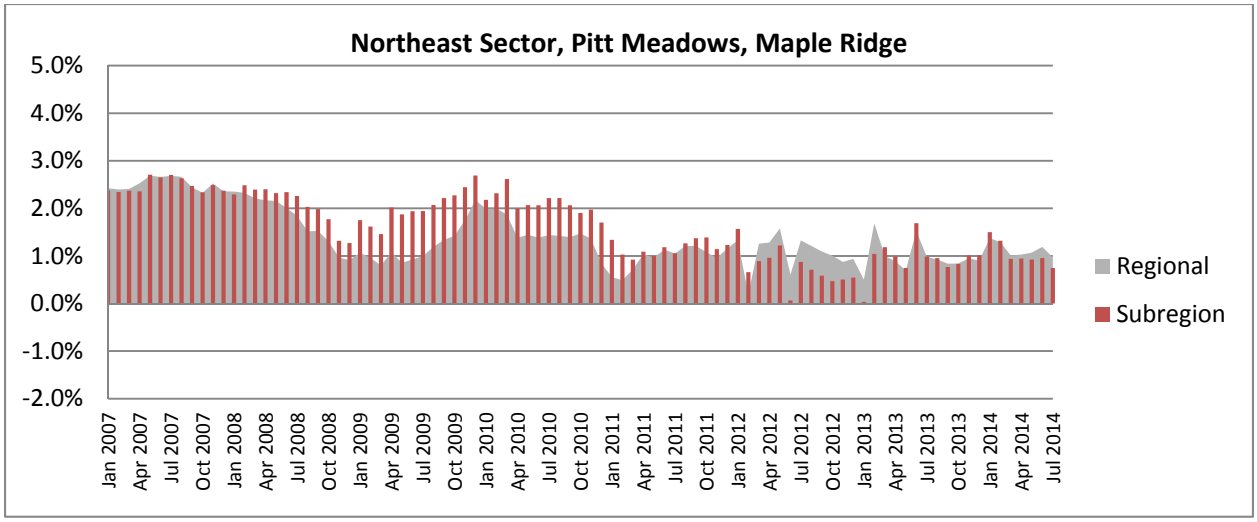

Figure 4. Year-Over-Year Change in Actively Licensed Passenger Vehicles: Northeast Sector, Pitt Meadows, Maple Ridge

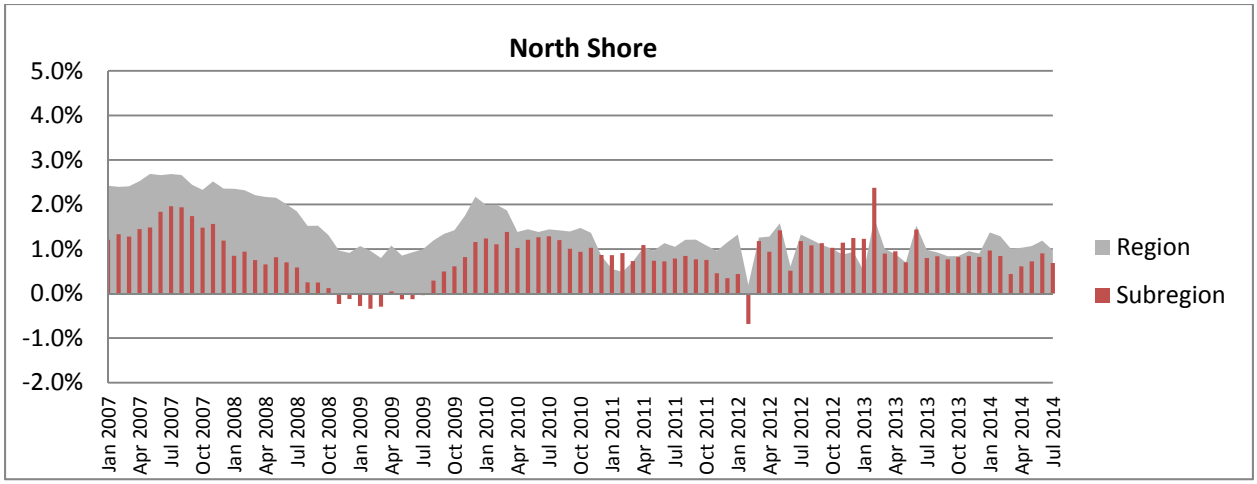

Figure 5. Year-Over-Year Change in Actively Licensed Passenger Vehicles: North Shore

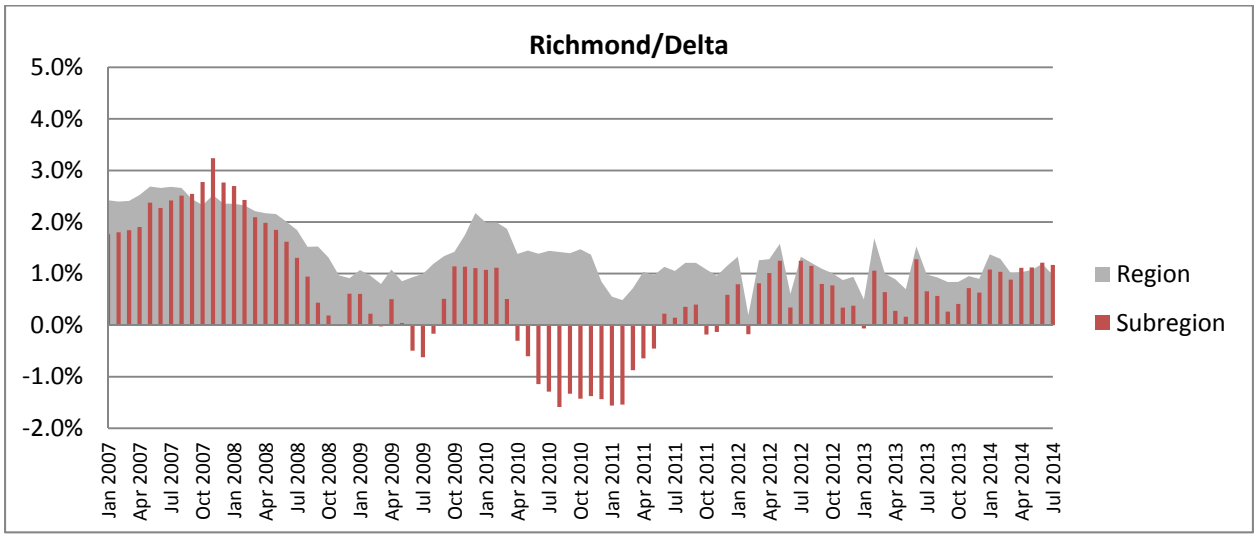

Figure 6. Year-Over-Year Change in Actively Licensed Passenger Vehicles: Richmond/Delta

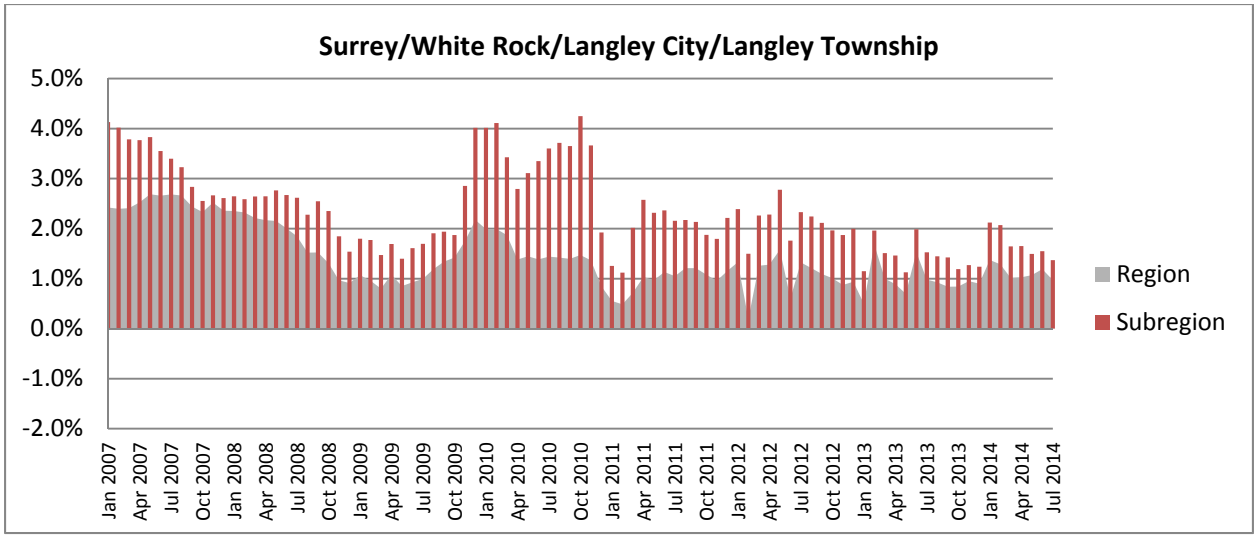

Figure 7. Year-Over-Year Change in Actively Licensed Passenger Vehicles: South of Fraser

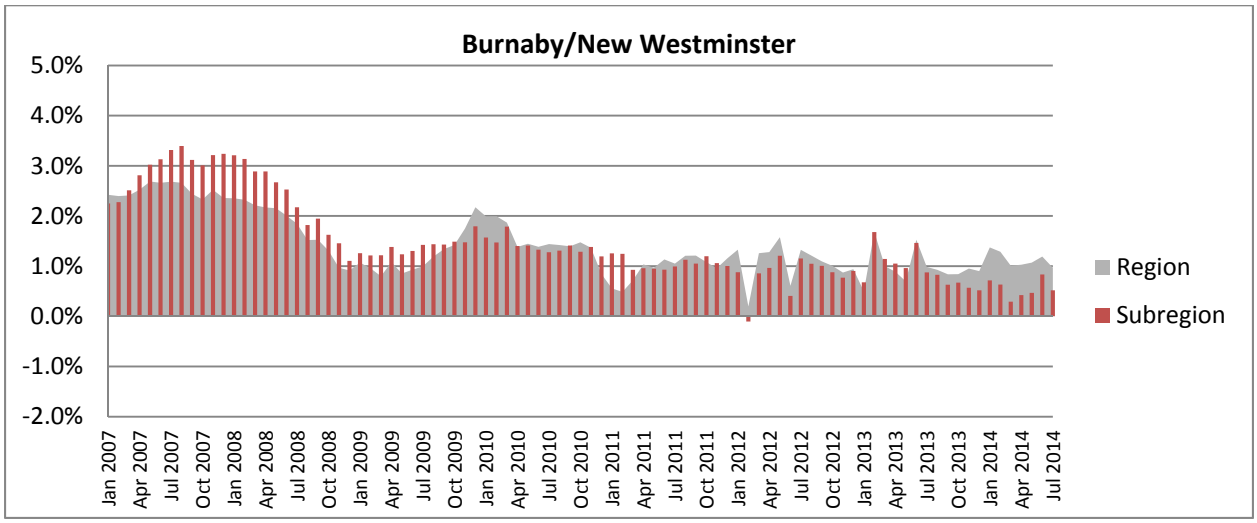

Figure 8. Year-Over-Year Change in Actively Licensed Passenger Vehicles: Burnaby/New Westminster

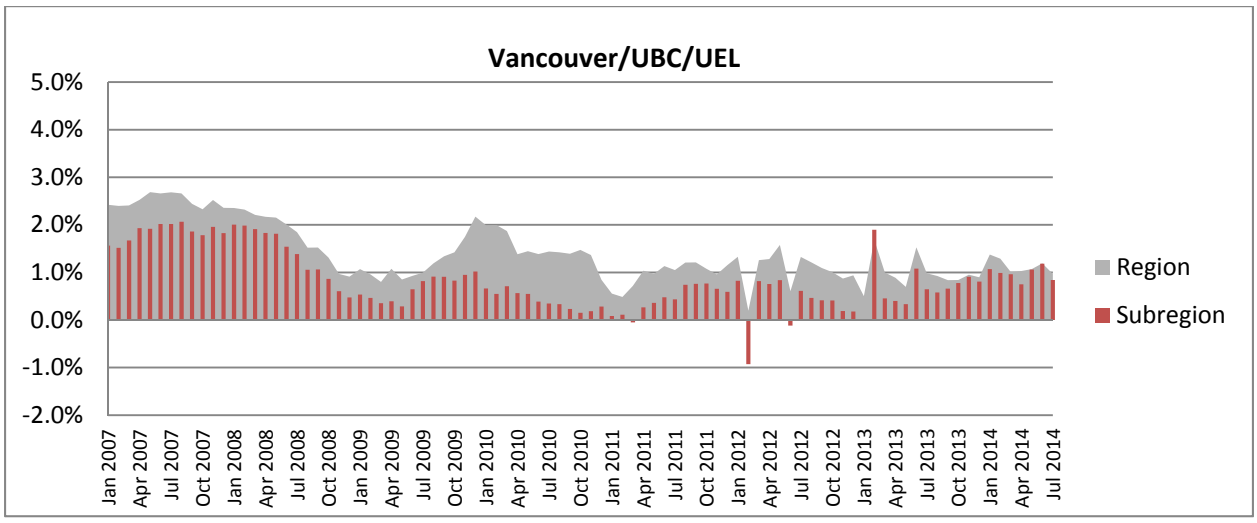

Figure 9. Year-Over-Year Change in Actively Licensed Passenger Vehicles: Vancouver/UBC/UEL

3.3.4 Forecasted Growth along the Frequent Transit Network

As car share providers look to expand their market into the rapidly growing suburban parts of the region, the areas that will share some of the broader attributes of the Metro Core will be the Urban Centres and Frequent Transit Development Areas. *Metro 2040* sets a target for focusing two-thirds of residential growth and three-quarters of employment growth in these areas. Many of the growth areas are focused around rapid transit stations. Beyond the well-established network of car share vehicles in the densely-populated parts of the City of Vancouver, car share companies are expanding to sites within walking distance to existing rapid transit stations in Surrey (e.g. Surrey Central Station), Richmond (e.g. Canada Line Stations), Burnaby (e.g. Patterson and Metrotown stations) and New Westminster (22nd Street and Columbia stations).

With the announcement of the Mayors' Council Transportation Vision in June 2014, three new rapid transit lines have been proposed – the Broadway Line in Vancouver (VCC-Clark to Arbutus), and two lines in Surrey: Newton-Surrey Metro Centre-Guildford (via King George Boulevard and 104th Avenue, and Fraser Highway (Surrey Metro Centre to Langley City), in addition to numerous enhanced frequent bus corridors. Looking ahead, the prospect is good for focusing population growth within a 10-minute walk (equivalent to about 800 metres) of many of these new and existing rapid transit stations, and redevelopment areas served by frequent bus. TransLink, municipalities, and developers are seeking ways to maximize the use of the transit system. In so doing, they will also accelerate land use patterns that make owning a car less crucial and strengthen car sharing's attractiveness as an additional mobility option to complement transit.

Table 7 provides an indication of the magnitude of growth that is possible relative to what's on the ground today along these rapid transit lines[11]. More growth could potentially be accommodated as station locations and Frequent Transit Development Areas are confirmed, municipalities update local area plans, and the real estate market recognizes the redevelopment opportunities in these areas.

Table 7. Indicative Population Growth within 800m Catchments of Rail Rapid Transit Stations

Rail-Based Rapid Transit	# Station Areas Appropriate for High Residential Grow[12]	The Range in Station Area Population Growth		
		Population, 2011	Potential Growth, 2011-2024	Potential Growth, 2024-2045
Existing Lines				
Expo Line	16	3,000 to 26,000	+2,000 to +15,000	+3,000 to +15,000
Millennium Line	7	2,000 to 15,000	+2,000 to +15,000	+4,000 to +16,000
Canada Line	12	1,000 to 32,000	+2,000 to +10,000	+2,000 to +15,000
Evergreen Line	4	4,000 to 11,000	+4,000 to +13,000	+5,000 to +16,000
Potential New Lines				
Broadway Line	7	10,000 to 21,000	+3,000 to +8,000	+2,000 to +5,000
104th Ave	5	5,000 to 12,000	+3,000 to +11,000	+4,000 to +15,000
King George Blvd	6	2,000 to 9,000	+4,000 to +7,000	+5,000 to +10,000
Fraser Highway	5	2,000 to 8,000	+3,000 to +4,000	+4,000 to +6,000

[11] Population forecasts were prepared by Metro Vancouver. The forecasts are updated from time to time to reflect updated Regional Context Statements, municipal planning outcomes, and Census counts.
[12] Stations that are common to multiple rapid transit lines are counted once only.

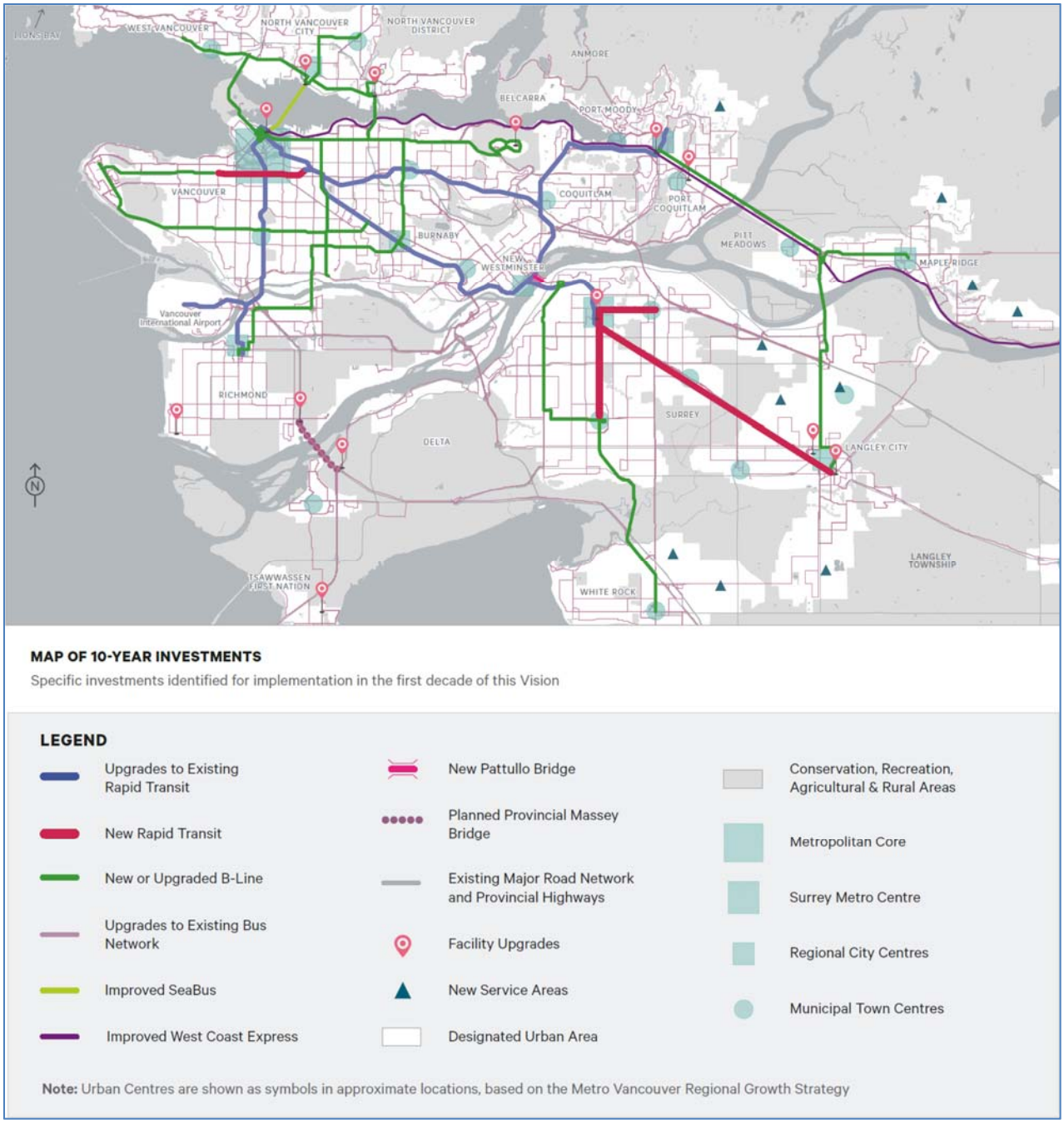

Figure 10. Mayors' Council Vision for Regional Transportation Investments (2014)

3.4 Key Informant Interviews

Metro Vancouver staff convened meetings with the executive directors of the three car share providers on July 4, 2013 and July 21, 2014 to gain a better understanding of the challenges and opportunities with car sharing in the region. Given the competitive nature of this industry, some requested information was not disclosed to staff. The key insights shared by the providers are described below[13].

Table 8. Key Informant Interviews with Car Share Providers

Topic	Car Share Provider Comments
The Role of Car Share in Reducing Auto Dependence	• All three car share providers suggested that to reduce private vehicle ownership, it will require more than simply the provision of car share programs. It will require good "city design" and incentives. • Incentives, in relation to car share, may include encouraging developers and car share companies to provide introductory free or discounted memberships to new apartment residents to encourage their use of car share vehicles.
Car Share as a Complement to the Transportation Network	• Car share vehicles are intended to be part of the larger transportation network to complement transit and other modes. • Car share is not intended to replace commute trips, but rather to provide additional options for non-work trips. • Generally, for two-way car sharing services, three vehicles should be introduced in a new neighbourhood to achieve a minimum critical mass. The three vehicles should be spatially distributed in an equilateral triangle, a few hundred metres apart. The vehicles should not be in the same apartment building, unless the building is in an established car sharing neighbourhood. The vehicles should be in designated street parking, or a surface lot to promote visibility and ease of access.
Financial Considerations when Choosing Locations	• The required investment and commitment for the car share provider to operate a vehicle is significant (acquiring the vehicle, paying for the parking, maintenance, insurance, and management). Car share providers typically strive for upwards of 60 members per car share vehicle to ensure a cost-effective utilization level[14]. • Areas that are looked upon favourably for service expansion are urban locations with higher densities and a mix of land uses, proximity to high quality transit, and sites readily accessible by members, such as surface parking lots. In more suburban areas, the costs and risks of lower utilization rates make it more challenging for operators to be financially viable in the near term. • A growing trend is for developers to incorporate car share vehicles into larger residential developments as a transportation demand management measure and amenity. In return, the developer may be permitted a reduction in the number of minimum parking stalls required. Upon completion of the project, the vehicle is transferred to the car share operator. The vehicle is typically operated under an initial three-year agreement. Car share providers typically strive for a break-even level after one year. In some arrangements in the past,

[13] The meeting participants were Phil Baudin (Modo), Mark Pribula (Zipcar), and David Holzer (car2go). Nathalie Baudoin, Chief Executive Officer of Modo, attended the July 21, 2014 meeting,

[14] According to the UC Berkeley Transportation Sustainability Research Centre, as of January 2014, the member to car share vehicle ratio in Canada was 54, and the ratio in the United States was 72.

Topic	Car Share Provider Comments
	the developer has funded the revenue shortfall for the duration of the agreement period. • Even if a vehicle and parking stall is provided by a developer, it may still not be financially viable to maintain a vehicle if the utilization rate remains low and unable to cover its operating expenses, insurance, and depreciation costs.
Municipal parking regulations and administration	• A single point of contact in each municipality is preferred for handling issues on parking administration and for receiving updates on construction or events that may make car sharing parking spaces temporarily unavailable. • Clear communication of municipal regulations on parking ticketing and towing is crucial to enabling car share providers to convey accurate information to members, especially as car share expands to more municipalities. • On-street dedicated parking spaces should not be near a stop sign or fire hydrant; vehicles have been towed before. • One car share provider would prefer that no decals for permit parking are required for vehicles because adding/removing parking decals on an annual basis is logistically challenging with vehicles moving about; another car share provider would prefer a universal regional decal.
Preferred Car Share Parking Locations in Multi-Unit Residential Developments	• The preferred order of parking locations are: 1. Dedicated on-street parking space adjacent to development site. 2. Dedicated surface-level parking space at grade on the development site. 3. P1 in parkades regardless of grade. The parking space should not be hampered by bulkheads and pillars and be sized appropriately for the intended car share vehicle. A two-gate system is preferable as car share vehicles would be parked in the visitor parking section to allow for ease of access.

4.0 Review of Current Municipal Practices

Some municipalities in the region have been active in facilitating access to car share vehicles through parking policies targeting multi-unit residential parking supply, and allowance of on-street and off-street parking. The following sections describe current practices in the region and for select cities elsewhere.[15]

4.1 Dedicated Parking Stalls in Multi-Unit Residential Developments

A few municipalities have established car share as a transportation demand management (TDM) measure for developers to provide on-site. In return, the municipality may grant the developer a reduction in the required number of on-site resident vehicle parking stalls. The premise is that the availability of car share vehicles (and other site-specific or TDM features) will allow households in the building to have fewer vehicles. The average cost of constructing a structured parkade can range from $20,000 to $45,000 per stall depending on the parking facility design and construction. Reductions in parking could translate to developer savings, and if these savings are passed on to consumers through reduced prices or rents, then affordability has been improved. Alternatively, this benefit could be returned to the municipality (via contributions or cash-in-lieu) for reinvestment in the community.

Table 9. Municipal Provisions Related to Multi-Unit Residential or Commercial Developments (May 2014)

Municipality	Provision
City of Vancouver	In multi-unit buildings, parking can be substituted at a 1:5 ratio to a maximum of one shared vehicle and one shared parking space for each 50 dwelling units, or a higher maximum as deemed appropriate by the Director of Planning and General Manager of Engineering Services. The exceptions are for secured market rental housing: a) For secured market rental housing in downtown, parking can be substituted at a 1:5 ratio, with no maximum number of shared vehicle parking spaces or shared parking spaces. b) For secured market rental housing not in downtown, parking can be substituted at a 1:5 ratio, to a maximum of 4 shared vehicles and 4 shared parking spaces for each 100 dwelling units. c) For developments with secured market rental housing and other residential uses, a combination of ratios set out above can be applied by the Director of Planning and General Manager of Engineering Services as deemed appropriate. Southeast False Creek area: For non-residential uses, up to 2% of the spaces for non-residential uses must be designated as shared vehicle parking spaces and these designated spaces may form part of the minimum non-residential parking requirement.
City of New Westminster	The minimum on-site parking requirements may be reduced by 5 parking spaces for each car share vehicle and space (net reduction of 4 parking spaces), up to 10 percent of the total required parking spaces.
City of Richmond	The minimum on-site parking requirements may be reduced by up to a maximum of

[15] For additional case studies of car sharing parking policies in U.S. cities, please refer to: Shaheen, S.A., Rodier, C., Murray, G., Cohen, A., and Martin, Elliot. (2010). Carsharing and Public Parking Policies: Assessing Benefits, Costs, and Best Practices in North America. Mineta Transportation Institute, San Jose State University.

Municipality	Provision
	10% where: a) The City implements transportation demand management measures, including the use of car co-operatives, transit passes, private shuttles, carpools, or enhanced end-of-trip cycling facilities; and b) The minimum on-site parking requirements are substantiated by a parking study that is prepared by a registered professional engineer and is subject to review and approval of the City.
City of Coquitlam	Up to 5% of the required off-street parking spaces for a commercial, apartment, or townhouse development may be reduced provided transportation demand management (TDM) measures are provided by the developer and approved by the General Manager of Engineering and Public Works. One typical TDM measure is a car share vehicle and/or car share memberships. The typical parking reduction is 2-4 stalls depending on the total value of the car share vehicle and/or memberships.

In addition, current practices in other cities with established car share networks were reviewed.[16]

Table 10. Multi-Unit Residential Provision in Other Car Share Cities

Municipality	Provision
City of Toronto	Negotiated approach; permitted reductions in parking requirements have ranged from 0 to 10 parking spaces per dedicated car share space.
City of Seattle	Residential development with 20+ parking spaces: parking is reduced by 3 spaces for each car share space, up to a maximum of 15% of the total number of required spaces. Residential development with fewer than 20 parking spaces: parking requirement is reduced by 1 parking space for each car share space, up to a maximum of 5% of the total number of required spaces.
City of Portland	Substitution of car sharing spaces for required parking is allowed if all of the following criteria are met: a. For every car-sharing parking space that is provided, the motor vehicle parking requirement is reduced by two spaces, up to a maximum of 25 percent of the required parking spaces; b. The car-sharing parking spaces must be shown on the building plans; c. A copy of the car-sharing agreement between the property owner and the car-sharing company must be submitted with the building permit.
City of San Francisco	Residential development with 50+ units: requirement of 1 car share space for dwellings with 50 to 200 units and an additional car share space for every additional 200 units. Non-residential development that requires 25+ parking spaces: requirement of 1 car share space and an additional required car share space for every additional 50 required parking spaces.

[16] Engel-Yan, J., and Passmore, D. (2013). Carsharing and Car Ownership at the Building Scale, *Journal of the American Planning Association*, 79:1, 82-91.

4.2 On-Street and Off-Street Parking

Municipalities in Metro Vancouver with operating car share services have generally accommodated car share providers by treating parking for car share vehicles just like for any other private vehicle. Typically, the car share providers pay an annual per vehicle fee to the municipality for the right to park in reserved spaces and/or in permit areas. Users can park the car share vehicles in these spaces or any unmarked/unrestricted space for free. The user is, however, responsible for any charges incurred as a result of parking in a metered space.

Modo has made arrangements with the Cities of Vancouver, Surrey, and Port Moody to have vehicles available for city staff to use for work-related trips. Modo also provides software management services to assist with automated booking of these vehicles by staff. For Vancouver, which has the longest experience, this arrangement has improved municipal efficiency by allowing the City to reduce the size of its corporate vehicle fleet. Car share providers also work with private property owners to reserve parking spaces for car share vehicles, such as in Richmond Centre Mall, Metropolis at Metrotown, and the planned Oakridge Mall redevelopment.

The full range of parking locations is shown below.

Table 11. Range of Allowable Car Share Parking Locations

Allowable Parking Location	Description
Any legal spot on streets with no restrictions or signage	--
On-street and public/private off-street reserved spaces for car share	Car share providers usually pay an annual per vehicle fee for the exclusive use of reserved spaces. In some areas, car2go trips can only start or end in a reserved car2go space.
On-street and public/private off-street with meters	In most situations, the user is responsible for paying the meter. Richmond is piloting a program with car2go whereby wireless technology allows the City to directly bill the car share provider in real-time. car2go trips cannot end in a metered location.
On-street and public/private off-street with time restrictions	car2go trips cannot end in time-restricted locations or non-sanctioned private facilities.
Streets requiring permits for parking	Car share providers usually pay an annual and per vehicle fee for the right to park in permit zones. In North Vancouver City, car share providers must pay for permits for the right to park in Residents Exempt areas for up to 72 hours at a time (normally, non-residents without permits can only park for a maximum of 2 hours between 9AM-6PM). In Vancouver, car share vehicles can park for an unlimited amount of time in residentially-restricted zones. Car share providers must pay an annual per vehicle fee for a parking permit.

Some of the specific provisions regarding parking spaces and fees are listed below.[17]

Table 12. Select Car Share Provisions in Municipal Bylaws (June 2014)

Municipality	Provision

[17] Additional case studies on parking policies

Municipality	Provision
City of Vancouver	The annual fee for a permit authorizing parking for each shared vehicle in all areas of the city is $64.76. Where the City designates a street for the reserved parking only of shared vehicles, the annual fees per shared vehicle are: a) Downtown area and Southeast False Creek $1,320 b) Elsewhere in Metro Core $660 c) Outside of Metro Core $300 d) For reserved shared vehicle parking space that the city would otherwise meter, that sum which is equal to the maximum annual revenue the parking space would have generated if metered.
City of North Vancouver	The City Engineer may charge a fee to the car share provider to establish reserved car share parking spaces. If the reserved space is in a metered zone, the annual fee would be equal to the meter revenue that would have been collected by the City. A car share provider which requests the establishment of a shared vehicle zone shall have exclusive use of that zone for two years. After this period, the use of the zone shall be determined by right of first refusal, whereby the car share provider may choose to continue to use the zone or relinquish the use of the zone. Car share companies can purchase Resident Exempt Parking Permits, which allow users to park in Resident Exempt zones for up to 72 hours at a time. The car share provider must pay an annual application fee of $25 per vehicle in its fleet.
City of Richmond	Council has approved on-street parking permits, on-street reserved parking spaces (near the Canada Line), general parking spaces at City Hall, and cellular-based payments for on-street and off-street metered parking. Under a one-year pilot project with car2go anticipated to start in 2014, the following fees will be paid by car2go to the City for access to city-owned parking locations: • $1,200 plus tax per year for exclusive use of four on-street reserved parking spaces near the Canada Line • $2.50 plus tax per vehicle, per hour, for use of on- and off-street metered parking • $50 plus tax per month, per vehicle, for use of on-street permit parking (subject to volume discounts)

5.0 Car Share Household Survey Data Analysis

Highlights of the lessons learned from the survey of current car share households are described first, followed by details of the survey findings.

5.1 Car Share Household Survey: Highlights of Data Analysis

As the key lessons and findings are presented, the reader should keep in mind the limitations of this survey dataset, including any biases. The survey distribution technique affected response rates. The highest response rate came from Modo members, then followed by car2go members[18]. Zipcar members were not well-represented in the survey. Moreover, car share households may be non-representative of the overall regional population insofar car share services may appeal to only certain demographic segments, and car share households primarily reside in the City of Vancouver where most of the car share vehicles are located currently.

5.1.1 Car Share Household Survey Profile

Age: Compared to the regional population profile, the car share household survey profile was generally overrepresented by 25-44 year olds, and underrepresented by children and young adults under 25 years of age, and underrepresented by older adults over 44 years old. When comparing Modo-only and car2go-only households, the former had a higher share of children under 16 years old and adults in the 35-54 year old cohort. In contrast, car2go-only households had a higher proportion of young adults in the 16-34 age range. An analysis of Zipcar-only households was not conducted due to a small sample size.

Household Size: The car share household size was similar to the regional average. The average size of car share households residing in apartments was 1.83 persons (compared to 1.86 in the 2011 National Household Survey); the size of households residing in single-detached houses was 3.34 persons (compared to 3.13 in the 2011 National Household Survey).

Housing Type: Car share households were overrepresented by renters (and underrepresented by homeowners). Renters made up 66 percent of apartment car share households (compared to 56 percent of all apartment households in the 2011 National Household Survey), and 21 percent of single-detached households (compared to 10 percent of all single-detached households in the 2011 National Household Survey).

Place of Residence: Most car share households (close to 90 percent) resided in the City of Vancouver. They lived where most car share vehicles are sited today, namely the Metro Core and the immediate neighbourhoods of Kitsilano, Fairview, Mount Pleasant, and Grandview-Woodlands.

Vehicle Holdings: One-half of car share households were car-free. A greater share of households in apartments and suites-in-house was car-free as compared to households in other housing types.

[18] Estimated Modo household response rate = 1847 / 7031 = 26%
car2go response rate = 2363 / 33286 = 7%

Car Share Membership: Most car share households were members of one of the three car share providers only (69 percent) versus two or more providers (31 percent). A majority of Modo-only households have been members for three years or longer.

Car Share Usage: Car-free households used the car share service more frequently in comparison to households with private personal vehicles. The amount of money spent per month reflected this usage pattern. Amongst car-free households, over one-half spent greater than $50 per month on car share, compared to only one-quarter of households with vehicles.

Car Share Trips: The four most commonly cited car share trips were not related to the commute to work, but rather shopping, visiting friends and family, recreation, and going to a restaurant/bar. Modo-only households tended to take more recreation, vacation, and medical trips. In contrast, car2go-only households tended to take more trips to restaurants and bars, and for commuting to and from work.

Motivation for Joining Car Share: Households chose to join car share primarily for the cost savings compared to owning or leasing a vehicle, the convenience compared to transit, the availability of a car share vehicle near home, and the additional mobility provided by car share. The environmental benefits (reducing pollution and fuel consumption) and the philosophy of sharing were cited less often.

Willingness to Give Up a Car: Car share households cited the availability of car share vehicles near home most often as the amenity that would encourage them to give up a private personal car or to postpone getting one. Frequent and direct transit service was cited the second most number of times. This ordering was reversed when households were asked about amenities near work.

Ways to Encourage More Usage: Car share households that were infrequent users would use car share more if usage fees were lower, if there were more car share vehicles near their home, and if there was greater flexibility in picking up and dropping off vehicles at different locations. Modo-only and car2go-only households cited the same desired improvements.

Overall Satisfaction: Car share programs enjoy a very high level of satisfaction by their member households. Nine out of 10 car share households were somewhat or very satisfied with their car share program. The degree of satisfaction also increased with frequency of usage.

5.1.2 Performance Outcomes

Vehicle Reductions: On average, up to 3 private personal vehicles were shed per car share vehicle. When the avoidance of acquiring private personal vehicles was included, then each car share vehicle is estimated to have removed 5-11 private personal vehicles from the use of current car share households.

Other factors also appear to be associated with vehicle shedding. For example, households that subscribed to more than one car share provider were more likely to have shed a private personal vehicle. Also, car shedding households tended to have joined car share for both cost-savings and environmental reasons.

Vehicle Kilometres Travelled: About one-half of the households with no vehicles prior to joining car share reported driving more after joining. In contrast, just under one-third of households with vehicles prior to joining car share reported a decline in driving after joining. Further investigation is required to understand the net change in vehicle kilometres travelled.

5.2 Car Share Household Survey: Survey Design and Conduct

The Car Share Household Survey provides a current baseline of information on the profile of car share members, such as their reasons for joining a car share program, typical means of accessing a car share vehicle, and whether the number of household-owned or leased vehicles has changed since becoming members.

The survey was conducted online between October 17 and December 2, 2013. Metro Vancouver developed and administered the survey. The hyperlink to the online survey was distributed by the administrators of Modo and car2go to their respective members via e-mail. Zipcar chose to distribute the survey link via Twitter. Members were advised to submit only one survey response per household. Respondents were given an opportunity to enter into a draw to win one of two gift certificates worth $50. Two winners were randomly selected after the survey closed in December.

5.3 Car Share Household Survey: Survey Responses and Demographic Profile

Approximately 3,400 responses were received (after data validation). Modo sent out an e-mail notification to its membership on October 17. Car2go followed with its e-mail notification on October 29. Finally, Zipcar “tweeted” the survey link in the first week of November.

Multiple responses from members of the same household are a known risk. The survey instructions stated clearly that only one survey be completed per household. It is assumed that these instructions were followed.

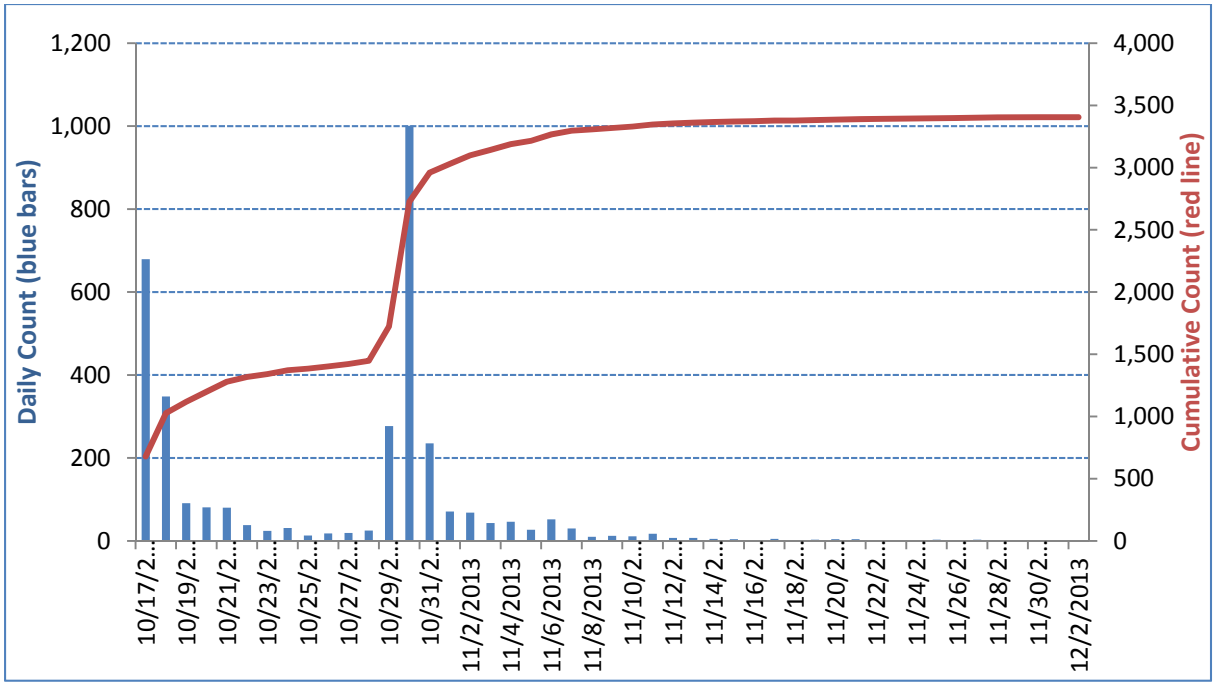

Figure 11. Daily and Cumulative Responses to the Car Share Household Survey

5.3.1 Municipal Distribution

Most of the respondents lived in municipalities with established car share programs. City of Vancouver residents represented close to 9 out of 10 responses. Residents of Burnaby, North Vancouver City and District, New Westminster, and Richmond represented most of the remaining responses.

Table 13. Car Share Member Survey Responses by Municipality

Municipality	Count	Distribution of Responses
Vancouver	2,972	87.3%
Burnaby	124	3.6%
North Vancouver City	79	2.3%
New Westminster	56	1.6%
North Vancouver District	53	1.6%
Richmond	42	1.2%
Surrey	25	0.7%
Other	15	0.4%
Coquitlam	12	0.4%
Delta	9	0.3%
Bowen Island	9	0.3%
West Vancouver	6	0.2%
Maple Ridge	1	0.0%
Pitt Meadows	1	0.0%
Langley City	1	0.0%
Total	**3,405**	**100%**

5.3.2 Housing Type Distribution

Car share households in the survey were mostly residents of apartments, making up 60 percent of responses. Using the 2011 National Household Survey for the region as a comparator, 40 percent of all occupied private dwellings were apartments versus 60 percent as ground-oriented dwellings.

Table 14. Housing Type Distribution

Housing Type	Responses	Distribution of Responses
Apartment	2,051	60%
Single-Detached House	629	19%
Suite in House	358	11%
Townhouse	229	7%
Duplex	115	3%
Laneway House	20	0.6%
Other	3	0.1%
Total	**3,405**	**100%**

5.3.3 Household Size Distribution

The majority of responses came from households of two or fewer persons. The average household size in this survey was 2.2 persons, which is less than the 2011 Census regional average of 2.6 persons. The lower average household size is consistent with the higher proportion of apartment dwellers represented in the survey.

Table 15. Household Size Distribution

Household Size	Responses	Distribution of Responses
1 person	883	26%
2 persons	1,519	45%
3 persons	466	14%
4 or more persons	497	15%
Total (40 respondents declined to answer this question)	**3,365**	**100%**

When segmented by apartment and single-detached house, the average household sizes were consistent with the 2011 National Household Survey regional averages.

Table 16. Average Household Size by Housing Type

Housing Type	Survey	2011 NHS
Apartment	1.83	1.86
Single-Detached House	3.34	3.13

5.3.4 Age Distribution

Car share households in the survey generally have a higher proportion of people in their prime working age of 25-44 years relative to the 2011 NHS for the region. Conversely, when compared to the 2011

National Household Survey, car share households generally have a lower proportion of people under 25 years of age, and people over 44 years of age (a comparison of Modo-only and car2go-only households is discussed in Section 5.4.1).

Table 17. Age Distribution

Age Cohort	Persons in All Households in Survey (n=7,494)	2011 NHS
0-15 years	12.5%	15.3% (0-14 cohort)
16-24 years	8.1%	13.2% (15-24 cohort)
25-34 years	32.5%	14.3%
35-44 years	22.4%	14.8%
45-54 years	13.2%	16.2%
55-64 years	8.5%	12.8%
65+ years	2.7%	13.5%

5.3.5 Housing Tenure Distribution

The majority of car share households surveyed were renters (57 percent) versus owners (43 percent). The 2011 National Household Survey for the region, in contrast, counted 35 percent of households as renters and 65 percent as owners. When the respondents were segmented by housing type, the respective patterns were broadly consistent with the 2011 National Household Survey insofar as households in apartments were generally renters, and households in single-detached houses were generally owners.

Table 18. Housing Tenure Distribution by Housing Type

	Survey		2011 NHS	
Housing Type	**% Own**	**% Rent**	**% Own**	**% Rent**
Apartment	35%	66%	44%	56%
Single-Detached House	79%	21%	90%	10%

5.3.6 Duration of Residency

The duration of residence for a majority of car share households surveyed was at least three years (57 percent), followed 1 to 2 years (24 percent), and less than a year (10 percent). This pattern suggests that the survey results on transportation choices should be fairly robust as households travel patterns usually stabilize after a year or so of moving to a new location.

Table 19. Duration of Residency by Housing Type

Housing Type	Less than 1 Year	1 to 2 Years	3 Years or More
Apartment	21%	27%	52%
Single-Detached House	9%	9%	83%
Townhouse	12%	18%	70%
Suite in House	26%	39%	35%
Duplex	13%	15%	72%

5.4 Car Share Household Survey: Car Share Membership Profile

As noted previously, due to the limited response rate from Zipcar-only member households, the bulk of the data analysis relied on Modo and car2go responses. Where appropriate, Zipcar responses were included in aggregated analysis.

5.4.1 Car Share Membership

The largest number of surveyed households belonged to car2go, followed by Modo, and Zipcar. The distribution of membership in this survey was consistent with the respective methods that the three companies used to distribute the survey link: both car2go and Modo sent out e-mails to their members and included the survey link on their membership websites, whereas Zipcar sent out a Twitter "tweet" only.

Table 20. Car Share Membership

Car Share Memberships	Responses	Distribution of Responses (%)
car2go Only	1,317	39%
Modo Only	1,009	30%
Zipcar Only	9	0.3%
car2go + Modo	753	22%
car2go + Zipcar	232	7%
car2go + Modo + Zipcar	61	2%
Modo + Zipcar	24	0.7%
Total	**3,405**	**100%**

A little over two-thirds of the surveyed households were members of only one of the three major car share companies. The remaining respondents were members of two car share companies (only a small fraction of households were members of all three companies).

Table 21. Number of Car Share Memberships

Number of Memberships	Responses	Distribution of Responses (%)
Membership with 1 company only	2,335	69%
Membership with 2 companies only	1,009	30%
Membership with 3 companies	61	2%
Total	**3,405**	**100%**

Households with multiple car share memberships generally belonged to either Modo+car2go, or to Zipcar+car2go. Rarely were households members of both Modo and Zipcar. These patterns were consistent with the fact that Modo and Zipcar offer similar services (two-way sharing), whereas car2go offers a dissimilar service (one-way sharing) which complements Modo and Zipcar.

From a household size perspective, there was little to distinguish between Modo-only, car2go-only, and multiple membership households.

Table 22. Household Size by Car Share Membership

Household Size	Modo Only (n=990)	car2go Only (n=1,304)	Multiple Provider (n=1,062)
1 person	28.5%	24.7%	26.1%
2 persons	40.7%	46.5%	47.6%
3 persons	14.2%	12.7%	14.9%
4 or more persons	16.6%	16.0%	11.5%
Total	**100%**	**100%**	**100%**

From an age cohort perspective, there were clear differences between Modo-only, car2go-only, and other car share households. The survey asked households the number of members in each of several age cohorts. As the table below shows, Modo appears to attract a higher proportion of households with children and adults in their middle-age years (35-54), and car2go attracts a higher proportion of younger adults (25-35 years).

Table 23. Age Cohort by Car Share Membership

	Distribution of Surveyed Household Members		
Age Cohort	**Modo Only (n=2,222)**	**car2go Only (n=2,938)**	**Other (n=2,334)**
0-15 years	16.8%	10.6%	10.9%
16-24 years	6.0%	11.5%	5.7%
25-34 years	24.1%	35.8%	36.5%
35-44 years	22.5%	18.6%	27.1%
45-54 years	16.7%	11.5%	12.0%
55-64 years	10.5%	9.2%	5.7%
65+ years	3.4%	2.8%	2.1%
Total	**100%**	**100%**	**100%**

5.4.2 Type of Car Share Membership

Personal membership to car share programs was the most common type of membership. Membership through one's employer was cited much less frequently.

Table 24. Car Share Membership Types

Type of Membership	Sole Membership	Multiple Membership	Number of Times Cited
Personal	3,085	184	3,269
Employer	98	180	278
Residential (strata or rental)	5	4	9
Don't Know	--	--	33

5.4.3 Duration of Car Share Membership

About 25 percent of households were members for under a year at the time of the survey (duration of the longest household membership). Another 35 percent were members for 1-2 years, and the remaining 39 percent were long-term members.

Table 25. Duration of Car Share Membership

Duration of Longest Membership	Responses	Distribution of Responses (%)
3 or more years	1,344	39%
1-2 years	1,200	35%
Less than 1 year	851	25%
Don't Know	10	0.3%
Total	**3,405**	**100%**

When broken out by car share provider, in this case comparing Modo-only and car2go-only households, the pattern was consistent with the tenure of the two companies in the region. Modo has been operating in the region for over a decade, hence, a majority of households were members for at least three years. In contrast, car2go began operations in 2011, therefore all households were technically members for two years at most.

Table 26. Duration of Car Share Membership (Modo Only)

Duration of Longest Membership (Modo-Only)	Responses	Distribution of Responses (%)
3 or more years	605	60%
1-2 years	206	20%
Less than 1 year	197	20%
Don't Know	1	0%
Total	**1,009**	**100%**

Table 27. Duration of Car Share Membership (car2go Only)

Duration of Longest Membership (car2go-Only)	Responses	Distribution of Responses (%)
1-2 years	767	58%
Less than 1 year	543	41%
Don't Know	7	1%
Total	**1,317**	**100%**

5.4.4 Vehicles per Household

The vehicle holdings profile for the surveyed car share households was markedly different from the regional profile derived from the 2011 TransLink Trip Diary[19]. A much greater proportion of surveyed car share households was carless, and a much smaller proportion had 2 or more vehicles.

Table 28. Vehicles Holdings

Survey	0-Vehicle Household	1-Vehicle Household	2-Vehicle Household	3-Vehicle Plus Household
2013 Metro Vancouver Car Share Household Survey	51%	37%	9%	3%
2011 TransLink Regional Trip Diary – Region	9%	41%	34%	13%
2011 TransLink Regional Trip Diary – City of Vancouver	17%	49%	22%	5%

The vehicle holdings profile for the surveyed car share household varied by housing type. Households residing in apartments and suites-in-house have nearly identical profiles: the vast majority had one or no vehicles. Households residing in single-detached houses, duplexes, and townhouses generally had one or more vehicles.

Table 29. Vehicle Holdings by Housing Type

Housing Type	0-Vehicle Household	1-Vehicle Household	2-Vehicle Household	3-Vehicle Plus Household
Apartment	63%	32%	4%	1%
Townhouse	33%	53%	12%	2%
Duplex	28%	51%	18%	3%
Single-Detached House	17%	49%	24%	10%
Suite in House	60%	33%	6%	2%

The vehicle holdings profile varied between members of different car share providers. Modo-only households had on average 0.51 vehicles. It can be surmised that these households tend to use the service as a substitute for having a private personal vehicle. Modo also offers a wider range of vehicles, such as sedans, mini-vans, sport utility vehicles, and light trucks. In contrast, car2go-only households on average had 1.01 vehicles. These households may tend to use the service as a supplement to trips that cannot be made conveniently using a private personal vehicle (e.g. travelling to and from a restaurant or bar in downtown Vancouver). Moreover, car2go vehicles can only seat two persons.

Table 30. Vehicle Holdings Prior to and After Joining Car Share

Membership	Vehicles per Household		Percent Change
	Prior to Joining Car Share	After Joining Car Share	
Modo Only	0.70	0.51	-27%
car2go Only	1.06	1.01	-5%
Modo+car2go	0.59	0.38	-36%

[19] TransLink's 2011 Regional Trip Diary surveyed about 20,000 households throughout the Lower Mainland on their travel behaviour in the preceding seven days. The results presented herein reflect residents of Metro Vancouver only. Four percent of households regionwide did not respond to the question about the number of vehicles in the trip diary (six percent in the City of Vancouver).

5.4.5 Willingness to Give Up or Postpone Getting a Vehicle

One of the impetuses for, and effects, of developing livable communities, is the ability to provide residents the opportunity to become less dependent on private personal vehicles. When car share households that had a vehicle were asked what new or improved physical amenities near their place of residence would make it possible to give up or postpone getting a vehicle, the two most frequently cited responses were: the availability of car share vehicles, and frequent and direct transit service.

The third most cited response was "None" and this is understandable because most households are satisfied with their transportation choices and see no need to make drastic changes. To encourage more households to shed vehicles and still maintain a level of mobility that is acceptable to them will likely require a combination of physical amenities, proximity to jobs, complementary external factors (e.g. transit quality, gas prices, tolls), and households that want to change (the topic of personal values and preferences is discussed in Section 5.5.3). The availability of shops and services nearby and bicycle facilities (separated bike routes and bike parking/storage) rounded out the top home-based amenities.

Table 31. Top Home-Based Amenities to Encourage Vehicle Reduction

Top Home-Based Amenities	Number of Times Cited
Availability of car share vehicles	919
Frequent and direct transit service	855
None of the listed amenities	460
Shops and services like grocery stores, daycare, restaurants	456
Bicycle routes separated from vehicle traffic	450
Bicycle parking/storage	300

The results were similar when car share households were asked about new or improved amenities near their place of work (outside of home). The two most frequently cited responses were frequent and direct transit service, and the availability of car share vehicles. The third most cited response was "None". Separated bike routes, carpooling options, and shops and services rounded the top work-based amenities.

Table 32. Top Work-Based Amenities to Encourage Vehicle Reduction

Top Work-Based Amenities	Number of Times Cited
Frequent and direct transit service	767
Availability of car share vehicles	713
None of the listed amenities	491
Bicycle routes separated from vehicle traffic	367
Availability of carpooling options	208
Shops and services like grocery stores, daycare, restaurants	168

5.4.6 Frequency of Usage

There was a fairly even distribution of surveyed households who used car share programs rarely (less than once per month), often (more than once per month), or very often (more than four times per month). A small number of respondents (68) were members but had yet to use a car share vehicle – they were excluded from subsequent analyses in this section.

When the surveyed members are segmented by vehicle ownership levels, a clear pattern of car share usage emerges. Zero-vehicle households were more inclined to use car share more than once per month. The opposite was true for households with vehicles – they were more likely to use car share only sparingly. This pattern provides evidence that for zero-vehicle households, car share offers an alternative to having a private personal vehicle.

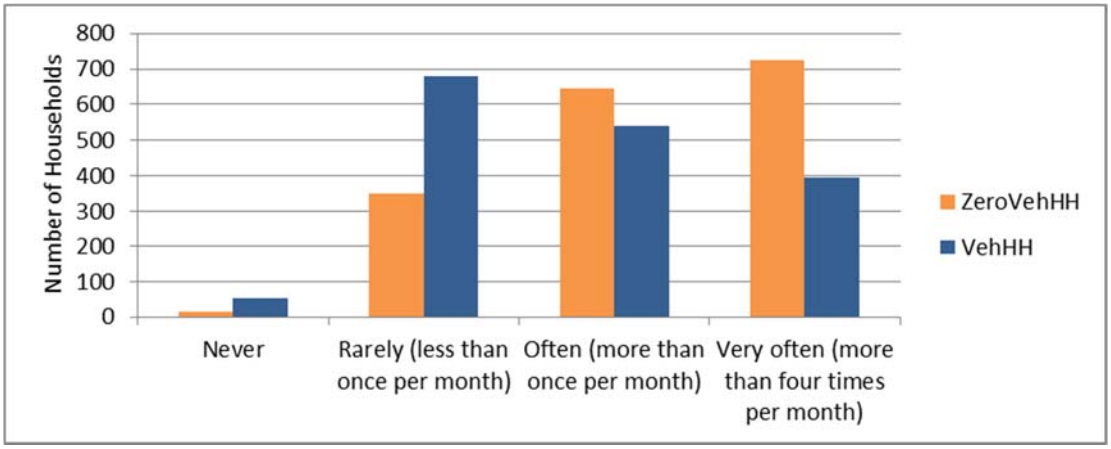

Figure 12. Frequency of Car Share Usage

5.4.7 Car Share Usage Expenses

The amount of money spent on car share per month mirrored the frequency of use for zero-vehicle households and households with vehicles. Amongst car-free households, over one-half spent greater than $50 per month on car share, compared to only one-quarter of households with vehicles.

Table 33. Car Share Usage Expenditures

Expenditures per Month	Zero-Vehicle Households (%)	Household with Vehicles (%)
$0-24	20%	49%
$25-49	23%	25%
$50-74	15%	10%
$75-99	13%	4%
$100-149	15%	4%
$150-199	6%	2%
$200+	6%	2%
Don't Know	2%	5%
Total	**100%**	**100%**

5.4.8 Top Five Car Share Trip Purposes

Car share services are used predominantly for discretionary trips, such as shopping, visiting friends and family, and going to restaurants and bars. The top five car share trips for which an active car share household are shown in the tables below, and disaggregated by car share program. Modo-only households took more recreation, vacation, and medical trips, whereas car2go-only households took more trips to restaurants and bars, and to/from work.

The differing patterns may be explained by the sharing model. One-way sharing allows users greater flexibility to go places (e.g., dinner in downtown) without having to return the vehicle by a certain time or location. Also, accessing a car2go vehicles does not require advanced booking. But one-way sharing as operated by car2go currently is constrained geographically for trip ends (the home area is primarily the City of Vancouver and parts of the North Shore). Two-way sharing services allows users to take longer trips for recreation and vacation purposes. In addition, two-way sharing, through reservation, provides assurances that the vehicle will be available for the return trip after a doctor's appointment, for example. In the future, as car sharing models evolve and expand beyond the City of Vancouver, the nature of trip purposes may also change because origins and destinations, and trip distances will be different.

Table 34. Top Five Car Share Trip Purposes

Trip Purpose	Number of Times Cited
1. Shopping	2,379
2. Visiting friends and family	1,855
3. Recreation	1,646
4. Restaurant/bar	1,377
5. To and from work	1,116

Table 35. Top Five Car Share Trip Purposes (Modo-Only Households)

Trip Purpose	Number of Times Cited
1. Shopping	756
2. Recreation	552
3. Visiting friends and family	515
4. Vacation	236
5. Medical	196

Table 36. Top Five Car Share Trip Purposes (car2go-Only Households)

Trip Purpose	Number of Times Cited
1. Restaurant/bar	774
2. Shopping	720
3. Visiting friends and family	638
4. To and from work	602
5. Recreation	461

Table 37. Top Five Car Share Trip Purposes (Joint Modo and car2go Households)

Trip Purpose	Number of Times Cited
1. Shopping	629
2. Visiting friends and family	493
3. Recreation	464
4. Restaurant/bar	319
5. To and from work	251

5.4.9 Places and Preferred Modes to Access a Car Share Vehicle

The places and preferred modes to access car share were consistent with the way car share vehicles are currently deployed in the region and the built environment of these locations. For households in Vancouver, the predominant place to access a vehicle was on a street close to home, and walking was the most cited mode of access. Locations close to work, school, or a transit station were cited less often, as were access via transit and other modes. These patterns were expected as most car share vehicles in Vancouver are located on streets or surface lots and the neighbourhoods that host car share vehicles have well-established sidewalk networks.

For households in other municipalities, car share vehicles were typically accessed on a nearby street, work/school, or a transit station. The top modes of access were equally split between walking and transit. These patterns were also consistent with the way car share vehicles are deployed in suburban locations – generally close to SkyTrain stations (connected by bus routes), apartments and townhouse developments, and major retail/commercial uses.

Table 38. Typical Places to Access a Car Share Vehicle (All Active Households)

Typical Places	Vancouver/UBC	Other Municipalities	Total
Street near home	2,623	211	2,834
Location close to work or school	952	149	1,101
Location close to transit station	515	166	681
Other building/parking facility near home	591	54	645
Location close to shopping mall	150	37	187
Within apartment/townhouse complex	102	10	112
Other	8	8	16

Table 39. Typical Modes to Access a Car Share Vehicle (All Active Households)

Typical Modes	Vancouver/UBC	Other Municipalities	Total
Walk	2,866	326	3,192
Bus	348	134	482
SkyTrain/SeaBus/West Coast Express	292	150	441
Cycle	272	33	305
Carpool	68	30	98
Drive own car or car share vehicle	27	16	43
Taxi	10	6	16
Drive a car share vehicle	10	1	11

5.4.10 The Importance of Car Share Programs

The survey posed a hypothetical question asking what households would do if all car share programs were discontinued permanently. The responses are listed in two tables to separate households with or without vehicles at the time of the survey.

Table 40. Responses to "If car share programs were discontinued permanently..." by Households with Vehicles (All Active Households)

Ranking of Responses by Households with Vehicles	Number of Times Cited
1. Drive household-owned/leased vehicles more often	1,008
2. Use transit more often	775
3. Use taxis more often	610
4. Buy or lease additional vehicle(s)	414
5. Rent a vehicle more often	326
6. Walk more often	275
7. Cycle more often	256
8. Get rides with someone else (carpool) more often	222
9. Borrow a vehicle from friend/family more often	217
10. Take fewer trips	185
11. Buy a motorcycle/scooter	80

Table 41. Responses to "If car share programs were discontinued permanently..." by Zero-Vehicle Households (All Active Households)

Ranking of Responses by Zero-Vehicle Households	Number of Times Cited
1. Use transit more	969
2. Buy or lease vehicle(s)	820
3. Rent vehicles more often	799
4. Use taxis more often	752
5. Take fewer trips	549
6. Borrow a vehicle from friend/family more often	469
7. Walk more often	422
8. Cycle more often	369
9. Get rides with someone else (carpool) more often	358
10. Drive household-owned/leased vehicle more often	181
11. Buy a motorcycle/scooter	124

The two lists are similar. TransLink, car rental agencies, taxi companies, and car dealerships would be the beneficiaries if car share programs ended. The responses suggest that as much as car share programs can, in theory, complement transit trips by providing a “first kilometre” or “last kilometre” connection to and from final destinations, they can also act as latent competitor to transit and other transportation choices.

The key differences between the two lists, other than the relative ranking of the various effects, are that households who already have vehicles would likely drive their private vehicles more often, and zero-vehicle households would be more inclined to buy/lease a vehicle, or take fewer trips. Zero-vehicle households may have initially given up a private personal vehicle or never had one. Having experienced

the benefits of mobility using a personal vehicle, it is understandable that many of these households would be inclined to buy or lease a vehicle to maintain their mobility.

If zero-vehicle households that may end up taking fewer trips, it could mean one of two things: either they are rationalizing the number of trips they make by cutting back on an excess of discretionary (non-work) trips or these households become less mobile and disadvantaged as a result of missing out on the economic and social benefits of trips not taken.

5.4.11 Reasons for Joining a Car Share Program

The survey asked households the top 3 reasons (out of 17 reasons) for choosing to join car share programs. The reasons cited for joining were consistent with expectations. The tables below compare the results for households with vehicles and without vehicles prior to joining car share programs, for different durations of membership, and for Modo-only and car2go-only households.

The following "financial" and "mobility" reasons were cited frequently (for convenience, they are highlighted in yellow in the following tables):

- cost savings compared to owning/leasing a private personal vehicle;
- a car share vehicle was available on a nearby street;
- car share provides an additional mobility choice; and,
- car share is more convenient compared to transit.

Amongst Modo-only households, the cost savings of car share over having a private personal vehicle was cited the most frequently, followed by the availability of car share vehicles on a nearby street, and the additional mobility choice. Reducing pollution and fuel consumption ("environment"), and the philosophy of sharing, were generally ranked in the middle. Longer-term Modo-only households that had vehicles prior to joining cited the environment most often than did other groups.

Amongst car2go-only households, the convenience of car share compared to transit was the most frequently cited reason. The cost savings over owning/leasing a private personal vehicle was ranked lower. The environment and philosophy of sharing were also ranked relatively lower when compared to Modo-only households.

The differences in the patterns between Modo-only and car2go-only households could suggest a generational shift in values/preferences, or simply that Modo (two-sharing) and car2go (one-way) offer two different types of services that offer different kinds of mobility benefits. Modo has larger vehicles that can be used for a wider range of trip purposes; whereas, car2go as currently implemented, allows users to enter and leave downtown Vancouver to get to restaurants and bars without the perceived inconvenience of having to depend on transit or taxis.

Moreover, for long-term Modo-only households that had vehicles prior to joining, the strong showing for the environment perhaps suggests that early adopters saw car share as being consistent with their

environmental beliefs and an opportunity to lessen their dependence on a private personal vehicle for both environmental and financial reasons. In contrast, car2go-only households with vehicles are using car share as a complement to their private personal vehicles, consistent with the relatively small change in average vehicle holdings before and after joining car share (see Section 5.4.4).

Notwithstanding the differences between Modo-only and car2go-only households, when households with memberships to both Modo and car2go were examined, the patterns that emerged were very similar to the Modo-only group.

Table 42. Most Frequently Cited Top 3 Reasons for Joining Modo (Had Private Personal Vehicle Prior to Joining, Member for 3 Years or More)

Rank	Reasons (Modo Only, 3 Years or More)	Times Cited
1	Cost savings compared to owning/leasing a vehicle	163
2	Car share vehicle located on nearby street	104
3	Additional mobility option	74
4	Reduce pollution and fuel consumption	68
5	Convenient compared to transit	59
6	Philosophy of sharing	58
7	More convenient than using owned/leased vehicle	39
8	Cost savings compared to car rentals	35
9	Personal vehicle stopped working	17
10	Better parking options	15

Table 43. Most Frequently Cited Top 3 Reasons for Joining Modo (Had Private Personal Vehicle Prior to Joining, Member for 2 Years or Less)

Rank	Reasons (Modo Only, 2 Years or Less)	Times Cited
1	Cost savings compared to owning/leasing a vehicle	88
2	Car share vehicle located on nearby street	65
3	Additional mobility option	64
4	Convenient compared to transit	41
5	Philosophy of sharing	34
6	Reduce pollution and fuel consumption	27
6 (tie)	Free or discounted membership	27
8	More convenient than using owned/leased vehicle	22
8 (tie)	Cost savings compared to car rentals	22
10	Car share vehicle located in apartment	12

Table 44. Most Frequently Cited Top 3 Reasons for Joining Modo (No Private Personal Vehicle Prior to Joining; Member for 3 Years or Longer)

Rank	Reasons (Modo Only, 3 Years or More)	Times Cited
1	Cost savings compared to owning/leasing a vehicle	125
2	Car share vehicle located on nearby street	101
3	Additional mobility option	87
4	Philosophy of sharing	63
5	Convenient compared to transit	53
6	Cost savings compared to car rentals	46
7	Reduce pollution and fuel consumption	36
8	More convenient than using owned/leased vehicle	27
9	Cost savings compared to taxis	24
10	Better parking options	15

Table 45. Most Frequently Cited Top 3 Reasons for Joining Modo (No Private Personal Vehicle Prior to Joining; Member for 2 Years or Less)

Rank	Reasons (Modo Only, 2 Years or Less)	Times Cited
1	Cost savings compared to owning/leasing a vehicle	93
2	Car share vehicle located on nearby street	68
3	Additional mobility option	66
4	Convenient compared to transit	46
5	Cost savings compared to car rentals	24
6	Car share vehicle located in apartment/townhouse	21
7	Philosophy of sharing	19
7 (tie)	Reduce pollution and fuel consumption	19
9	More convenient than using owned/leased vehicle	16
10	Free or discounted membership	12

Table 46. Most Frequently Cited Top 3 Reasons for Joining car2go (Had Private Personal Vehicle Prior to Joining, Member for 2 Years or Less)

Rank	Reasons (car2go Only, 2 Years or Less)	Times Cited
1	Convenient compared to transit	431
2	Additional mobility option	346
3	Free or discounted membership	295
4	Car share vehicle located on nearby street	269
5	Cost savings compared to taxis	227
6	Better parking options	193
7	Cost savings compared to owning/leasing a vehicle	149
8	Reduce pollution and fuel consumption	57
9	Philosophy of sharing	56
10	More convenient than using owned/leased vehicle	47

Table 47. Most Frequently Cited Top 3 Reasons for Joining car2go (No Private Personal Vehicles Prior to Joining; 2 Years or Less)

Rank	Reasons (car2go Only, 2 Years or Less)	Times Cited
1	Convenient compared to transit	132
2	Car share vehicle located on nearby street	114
3	Additional mobility option	110
4	Cost savings compared to owning/leasing a vehicle	93
5	Free or discounted membership	71
6	Cost savings compared to taxis	63
7	More convenient than using owned/leased vehicle	32
8	Better parking options	30
9	Philosophy of sharing	27
10	Reduce pollution and fuel consumption	19

5.4.12 Top Three Desired Improvements for Car Share Programs

For survey respondents who rarely used car share (less than once per month) or have yet to use the service since becoming a member, the top cited improvements were lower usage fees, having more car share vehicles near their home, and having greater flexibility in pick-up and drop-off locations. If improvements were made to these features, then these respondents would use car share more often than they currently do.

Membership fees did not appear to be a barrier to using car share vehicles. The financial threshold is fairly low to becoming a car share member. The quality of connections to car share vehicles via transit service, walking, or cycling was cited the least (it should be reminded that most of the responses came from residents of the City of Vancouver, where there exists a dense network of sidewalks, cycling lanes, and frequent transit).

Surveyed respondents also identified other ways to improve car share services that were not originally identified in the survey. These possible improvements include having more dedicated street parking for car share vehicles, expanding the service area (primarily for car2go), provision of on-board child seats, bicycle racks on the vehicles, allowing pets to be transported, and improving the cleanliness of the vehicles. Modo-only and car2go-only households cited identical prioritized lists of possible improvements.

Table 48. Top Improvements (list of options were presented for respondents to choose from)

Rank	Top Improvements as cited by inactive and infrequent users	Number of Times Cited
1	Lower Usage Fees (per hour of km)	625
2	More car share vehicles near home	550
3	Greater flexibility to pick up and drop off vehicles at different locations	463
4	Improved access to vehicles (on-street parking, signage, reservation systems)	190
5	More car share vehicles near work	176
6	More sport-utility vehicles, minivans, or pick-up trucks	149
7	More car share vehicles near transit stations	114
8	Lower membership fees	89
9	More fuel-efficient/ electric vehicles	81
10	None	77
11	Improved transit service to and from car share locations	43
12	Improve walk/cycle access to and from car share locations	31
13	Other (specified by respondent): Expand service area	23
14	Other (specified by respondent): More dedicated parking	19
15	Other (specified by respondent): Include child seats	12
16	Other (specified by respondent): Allow pets	7
17	Other (specified by respondent): Include bike racks	6
18	Other (specified by respondent): Improve cleanliness	4

5.4.13 Overall Satisfaction with Car Share Programs

Nearly 9 out of 10 households were somewhat or very satisfied with current car share programs. This level of customer satisfaction reflects in part the benefits the member households have been obtaining from the services. For members who have yet to use the service, they were the most ambivalent. For active members, overall satisfaction rose with the frequency of usage.

Table 49. Overall Satisfaction with Car Share Programs (All Active Households)

Satisfaction	Modo Only (n=988)	car2go Only (n=1,276)	Other (n=1,073)
Very satisfied	66%	47%	59%
Somewhat satisfied	28%	44%	37%
Neutral	5%	7%	2%
Somewhat dissatisfied	1%	2%	1%
Very dissatisfied	0%	0%	0%
Total	100%	100%	100%

Table 50. Overall Satisfaction by Frequency of Usage

Satisfaction	Never (n=68)	Rarely (n=1,030)	Often (n=1,186)	Very Often (n=1,121)
Very satisfied	10%	44%	59%	65%
Somewhat satisfied	19%	42%	38%	32%
Neutral	57%	10%	3%	1%
Somewhat dissatisfied	12%	3%	1%	1%
Very dissatisfied	1%	0%	0%	0%
Total	100%	100%	100%	100%

5.5 Car Share Household Survey: Changes in the Number of Vehicles and Driving

5.5.1 Household Vehicle Shedding

Among active car share members, a pattern of vehicle reduction emerges when comparing the number of household with vehicles before (12 months prior) and after joining a car share program[20]. The largest shift occurred for 1-vehicle households transitioning to become zero-vehicle households (n=323). The second largest shift occurs for 2-vehicle households becoming 1-vehicle households (n=121). From an elasticity perspective, the rate of vehicle shift was greatest amongst 2-vehicle households (139/387=36%), followed by 1-vehicle households (323/1243=26%). The majority of households retained the same number of vehicles before and after joining a car share program. Hence, the shifts in vehicle holdings were largely incremental. Households that increased the number of vehicles were primarily zero-vehicle households (n=82).

In the aggregate, the share of zero-vehicle households increased from 38% to 48%; the share of 1-vehicle households declined from 45% to 40%; the share of 2-vehicle households declined from 14% to 10%; and, the share of households with 3 or more vehicles remained nearly the same. Altogether, a net of 392 vehicles were shed out of the pool of 2,780 active car share households in the survey.

Table 51. Comparison of Household Vehicle Holdings Before and After Joining Car Share

After Joining Car Share / Before Joining Car Share	Zero Vehicle Household	1-Vehicle Household	2-Vehicle Household	3 Plus Vehicle Household	Total
Zero Vehicle Household	984	80	1	1	1,066 (38%)
1-Vehicle Household	323	905	15	0	1,243 (45%)
2-Vehicle Household	18	121	242	6	387 (14%)
3 Plus Vehicle Household	0	2	11	71	84 (3%)
Total	1,325 (48%)	1,108 (40%)	269 (10%)	78 (3%)	2,780

Table 52. Changes in Vehicle Holdings

Household Response	Before Joining Car Share: Number of Household Vehicles	After Joining Car Share: Number of Household Vehicles	Change
No change to vehicles	1,614 vehicles	1,614 vehicles	0
Decreased number of vehicles	649 vehicles	151 vehicles	-498 vehicles
Increased number of vehicles	27 vehicles	133 vehicles	+106 vehicles
Net Change	--	--	**-392 vehicles**

[20] A number of household records were excluded for the vehicle analysis because the responses to the survey questions about their vehicles and changes in number of vehicles were either inconsistent or no data was entered by the survey respondent. Additional records were subtracted if household respondents reported not having used the car share service for which they have a membership. Hence, the total number of households is 2,780.

Based on the survey responses and extrapolated to the car share population, it is estimated that up to 3 private personal vehicles have been shed by car share households for every car share vehicle (see Appendix 5 for details of the calculations).

The estimated vehicle shed rate was lower than the range estimated in the 2008 University of California, Berkeley study, which found 4 to 7 vehicles were shed per car share vehicle. One possible reason is that the Berkeley study comprises respondents from Canadian and American cities. Car share members in these other jurisdictions may have higher rates of vehicle holdings when compared to car share households in this region (predominantly residents of the City of Vancouver).

In general, it should be cautioned that these results represent the "average" outcome, as opposed to the "marginal" outcome. For example, the potential effect of introducing a car share vehicle to an area with no prior car share service may have different associated outcomes as compared to adding an additional vehicle to an area with existing car share services and established demand. And, even in areas with established services, demand may resemble a sigmoidal curve in which thresholds of supply may need to be reached to bring about incremental outcomes. It is more likely that a critical mass of vehicles is a necessary condition before measurable behaviour outcomes emerge. Further investigation is warranted to quantify the optimal range of car share vehicles with respect to utilization, cost-effectiveness, and impact on vehicle holdings in different neighbourhood contexts.

5.5.2 Household Vehicle Avoidance

In addition to the self-reported claims of reductions in vehicles before and after joining car share, another important possible effect of car share is to enable households to avoid/postpone the acquisition of a private personal vehicle. To gauge this outcome, households were asked hypothetically what they would do if car share programs were discontinued permanently. The table below presents results for those households who neither decreased nor increased the number of private personal vehicles since joining car a share program.

Table 53. Propensity to Buy or Lease an Additional Vehicle if Car Share was Discontinued Permanently

Buy/Lease Additional Vehicle	Zero Vehicle Households (n=984)	Other Households (n=1,216)	Total Households (n=2,200)
Definitely buy/lease	10.8%	9.0%	9.8%
Likely buy/lease	32.4%	22.3%	26.8%
Likely not buy/lease	19.7%	18.0%	18.8%
Definitely not buy/lease	22.6%	32.5%	28.0%
Not sure	14.5%	18.3%	16.6%
Total	**100%**	**100%**	**100%**

Overall, between 10% and 37% of these households would be inclined to acquire a vehicle. Zero-vehicle households would be more inclined to acquire a vehicle relative to households that already have a vehicle (43% to 31%). When broken down by car share provider, the propensity to buy or lease an

additional vehicle was fairly consistent between Modo/Zipcar households, Modo/Zipcar+car2go households, and car2go-only households.[21]

Table 54. Propensity to Acquire Additional Vehicle by Car Share Membership

Buy/Lease Additional Vehicle	Modo/Zipcar Households (n=574)	Modo/Zipcar+car2go Households (n=593)	car2go-only Households (n=1,033)
Definitely buy/lease	9.9%	13.0%	7.8%
Likely buy/lease	28.6%	33.2%	22.2%
Likely not buy/lease	16.9%	19.4%	19.5%
Definitely not buy/lease	28.4%	20.7%	32.0%
Not sure	16.2%	13.7%	18.5%
Total	**100%**	**100%**	**100%**

Based on the survey responses, and extrapolated to the car share population, it is estimated that each car share vehicle has allowed households to avoid acquiring between 2 and 8 private personal vehicles. When the number of vehicles shed and avoided are combined, then between 5 and 11 private personal vehicles were estimated to have been reduced for every car share vehicle (see Appendix 5 for details of the calculations). This range is in the same order of magnitude as the range estimated in the 2008 University of California, Berkeley study (9 to 13 private personal vehicles reduced per car share vehicle).

5.5.3 Additional Factors

Given the importance of understanding changes in household vehicles before and after joining car share, additional factors were examined: original motivation for joining car share, multiple memberships, membership duration, and whether a household had moved home and/or job locations after joining car share.

Motivation for Joining Car Share

As discussed earlier in Section 5.4.11, surveyed households were asked to select the top 3 reasons for joining car share. The most frequently cited "top 3" reasons were compiled. Generally, the top reasons were: cost savings compared to owning/leasing a private personal vehicle; car share was available on a nearby street; car share provides an additional choice of transportation; and car share is more convenient compared to transit.

Households that shed a vehicle or reduced the amount of driving both cited "reduce pollution and fuel consumption" (highlighted in green) and "cost savings of car share compared to owning/leasing a vehicle" (highlighted in orange) more frequently as top reasons for joining car share. The former reason is a personal belief or preference, and the latter is to some degree a circumstance of a household's economic situation (income and expenses). So, whether this combination of personal belief and household circumstance must be present in order to actualize vehicle shedding or VKT reduction illustrates the latent complexity of public policy efforts to lessen the collective dependence on private

[21] Modo/Zipcar households = Modo only, Zipcar only, and Modo+Zipcar
Modo/Zipcar+car2go = Modo+car2go, Zipcar+car2go, and Modo+Zipcar+car2go

personal vehicles. Consideration should be made to personal beliefs and recognition must be made to household wealth and financial burden when attempting to understand household behaviour.

Table 55. Households that Shed a Vehicle: Motivation for Joining Car Share

Rank	Reasons	Times Cited
1	Cost savings compared to owning/leasing a vehicle	369
2	Car share vehicle located on nearby street	222
3	Convenient compared to transit	147
4	Reduce pollution and fuel consumption	144
5	Car share is an additional mobility option	108

Table 56. Households that Did Not Shed a Vehicle: Motivation for Joining Car Share

Rank	Reasons	Times Cited
1	Convenient compared to transit	583
2	Car share is an additional mobility option	572
3	Car share vehicle located on nearby street	401
4	Free or discounted membership fee	379
5	Cost savings compared to taxis	296
6	Cost savings compared to owning/leasing a vehicle	281
…		
9	Reduce pollution and fuel consumption	103

Table 57. Households that Reduced Driving: Motivation for Joining Car Share

Rank	Reasons	Times Cited
1	Cost savings compared to owning/leasing a vehicle	328
2	Car share vehicle located on nearby street	228
3	Convenient compared to transit	223
4	Car share is an additional mobility option	177
5	Reduce pollution and fuel consumption	148

Table 58. Households that Did Not Reduce Driving: Motivation for Joining Car Share

Rank	Reasons	Times Cited
1	Car share is an additional mobility option	434
2	Convenient compared to transit	421
3	Car share vehicle located on nearby street	316
4	Free or discounted membership	286
5	Cost savings compared to owning/leasing a vehicle	229
…		
9	Reduce pollution and fuel consumption	73

Multiple Car Share Provider Memberships

A greater portion of households with memberships to two or three car share providers reported shedding private personal vehicles than did single-car share provider households. This finding suggests that some households have been able to integrate multiple car share services into their routine to the point that they could shed a private personal vehicle.

Table 59. Changes in Vehicle Holdings for Car Share Households with Personal Vehicles Prior to Joining

Change in Number of Owned/Leased Vehicles	Households with Membership in One Car Share Company (n=1,288)	Households with Membership in Two or Three Car Share Companies (n=426)
No Change	77.6%	50.7%
Decreased number of vehicles	21.1%	48.1%
Increased number of vehicles	1.2%	1.2%
Total	**100%**	**100%**
Statistical significance: A Chi-square test for independence indicated a significant association between changes in vehicles and multiple memberships.		

Duration of Membership

Amongst Modo-only households, the proportion of households that claimed a decrease in private personal vehicles rose with duration of membership. In particular, the three-year mark appeared to be a threshold in behaviour. Ideally, for research purposes, the same member households would be tracked longitudinally -- over a period of time – to ascertain precise behavioural changes.

Table 60. Changes in Vehicles for Modo-Only Households with Vehicles Prior to Joining

Change in Number of Owned/Leased Vehicles	Less than 1 Year (n=85)	1-2 Years (n=95)	3 or More Years (n=251)	Total (n=431)
No Change	67.1%	63.2%	45.4%	53.6%
Decreased number of vehicles	30.6%	34.7%	53.4%	44.8%
Increased number of vehicles	2.4%	2.1%	1.2%	1.6%
Total	**100%**	**100%**	**100%**	**100%**
Statistical significance: A Chi-square test for independence indicated a significant association between changes in vehicles and membership duration. In the test, the "No Change" and "Increased number of vehicles" categories were conflated to meet the minimum expected cell frequency criterion.				

One possible explanation for this pattern is that as the surveyed Modo households over time became more accustomed to using car share, those surveyed found themselves less dependent on their private vehicles, and therefore were willing to shed them. Another possible, and complementary, explanation could be that Modo households who joined car share three or more years ago have different values or attitudes, and may have been "predisposed" to giving up a vehicle – the availability of car share made the vehicle shedding choice feasible[22]. Perhaps these longer-term households were along the lines of the "early adopters", and were more conscientious of the environmental impacts of transportation and

[22] Also, researchers in Brisbane, Australia found that individual travel preferences is relatively more influential in transport mode choice decisions compared with built environment features. Kamrussaman, M., Baker, D., Washington, S., and Turrell, Gavin. (2013) Residential Dissonance and Mode Choice. *Journal of Transport Geography*, 33, pp. 12-28.

the philosophy of sharing. There is some evidence to support this assertion as discussed in Section 5.4.11.

Households that subscribed to car2go only were also examined. No evidence of a significant association was found between changes in vehicles and membership duration. It may simply be too early to declare no association given the short duration that car2go has been operating in the region. The evidence does suggest possible shifts in household behaviour, whether vehicle shedding or the opposite. Longer-term data will be need to be collected to confirm these patterns statistically.

Table 61. Changes in Vehicles for car2go-Only Households with Vehicles Prior to Joining

Change in Number of Owned/Leased Vehicles	Less than 1 Year (n=346)	1-2 Years (n=504)	Total (n=850)
No Change	91.6%	88.7%	89.9%
Decreased number of vehicles	7.8%	10.1%	9.2%
Increased number of vehicles	0.6%	1.2%	0.9%
Total	**100%**	**100%**	**100%**

Households that Moved Home or Work Locations

Major life events, such as a move in home or work locations, can influence decisions on whether to acquire or to shed a vehicle. Amongst households that shed a vehicle and moved after joining car share, they cited car share as the predominant contributing factor for the vehicle shedding.

Table 62. Contributing Factor for Vehicle Shedding (Households that Moved Home or Job Locations)

Factor for Shedding Private Personal Vehicles	Responses	Distribution of Responses (%)
Mostly car sharing	108	50.7%
More car sharing than the move	16	7.5%
Equally car sharing and the move	26	12.2%
More the move than car sharing	17	8.0%
Mostly the move	16	7.5%
Other factors (not solicited)	30	14.1%
Total	**213**	**100%**

Conversely, amongst households that acquired additional private personal vehicles and changed home or work locations since joining a car share program, the move was found to be the predominant contributing factor.

Table 63. Contributing Factor for Vehicle Acquisition (Households that Moved Home or Job Locations)

Factor for Shedding Private Personal Vehicles	Responses	Distribution of Responses (%)
Mostly car sharing	4	6.2%
More car sharing than the move	2	3.1%
Equally car sharing and the move	3	4.6%
More the move than car sharing	10	15.4%
Mostly the move	19	29.2%
Other factors (not solicited)	27	41.5%
Total	**65**	**100%**

Future surveys could probe further in terms of whether households moved within or between municipalities, or outside the region, and other lifestyle changes that may have spurred these mobility decisions (e.g. having children, retirement, etc.).

5.5.4 Vehicle Kilometres Travelled

As indicated above, having access to a car share vehicle can be associated with a decrease in household vehicles. What also needs to be accounted for is any association with changes in distance drive. It is the total vehicle kilometres travelled (VKT) that determines the amount of energy used for travel, emissions produced, and the general level of traffic in the region.

For all active households, the change in driving was decidedly mixed: about 30 percent of households claimed a reduction in VKT, while 21 percent reported an increase in VKT.[23]

Table 64. Changes in VKT

Change in VKT (Active Car Share Households)	Responses	Distribution of Responses (%)
Stayed about the same	1,175	35.2%
Decreased VKT	985	29.5%
Increased VKT	702	21.0%
Don't Know	475	14.2%
Total	**3,337**	**100%**

Interesting patterns emerged when the data was disaggregated by households with and without vehicles prior to joining car share and membership duration. For Modo-only households that had a vehicle prior to joining car share, there was a statistically significant association between VKT changes and membership duration. The evidence suggests longer-term households have a tendency to drive less as compared to more recent members.

Table 65. Changes in VKT for Modo-Only Households with Vehicles Prior to Joining Car Share

Change in VKT for Households with Vehicles Prior to Joining Car Share	Less than 3 Years (n=171)	3 or More Years (n=216)	Total (n=387)
Stayed about the same	50.3%	37.5%	43.2%
Decreased VKT	42.7%	55.1%	49.6%
Increased VKT	7.0%	7.4%	7.2%
Total	**100%**	**100%**	**100%**
Statistical significance: A Chi-square test for independence indicated a significant association between changes in VKT and duration of membership for households with vehicles prior to joining car share.			

Similar to the discussion about vehicle reduction, the predisposition of long-term member households to place a higher priority on the environment may explain in part the reduction in driving. An alternative

[23] The reported increase in VKT is consistent with the 2004 TCRP survey, which found 26% of respondents reporting an increase in VKT.

explanation is that the longer a household subscribes to car share, the more likely that household will begin to ration the amount of driving, and therefore reduce the overall amount of VKT.

For Modo-only households that were carless prior to joining car share, more than one-half claimed an increase in driving after joining. There was no evidence of a statistical significance association with membership duration. Even so, the data hints at a possible similar pattern in which the proportion of households claiming an increase in driving *declines* with the duration of membership. Similar to the analysis on vehicle reduction, it would be ideal to survey the same member households over a long period of time to ascertain actual behavioural changes.

Table 66. Changes in VKT for Modo-Only Households with No Vehicles Prior to Joining Car Share

Change in VKT for Households with Vehicles Prior to Joining Car Share	Less than 3 Years (n=118)	3 or More Years (n=168)	Total (n=286)
Stayed about the same	33.1%	35.1%	34.3%
Decreased VKT	5.9%	9.5%	8.0%
Increased VKT	61.0%	55.4%	57.7%
Total	**100%**	**100%**	**100%**

In the absence of VKT data and longitudinal tracking of household travel behaviour, the net traffic and environmental impacts associated with car share cannot be concluded. It should be noted that Modo has tended to replace their vehicles with new ones on a more frequent cycle – the average age of the fleet is about four years. Modo has also incorporated hybrids and electric-charge vehicles into their fleets[24]. Also, car2go vehicles are generally newer model vehicles and lighter in weight. Given that the general passenger vehicle fleet is older than the car share fleet (i.e., fuel efficiency is lower and the emissions control systems are older), each private personal vehicle taken off the road or driven less, will provide net environmental benefits. Moreover, it could be speculated that car share households on average drive fewer kilometres than do non-car share households, all else being equal. Further work is required to substantiate these assertions at regional and neighbourhood scales.

Table 67. Average Age of Passenger Vehicles (as of April 2014)

Vehicle Registration Address[25]	Mean Age of Passenger Car	Mean Age of Light Truck
Metro Vancouver	9.0 years	9.3 years
City of Vancouver	9.2 years	9.8 years

[24] Modo replaced 47 older vehicles with new vehicles in 2013 (representing a replacement rate of over 10%). In addition, 10% of the Modo fleet comprises the Toyota Prius (hybrid) and Nissan Leaf (electric charge).
[25] This refers to the vehicle registration address, which is not necessarily the same as the place of operation/storage (source: Jimmy Wong, AirCare).

6.0 Apartment Household Survey Data Analysis

Highlights of lessons learned from the survey of apartment households are described first, followed by details of the survey findings.

6.1 Apartment Household Survey: Highlights of Data Analysis

6.1.1 Apartment Household Attitudes and Behaviour

Willingness to Shed or Avoid Getting a Private Personal Vehicle: Apartment households consistently cited frequent and direct transit as the top amenity at home or at work that would enable them to give up or postpone getting a car. Interestingly, the availability of car share vehicles was the second most cited amenity.

Willingness to Join Car Share: Non-members cited the following as the top ways to encourage their participation in car share: lower membership and usage fees, more car share vehicles near home, flexibility in drop-off locations, more car share vehicles near work, and improved access to the car share vehicles (e.g., parking, signage, reservation).

Willingness to Walk to Car Share: Among non-members who had considered joining car share in the past year, they would most likely walk or take transit to access a car share vehicle. The threshold for an acceptable walking duration by a majority of households was about 8 minutes, or 600 metres.

Presence of On-Site Car Share: The availability of a car share vehicle within an apartment building is correlated with a higher rate of membership (67 percent v. 56 percent) and a higher degree of interest in joining car share amongst non-member households (38 percent v. 26 percent).

Awareness of Car Share: For non-member households residing in apartment buildings with on-site car share, about one-half (49 percent) were aware of the existence of the vehicle. In contrast, three-quarters (73 percent) of member households were aware of on-site car share. If car share vehicles were available on nearby streets (not in building), then the level of awareness was generally higher amongst both non-members and members (61 percent and 91 percent).

6.1.2 Policy Outcomes

Vehicle Holdings between Members and Non-Members: When examining vehicle holdings in Metro Core, rest of City of Vancouver, and all other municipalities in aggregate, there was a significant difference in mean vehicle holdings between member and non-member households.

Vehicles Holdings between Car Share Buildings and Other Buildings: No evidence was found for a significant difference in mean vehicle holdings between households living in buildings with on-site car share versus households in buildings without on-site car share. Given that the provision of on-site car share is still a fairly recent practice, it may be too soon to detect measurable impacts of on-site car share availability on apartment household vehicle holdings.

Availability of Car Share Vehicles: Evidence was found indicating that household vehicle holdings at the apartment building scale is a function of property assessed value, distance to the Frequent Transit Network, and the number of car share vehicles within walking distance of home, whether within an apartment site or parked on streets. It should be noted that car share availability was also found to be correlated with population density.

6.2 Apartment Household Survey: Survey Design and Conduct

The Apartment Household Survey was targeted to households residing in 110 sites. The apartment sites were selected based generally on the following criteria:

- Strata tenure, with exceptions for some rental or mixed strata/rental sites if car share vehicles were located on-site or on a nearby street;
- Within 800 metres to Modo or Zipcar car share vehicle;
- Availability of on-site car share vehicles; and,
- Constructed within the past 5-7 years.

The survey was conducted between late October and December 2, 2013. Metro Vancouver developed and administered the survey. Invitation letters to participate in the online survey were mailed to all units. Each invitation letter contained a unique access code which was required to enter into the online survey for authentication purposes. Respondents were provided an opportunity to enter into a draw to win one of two gift certifications worth $50. Two winners were randomly selected after the survey period in December. The full list of apartment sites is shown in Appendix 4.

6.3 Apartment Household Survey: Survey Responses and Demographic Profile

The survey achieved 2,054 responses (after data validation). The gross response rate was 12.8 percent based on 16,021 invitations letters originally sent out on the week of October 14. Two sets of reminder postcards were mailed on November 5 (14,232 pieces) and November 25, 2013 (9,111 pieces).

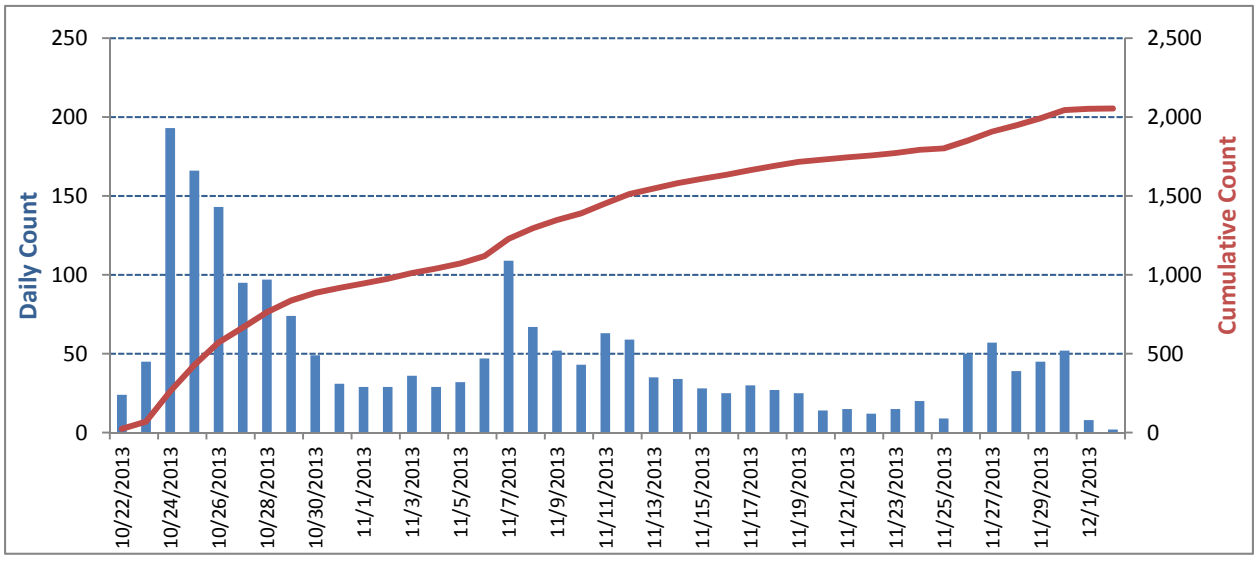

Figure 13. Daily and Cumulative Responses to the Apartment Household Survey

6.3.1 Municipal Distribution

Residents of Vancouver represented 40 percent of survey responses, with Metro Core residents representing the majority within this group. Burnaby residents made up the second largest group of respondents. New Westminster, North Vancouver City and District, Surrey, Richmond, UBC, and Coquitlam made up the remaining 36 percent of survey respondents.

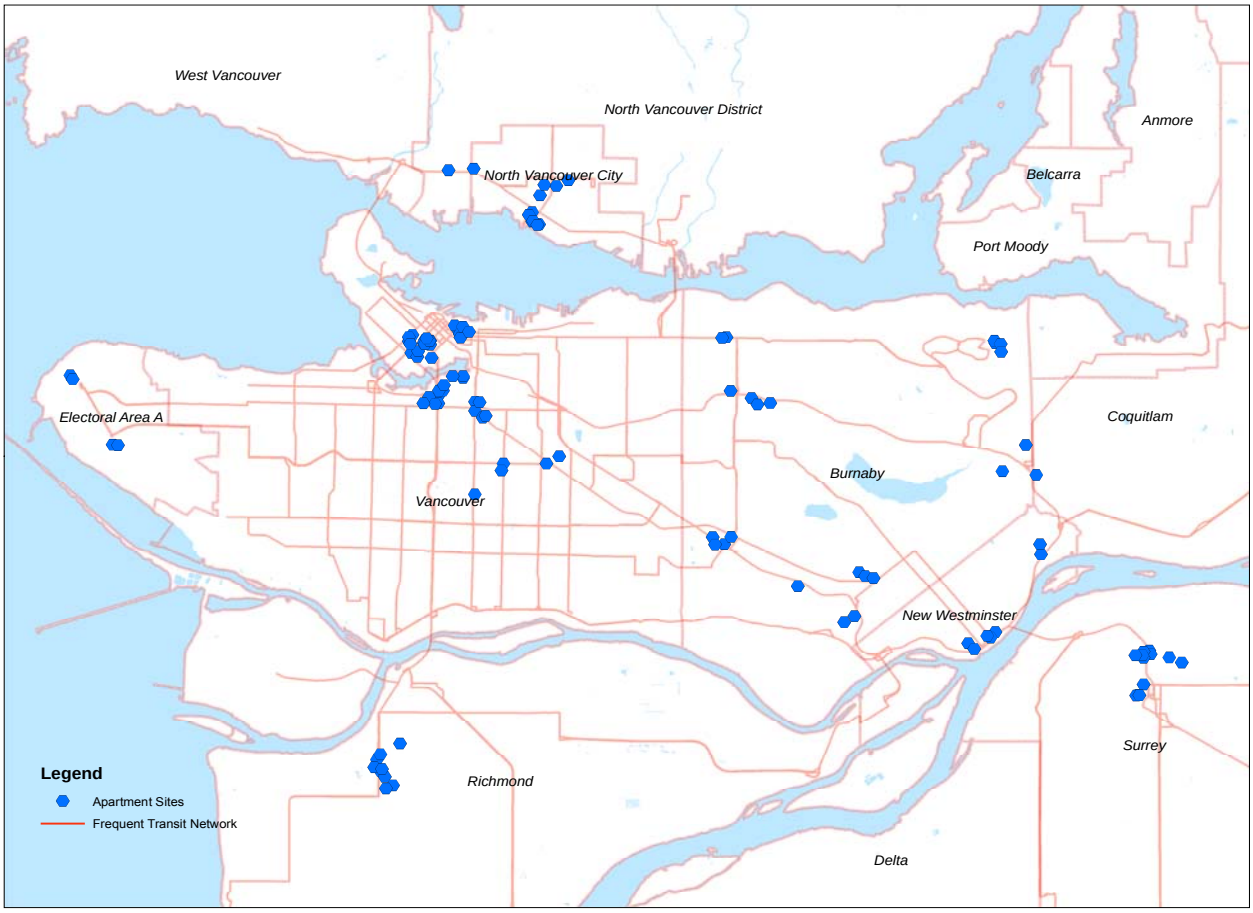

Figure 14. Distribution of Apartment Sites

Table 68. Distribution of Responses by Municipality

Municipality	Sites	Responses	Distribution of Responses
Burnaby	22	485	23.6%
Metro Core	21	479	23.4%
Vancouver (excl. Metro Core)	21	349	17.0%
New Westminster	7	206	10.0%
North Vancouver City/District	13	181	8.8%
Surrey	12	168	8.2%
Richmond	9	138	6.7%
UBC	4	30	1.5%
Coquitlam	1	18	0.9%
Total	**110**	**2,054**	**100%**

6.3.2 Building Tenure Distribution

Households in strata units represented most of the responses. The "mixed strata/rental" category comprises responses from the Woodward's site in Vancouver, which comprises a mix of strata, market rental, and subsidized housing units.

Table 69. Building Tenure Distribution

Building Tenure	Responses	Distribution of Responses (%)
Strata	1,978	96.3%
Market Rental	45	2.2%
Mixed Strata/Rental(Woodward's)	31	1.5%
Total	**2,054**	**100%**

6.3.3 Resident Tenure Distribution

Nearly two out of three respondent households owned and occupied their apartments. In comparison to the 2011 National Household Survey, of the apartments built between 2006 and 2011, 57 percent were occupied by owners and 43 percent by renters. In addition, of all apartments in the region, 44 percent were occupied by owners and 56 percent by renters. These patterns suggest an over-representation of owner-occupied households in the apartment household survey.

Table 70. Resident Tenure Distribution

Resident Tenure	Responses	Distribution of Responses (%)	Apartments Built between 2006-2011 (2011 NHS)	All Apartments (2011 NHS)
Own	1,412	68.7%	57%	44%
Rent	642	31.3%	43%	56%
Total	**2,054**	**100%**	**100%**	**100%**

For strata apartment sites only, the proportion of owner-occupiers was 70 percent.

Table 71. Resident Tenure Distribution (Strata Sites Only)

Resident Tenure	Responses	Distribution of Responses (%)
Own	1,390	70.3%
Renter	588	29.7%
Total	**1,978**	**100%**

6.3.4 Apartment Unit Type Distribution

About 9 out of 10 household respondents lived in 2-bedroom units, 1-bedroom units, or bachelor suites. This pattern reflects the current apartment housing market which favours the construction of 1 or 2-bedroom units.

Table 72. Apartment Unit Type Distribution

Unit Type	Responses	Distribution of Responses (%)
Bachelor Suite	83	4.0%
1-Bedroom Units	777	37.8%
2-Bedroom Units	1,051	51.2%
3-Bedroom Units	139	6.8%
4 Plus-Bedroom Units	4	0.2%
Total	**2,054**	**100%**

6.3.5 Household Age Distribution

Due to a technical issue with the online survey, data was not recorded for entries in the 55-64 years category.

Table 73. Household Age Distribution (note: percentages do not add to 100%)

Cohort	Number of Households with at least one member in cohort	Proportion of Total (2,054) Households (%)
0-15 years	382	19%
16-24 years	314	15%
25-34 years	1,358	66%
35-44 years	840	41%
45-54 years	481	23%
55-64 years	Data not recorded	Data not recorded
65 and older	187	9%

6.3.6 Duration of Residence

Close to two out of three owner-occupied households have been living in their current place of residence for at least the past three years. Renter-occupied households were relatively more transient – only about one out of four households have lived in their current residence at least three years. The balance of the households have been living in their current residence for two years or less.

Table 74. Duration of Residence

Duration	Owner-Occupied Households	Distribution (%)	Renter-Occupied Households	Distribution (%)
Less than 1 year	153	10.8%	234	36.4%
1 to 2 years	398	28.2%	236	36.8%
3 or more years	861	61.0%	172	26.8%
Total	**1,412**	**100%**	**642**	**100%**

6.4 Apartment Household Survey: Transportation and Car Share Profiles

6.4.1 Car Share Membership

Most respondents did not have car share memberships. For those who did, the vast majority subscribed to one car share provider only.

Table 75. Car Share Membership by Resident Tenure

Car Share Membership	Owner-Occupied Households (n=1,412)	Renter-Occupied Households (n=642)
None	78.3%	69.0%
1 car share company	17.8%	24.3%
2 car share companies	2.4%	4.4%
3 car share companies	0.2%	0.9%
Don't Know	1.3%	1.4%
Total	**100%**	**100%**

6.4.2 Vehicle Holdings (Vehicles per Household)

The vehicle profile of owner-occupied households differed from that of renter-occupied households. A higher proportion of owner-occupied households had one or more vehicles; conversely, a higher proportion of renter-occupied households were car-free. This pattern is consistent with that found in the 2012 Metro Vancouver Apartment Parking Study.

Table 76. Vehicle Holdings by Resident Tenure

Number of Vehicles	Owner-Occupied Households	Distribution (%)	Renter-Occupied Households	Distribution (%)
0	159	11.4%	151	23.7%
1	953	68.4%	385	60.3%
2	267	19.2%	94	14.7%
3	10	0.7%	7	1.1%
4	4	0.3%	1	0.2%
Total	**1,393**	**100%**	**638**	**100%**

On average, car share households had fewer vehicles than did non-car share households.

Table 77. Average Vehicle Holdings

	Not a Car Share Member (N=1,529)	Car Share Member (N=502)
Vehicles per household	1.12	0.83
Statistical significance: an independent-samples t-test found a significant difference in vehicles per household for members and non-members at the 95% confidence level		

6.4.3 Willingness to Give Up or Postpone Getting a Vehicle

The most frequently cited amenities, whether home-based or work-based, that households (excluding zero-vehicle households) said would allow them give up or postpone getting a vehicle were similar to the results from the Car Share Household Survey. For home-based amenities, frequent and direct transit service was cited the most frequently, followed by the availability of car share vehicles, and access to shops/services. For work-based amenities, frequent and direct service was also the top amenity, followed by the availability of car share vehicles and carpooling options. The results for non-members were consistent. The results confirm that for households to choose to shed one or more vehicles, mobility options that they feel could substitute for the benefit of having a private personal vehicle must be available. It should be noted that "None" was cited the most often in the aggregate, indicating that many households either see no need to reduce a private personal vehicle or that some households would like to do so but other factors are at play beyond transportation infrastructure and the built environment.

Table 78. Top Five Amenities for Encouraging Vehicle Reductions

Top 5 Home-Based Amenities	**Number of Times Cited**
Frequent and direct transit service	710
None of the listed amenities	690
Availability of car share vehicles	443
Shops and services like grocery stores, daycares, restaurants	436
Parks and recreational facilities	274
Bicycle routes separated from vehicle traffic	266
Top 5 Work-Based Amenities	**Number of Times Cited**
None of the listed amenities	762
Frequent and direct transit service	729
Availability of car share vehicles	349
Availability of carpooling options	193
Shops and services like grocery stores, daycares, restaurants	192
Bicycle parking/storage	187

6.4.4 Car Share Membership and Presence of an On-Site Vehicle

The presence of an on-site car share vehicle was generally correlated with a higher rate of membership. Four in 10 households residing in buildings with an on-site car share vehicle were members. In contrast, three in 10 households residing in buildings with no on-site car share vehicles were members.

Table 79. Awareness of On-Site Car Share

Car Share Membership	**On-site Car Share Vehicle (n=238)**	**No On-site Car Share Vehicle (n=786)**
None	55.5%	66.8%
Yes	43.3%	32.3%
Don't Know	1.3%	0.9%
Total	**100%**	**100%**
Statistical significance: A Chi-square test for independence indicated a significant association between membership and the presence of on-site car share.		

6.4.5 Past Interest in Joining a Car Share Program as a Function of Proximity

The survey asked non-households whether in the past 12 months they had considered joining a car share service. The presence of on-site car share was correlated with a higher rate of households having considered joining car share.

Table 80. Past Interest in Joining Car Share

Considered Joining Car Share	On-site Car Share Vehicle (n=132)	No On-site Car Share Vehicle (n=524)
Yes	37.9%	25.6%
No	50.0%	66.4%
Not sure	9.1%	5.3%
Inactive or cancelled	3.0%	2.7%
Total	100%	100%
Statistical significance: A Chi-square test for independence indicated a significant association between interest in joining and the presence of on-site car share.		

6.4.6 Awareness of Car Share Availability

Generally, the level of awareness of the availability of car share vehicles inside a building or on a nearby street was associated with having a membership. If a building possessed an on-site car share vehicle, then 49 percent of non-members were aware of the vehicle compared to 73 percent of members. If car share vehicles were available on nearby streets (not in building), then the level of awareness was generally higher amongst both non-members and members (61 percent and 91 percent).

Table 81. Awareness of Available On-site Car Share Vehicles

Awareness of Existing Car Share Vehicle in Building	Non-Members (n=135)	Members (n=103)
Yes	48.9%	72.8%
No	22.2%	15.5%
Don't Know	28.9%	11.7%
Total	100%	100%
Statistical significance: a Chi-square test for independence confirmed a significant association between awareness of car share in building and membership at the 95% confidence level.		

Table 82. Awareness of Available Car Share Vehicles in Neighbourhood (excludes buildings with on-site vehicles)

Awareness of Existing Car Share Vehicle in Neighbourhood	Non-Members (n=531)	Members (n=255)
Yes	61.0%	91.4%
No	5.6%	0.8%
Don't Know	33.3%	7.8%
Total	100%	100%
Statistical significance: a Chi-square test for independence confirmed a significant association between awareness of car share in neighbourhood and membership at the 95% confidence level.		

6.4.7 Encouraging Greater Car Share Participation

Encouraging more households to join car share programs will require ongoing understanding of the preferences of households who are currently not members. The table below shows the incentives that were cited most frequently by non-members as ways to encourage them to join. Lower membership and usage fees were the top two incentives. More car share vehicles near home and work were also cited frequently. Having greater flexibility in the drop off location of car share vehicles was also identified. "None" was cited the fourth most number of times – evidence of households who have no need or interest in joining car share services. Less frequently cited were improvements to walk/cycle access, transit service, and the type of vehicle.

Table 83. Top Cited Incentives to Encourage Greater Car Share Participation (Non-Members)

Incentives to Encourage Greater Car Share Participation	Number of Times Cited
Lower Membership Fees	620
Lower Usage Fees	617
More Car Share Vehicles Near Home	601
None	503
Flexibility in Drop-Off	487
More Car Share Vehicles Near Work	336
Improved access to vehicles via on-street parking, signage, reservations systems	334
More car share vehicles near transit stations	227
More fuel-efficient/electric cars	181
Move sport-utility vehicles, minivans, or pick-up trucks	139
Improved transit service to and from car share locations	135
Improved walk/cycle access to and from car share locations	71

The top preferred mode to access a car share vehicle was walking for households of Vancouver, and transit for households of other municipalities. This pattern was seen earlier in the Car Share Household Survey and reflects in part travel patterns and the built environment. Vancouver has a well-established grid network and many complete sidewalks, which make walking to car share convenient. Outside of Vancouver, where neighbourhoods are comparatively more dispersed and lower in density, transit was the most frequently cited way to access car share. As the walkability of neighbourhoods within the Urban Centres and transit station areas improve over time through new developments and higher densities, it can be expected that walk access to car share will improve.

Table 84. Preferred Mode to Access Car Share Vehicles (Non-Member Household Responses)

Preferred Mode of Transport to Access Car Share Vehicle	Households of Vancouver/UBC	Households of Other Municipalities	Number of Times Cited
Walk	321	556	877
Bus	117	390	507
SkyTrain/SeaBus/West Coast Express	105	379	484
Cycle	54	84	138
Carpool	30	98	128
Taxi	14	19	33

Among interested households, the willingness to walk to access a car share vehicle declined with distance. Relative to the minimum travel time of two minutes, 80% of respondents were willing to walk an additional three minutes (cumulative 5 minutes); 32% were willing to walk an additional 8 minutes (cumulative 10 minutes); and, finally, only 5% were willing to walk an additional 13 minutes (cumulative 15 minutes). By interpolation, the majority (50% +1) of non-members who expressed interest in joining car share have an expectation for vehicles to be available within an 8-minute walk. Interestingly, when households in Vancouver/UBC were compared to households in other municipalities, a majority of the latter were willing to walk an additional minute (cumulative 7.4 minutes v. 8.5 minutes). These hypothetical responses may overestimate actual behaviour. The limitations of sidewalks and connected local street networks in many suburban neighbourhoods would make walking long distances to access car share an inconvenience. Alternatively, residents in more suburban contexts may be more accustomed to walking further to more dispersed destinations. Future studies could examine how far members actually walk to access a car share vehicle in different neighbourhood contexts.[26]

Table 85. Willingness to Walk to Access Car Share (Non-Member Household Responses)

Willingness to Walk to Access Car Share Vehicle	Households of Vancouver/UBC (n=331)	Households of Other Municipalities (n=543)	Respondents (n=874)
2 minutes	100%	100%	100%
+ 3 minutes (cumulative 5 minutes)	74%	84%	80%
+ 8 minutes (cumulative 10 minutes)	27%	36%	32%
+ 13 minutes (cumulative 15 minutes)	5%	7%	6%

6.4.8 Vehicle Holdings between Member and Non-Member Households

Vehicle holdings for members and non-members were compared within specific geographies. Generally, car share households had fewer vehicles on average than did non-member households, which is consistent with the 2012 study.

Table 86. Comparison of Vehicle Holdings between Member and Non-Households in Various Geographies

Geography	Member	Non-Member	Statistically Significant Difference[27]
Metro Core Only	0.55 (n=162)	0.87 (n=281)	Significant difference
Vancouver/UBC, excluding Metro Core	0.90 (n=134)	1.22 (n=196)	Significant difference
Other Municipalities	1.05 (n=170)	1.17 (n=1,012)	Significant difference

[26] For example, a common conjecture of transit planners is that people are willing to walk up to 800 metres to access a rapid transit station, versus 400 metres to a bus stop that is not associated with a rapid transit station.
[27] Independent-samples t-tests were conducted. The differences were statistically significant at the 95% confidence interval. The magnitude of the difference in the means was moderate for all three geographies tested.

6.4.9 Vehicle Holdings and On-Site Car Share

Amongst member households only, there was mixed evidence of significant differences in vehicle holdings between residents of apartments with on-site car share and residents in apartments without on-site car share. In Vancouver/UBC, a statistically significant but small difference was found. Elsewhere in other municipalities in aggregate, no evidence was found of a significant difference in vehicle holdings. Given that the provision of on-site car share is still a fairly recent practice, it may be too soon to detect consistent measurements of the potential effects of on-site car share availability on household vehicle holdings.

Table 87. Comparison of Vehicle Holdings Among Member Households with or without On-Site Car Share

Geography	Presence of On-Site Car Share	No On-Site Car Share	Statistical Difference[28]
Vancouver/UBC	0.51 (n=70)	0.77 (n=226)	Significant difference
Other Municipalities	1.02 (n=61)	1.06 (n=109)	No significant difference

6.4.10 Building-Level Analysis

Multivariate regression analysis was conducted to better understand the relative unique and joint contributions that different attributes of the built environment and household characteristics may have on vehicle holdings in apartments. The dependent variable was vehicles per household (or vehicles per apartment unit). The independent variables included spatial characteristics of the built environment and household attributes, such as the number of workers or children in the household. The table below summarizes the independent variables that were found to be statistically significant in various regression models. The signs (+/-) were in the expected directions. It should be noted that the number of buildings in these regressions was small, and this may affect the robustness of the results.

Table 88. Independent Variables Found to be Statistically Significant in Regression Analyses

Independent Variable	Description	Source
ASSESSMENT	Average 2013 property assessment value per apartment unit	BC Assessment Authority
LGFTNSTN	Logarithm of the straight line distance to the nearest SkyTrain or SeaBus station	GIS analysis
LGFTNBUS	Logarithm of the straight line distance to the nearest Frequent Transit Network bus stop	GIS analysis
CS400	Number of fixed-location car share vehicles within 400m of apartment site (including on-site vehicles)[29]	GIS analysis
CS800	Number of fixed-location car share vehicles within 800m of apartment site (including on-site vehicles)	GIS analysis
POP800	Estimated 2011 population within 800m of home of apartment site	2011 Census and GIS

[28] Independent-samples t-tests were conducted.

[29] Because car2go vehicles do not have a fixed location per se, a nearest distance variable was not ascribed to car2go vehicles. Instead, a binary variable indicating whether an apartment was inside the car2go home area was constructed. However, this variable was not a significant predictor of vehicle holdings.

Apartment sites were selected for inclusion in the regression analysis based on either the apartment response rate (20 percent or higher) or the number of responses per building (20 or more). About one-half of the sites were in Vancouver, and the remainder in Burnaby, New Westminster, North Vancouver City, Richmond, and Surrey.

Table 89. Location of Selected Apartment Sites for Regression Analysis

Geography	Apartment Sites with no On-Site Car Share	Apartment Sites with On-Site Car Share	Total
Burnaby	6	4	10
New Westminster	5	0	5
North Vancouver City	5	0	5
Richmond	2	0	2
Surrey	2	1	3
Vancouver	10	2	12
Metro Core	8	4	12
Total	38	11	49

The regression analysis provide evidence that property assessment value, proximity to transit, and the number of nearby car share vehicles can be significant predictors of apartment vehicle holdings[30,31]. Population density, which was highly correlated with car share availability, was also found to be a significant explanatory variable (since there was a high degree of multicollinearity between these two variables, only one variable could be entered into the regression at a time). Model 1 was a moderately strong model with an adjusted R^2 value of 0.714. Model 2 was a stronger model statistically, but the constant was not significant at the 95 percent confidence level.

Table 90. Regression Analysis Results

	Model 1	Model 2	Model 3	Model 4
Constant	0.387**	0.216	0.274	0.359*
ASSESSMENT	0.000000543**	-	0.000000528**	0.000000572**
BEDROOMS	-	0.194**	-	-
LGFTNBUS	0.133**	0.131**	0.159**	0.127*
LGFTNSTN	0.115**	0.142**	0.137**	0.169**
CS800	-0.00702**	-0.005**	-	-
CS400	-	-	-0.018**	-
POP800	-	-	-	-0.0000109**
N	49	49	49	49
R^2	0.738	0.757	0.667	0.628
Adjusted R^2	0.714	0.735	0.637	0.594
** Significant at the 0.01 level ($p \leq 0.01$)				
* Significant at the 0.05 level ($p \leq 0.05$)				

[30] Property assessment value is a proxy for household wealth, which is also a proxy for vehicle ownership.
[31] Heteroskedasticity was tested on Model 1 using the Breusch-Pagan/Cook-Weisberg test and White test. No significant evidence for heteroskedasticity was found using these tests (see Appendix 6 for details).

The regression analysis points to the availability of car share vehicles nearby (whether on-street or off-street) as a determinant of vehicle holdings. No evidence was found for a significant contribution by either the presence of on-site car share or the number of on-site car share vehicles on apartment vehicle holdings. One possible explanation is that the number of recently-constructed apartment buildings with on-site car share is still quite limited. The limited sampling may not have revealed any significant relationship. On-site car share availability is just now becoming more popular with developers and municipalities, so it may take a period of several years of sustained car share presence and utilization before measurable effects on vehicle holdings become statistically significant.[32]

It should be noted that population density also has an effect, which suggests that other attributes of the built environment, beyond car share, may have an equivalent or stronger effect on vehicle holdings. For example, the literature suggests land use mixes and transit/auto access to employment are significant predictors of auto ownership[33]. POP800 confirmed this relationship with vehicle holdings. From a theoretical standpoint, density is a broad-brushed characterization of the concentration of people and activity within a geographic area. Density is typically associated with other attributes of the built environment, such as the availability of grocery stores, medical services, schools, and so forth. To the extent that density may be a significant predictor, it is the underlying built environment characteristics that are driving the transportation behaviour or outcomes. And one of these built environment attributes is the number of car share vehicles within walking distance from home.

Moreover, the regression analysis does not preclude other built environment attributes from having a predictive effect on vehicle holdings – in fact, Model 1 suggests as much since it only explained 71 percent of the variation in vehicle holdings. The key takeaway message is that evidence was found that the concentration of car share vehicles may have a small, but significant, contributory effect on the vehicle holdings of apartment households.

6.4.11 Application of Regression Model for Sketch Planning

A common application of multiple regression equations is for prediction and sketch planning purposes. The predictive qualities of any model are only as good as the underlying data and specification, and the inputs should only be within the range of the variables that were used to construct the model. Model 1 was applied to sketch out the parking implications of varying the availability of car share vehicles near an apartment building.

[32] One of the first apartment developments in the region to incorporate on-site car share in lieu of some assigned parking stalls was the Electric Avenue project (2006) in Metro Core.

[33] IBI Group. (2000). *Greenhouse Gas Emissions from Urban Travel: Tool for Evaluating Neighbourhood Sustainability*. Healthy Housing and Communities Series (p. 74). Report prepared for the Canada Mortgage and Housing Corporation.

Table 91. Descriptive Statistics for the Independent Variables in Model 1

Variable	Minimum	Maximum	Mean
Average unit value (2013)	$220,000	$700,000	$440,000
Distance to FTN bus	10 metres	520 metres	120 metres
Distance to FTN station	20 metres	1,840 metres	600 metres
Number of car share vehicles within 800m	1 vehicles	71 vehicles	19 vehicles
Vehicles per household	0.39	1.50	1.05

Table 92. Sketch Planning: New Strata Apartment Development in a Transit-Oriented Location

Variable	Scenario 1: Limited Car Share Availability	Scenario 2: Moderate Car Share Availability	Scenario 3: High Car Share Availability
Number of apartment units	150 units	150 units	150 units
Average apartment unit value	$400,000	$400,000	$400,000
Distance to FTN bus	150 metres	150 metres	150 metres
Distance to FTN station	500 metres	500 metres	500 metres
Number of car share vehicles within 800m	5 vehicles	20 vehicles	40 vehicles
Model 1 Prediction: Potential parking demand	***1.17 vehphh or 175 vehicles***	***1.06 vehphh or 160 vehicles***	***0.92 vehphh or 139 vehicles***
Minimum parking supply required (1.3 residential stall/unit + 0.1 visitor stall/unit)	195+15 stalls		
Potential oversupply of residential parking	19 stalls	35 stalls	56 stalls
Number of redundant below-grade parking levels (assume 53 stalls in each of 4 levels; rounded down to nearest 0.5 stall)	0 level	0.5 level	1.0 level
Construction cost savings[34] (assume $35,000 per parking stall; excludes cost of providing a car share vehicle and stall)	$0	$900,000	$1,900,000
Equivalent cost savings per apartment unit	$0	$6,000	$12,000

This exercise offers several lessons. First, notwithstanding the availability of car share vehicles, the sheer proximity of an apartment site close to the Frequent Transit Network alone implies that vehicle holdings would be lower than the base minimum parking requirements set out in some municipal parking bylaws. The evidence furnished by this study and the 2012 study can help municipalities to examine opportunities to reduce or maintain reduced parking requirements near the Frequent Transit Network[35].

[34] In key informant interviews conducted for the *2012 Metro Vancouver Apartment Parking Study*, developers cited a range of $20,000 to $45,000 for the average construction cost per structured parking stall. The precise cost depends on site conditions and whether the parkade will be above grade or below grade.

[35] For example, Richmond has an apartment minimum residential parking requirement of 1.5 stalls per unit; and Burnaby has a minimum rate of 1.1 stalls per unit (after density bonusing). New Westminster has a minimum parking rate that varies by the number of bedrooms (1.0 stall per bachelor suite, 1.2 stalls per one-bedroom unit, 1.4 stalls per two-bedroom unit, and 1.5 per three plus-bedroom unit). Visitor parking rates in these municipalities are either 0.1 visitor stall per unit or 0.2 visitor stall per unit.

Second, the provision of structured parking is lumpy. For below grade parkades, it may be possible to have a partial floorplate of parking. For above grade structured parkades, changes typically only occur on a full floorplate. In order for construction savings to materialize, the parking reduction from the base requirement must be sufficiently large to meet these practical thresholds.

Third, the scenarios only isolated the effects of car share while holding other parameters constant. For example, some municipalities allow for reductions in minimum parking requirements for apartments developments in transit-oriented locations with or without voluntary contributions from the developer, such as the provision of on-site car share vehicles, or non-market rental units. Additional parking reductions may be possible once these other policies are layered together.

Fourth, the scenarios likely underestimate the vehicle reduction potential of car share. Model 1 does not account for car2go vehicles – the car share variable in the model was based on the availability of Modo and Zipcar vehicles only.

Finally, the high availability of car share in Scenario 3 is unlikely to materialize in the near term in many suburban areas unless incentives are provided to procure the vehicles and to mitigate the revenue risks. Car share providers take on the risk of underutilized car share vehicles. The long-term availability of the vehicles is also important. If car share providers can change fleet locations frequently, then households cannot count on these services reliably. The challenge is that without a level of surety and a critical mass of car share vehicles in these emerging growth areas, viable demand may not materialize, and neither will the full effect on apartment vehicle holdings.

7.0 Summary

7.1 Car Share and Regional Interests

The illustration below captures the "big picture" of how the regional interests – land use, transportation, affordability, and environment – are intrinsically connected. The research literature has consistently found a statistical relationship between land use/transportation attributes and vehicle ownership, and between land use/transportation attributes and vehicle kilometres travelled[36]. Household attributes also play an important and determinant role in transportation behaviour. VKT is itself a function of vehicle ownership. The amount of vehicular emissions generated is a function of VKT.

The current study has added evidence that the availability of car share vehicles could have an explanatory role in vehicle ownership. There is, however, incomplete evidence of whether it induces a net increase or decrease in VKT.

In turn, the fixed and operating costs of owning a vehicle determines how much households pay for private transportation. When combined with public transportation and housing payments, a more fulsome picture is drawn of the financial burden faced by households.

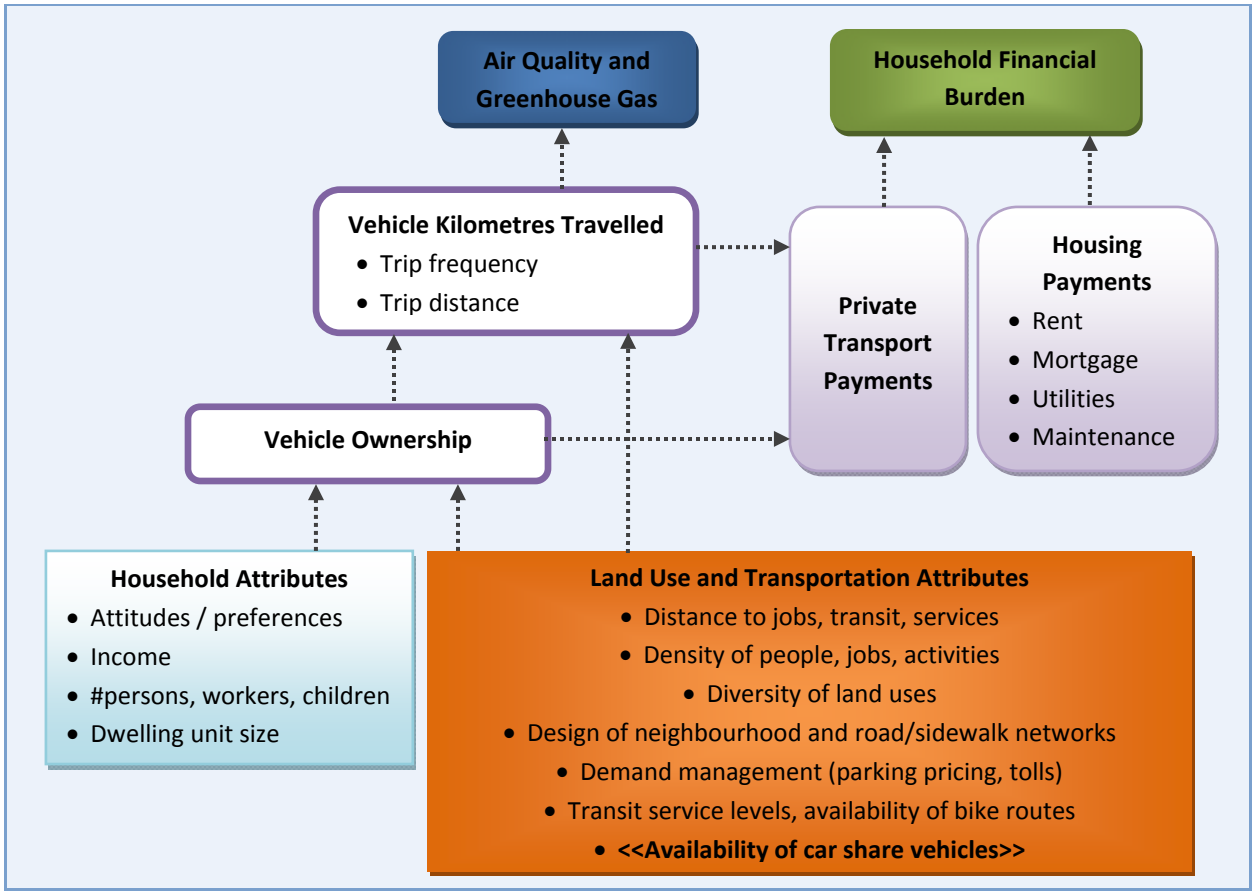

Figure 15. A Simplified Framework for Situating Car Share among Regional Interests

[36] Litman, T. (2014). "Land Use Impacts on Transport: How Land Use Patterns Affect Travel Behaviour". Available at: http://www.vtpi.org/tdm/tdm20.htm#_Toc119886788

7.2 Car Share and the Land Use/Transportation Interest

It should come as no surprise that the vast majority of car share vehicles are located in Metro Core and the surrounding urban neighbourhoods. These areas have the highest densities in the region. These are places where car share members can easily walk to access the vehicles, and where a critical mass of potential customers is situated. The mix of land uses provides a more diverse customer base to encourage car share use throughout the day. The Frequent Transit Network is densest in this part of the region. The combination of frequent and dense transit, and availability of car share can allow households to go without a private personal vehicle. The density of businesses also support corporate memberships.

The recent expansion of car share into the North Shore, Richmond, and Surrey is an acknowledgement by car share providers that new markets are being created through the redevelopment and intensification of land uses in Urban Centres and Frequent Transit Development Areas. These are the strategic growth areas promoted in *Metro 2040* that could accommodate upwards of three-quarters of all residential growth in the next three decades. In the suburban context, these are the areas that are most likely to share some of the key determinants of car share success that is experienced in Vancouver – namely, density of residents, proximity to frequent transit, mix of land uses, and restraints on parking.

Unlike the inner urban areas in the City of Vancouver, many of these emerging Urban Centres and Frequent Transit Development Areas lack the fine grid network of local streets and sidewalks that would encourage walking. It is the role of municipalities, with funding support from TransLink and other financiers, to develop robust walking networks within these growth areas, and, in particular, between the neighbourhoods and the transit system.

7.2.1 Apartment Parking Supply

The majority of new residential developments in the region are apartments and townhouses[37]. Given the cost of excavation or building an at-grade parkade in high-valued or dense locations in Urban Centres and Frequent Transit Development Areas, developers are looking for opportunities to rationalize the amount of parking required. Conversely, municipalities and neighbourhood residents are justifiably conscientious of any developments that may introduce more traffic and parked cars on local streets and concerned with any proposals that may have parking reduced from base bylaw levels. The provision of a critical mass of car share vehicles could play a long-term role in managing the growth in private personal vehicles in these new neighbourhoods.

Four municipalities in the region (Coquitlam, Richmond, New Westminster, and Vancouver) currently have parking substitution provisions for car share vehicles in apartment developments in their bylaws. Variances can also occur through project-specific negotiations. It is the role of municipalities to determine the appropriate substitution ratios as guided by past projects, current trends, and acceptability. It should be cautioned that parking supply should first be rationalized relative to current demand, in particular for sites close to the Frequent Transit Network in Urban Centres and Frequent

[37] Of the average 16,300 housing starts per year between 2007 and 2011 in the region, 59 percent were apartments, 18 percent townhouse/rowhouse/semi-detached, and 23 percent single-detached houses.

Transit Development Areas.[38] Further incremental variances could be considered based on the availability of nearby car share vehicles, including any on-site car share vehicles.

7.2.2 Unbundling Parking from Apartment Units

One alternative to using car share as a tool for negotiating variances to parking supply is to link the provision of car share with "parking unbundling". The 2012 Metro Vancouver study identified "parking unbundling", whereby the parking stall is unbundled from the purchase price or rental price of an apartment unit, as a possible standalone measure to reduce parking requirements and improve housing affordability. The provision of one or more car share vehicles on-site may provide synergistic effects on private vehicle ownership and VKT.

A 2011 study from San Francisco found that when on-site car share was coupled with parking unbundling, there was a significant difference in car share membership, vehicle holdings, and drive-alone mode shares as compared to a control group with neither of these two features.[39] The findings pointed to a synergy: people who choose to purchase or rent a unit without an assigned parking stall were more likely to use car share, in addition to transit.

From the car share provider's perspective, this arrangement establishes early and potentially sustained demand for the on-site car share and improves the financial viability of maintaining one or more car share vehicles on-site. Typically, the developer purchases a car share vehicle, which is maintained by a car share company through an initial three-year agreement with the strata council. If the car share vehicle is not financially viable, and the initial agreement is not renewed, then the car share vehicle could be reassigned to a different location[40]. For households that had relied on car share, adjustments to household routines would have to be made. Households with no cars may have to acquire one, and if there is insufficient parking with the building, then the demand for street parking will naturally increase.

7.2.3 Access to Car Share

Visibility and ease of physical access to car share vehicles are important to create awareness and convenience. Any barriers to visibility and physical access may artificially constrain the pool of potential members who are seeking to join car share or to use car share vehicles. This is why car share providers generally prefer to park their vehicles on surface lots or on the street.

Municipalities can encourage car share expansion and use through modifications to street parking regulations and signage. In some neighbourhoods, it could be anticipated that it will be challenging to

[38] The 2012 Metro Vancouver Apartment Parking Study found parking supply exceeded observed demand by 18-35 percent.

[39] ter Schure, J., Napolitan, F., and Hutchinson, R. (2011). Cumulative Impacts of Carsharing and Unbundled Parking on Vehicle Ownership and Mode Choice. *Transportation Research Record*, 2319/2012, 96-104.

[40] Based on Modo's experience, a handful of agreements did fail and they were made before 2009. These agreements were struck during a time in which Modo, developers, and municipalities were experimenting with having car share vehicles on site.

convince residents of the merits of reserving spaces for car share vehicles only or allowing car share vehicles to be parked in residents only or residential-permit street areas [41].

Municipalities and TransLink can seek opportunities to expand the availability of reserved parking spaces near transit stations and stops in urban and suburban locations. Possible locations may include the rapid transit stations and other locations along the Frequent Transit Network[42].

7.3 Car Share and the Affordability Interest

The regional interest in affordability is rooted in the desire for people to have access to housing choices and transportation choices that they want and can afford in order to live and work in the region. A prosperous region needs an adequate supply of housing to meet current and future demands, a housing stock that has a mix of housing types and tenures that can accommodate the full range of household incomes and needs, and transportation choices so that owning a car is not the only way to get to work, school, or other activities.

Car share confers affordability benefits to member households directly and potentially to residents of apartment sites with on-site car share and reduced parking. The first set of affordability benefits is achieved when private personal vehicles are shed and payments for fixed costs (insurance, maintenance, depreciation, and financing expense) and variable costs (gasoline and maintenance) are eliminated. Carless households also avoid having to make payments to buy or lease a car. The cost of using car share is the fee charged on an hourly and/or per kilometres basis by the car share provider.

The table below shows the financial trade-off: a household with a private vehicle must pay for the relatively high fixed costs whether the vehicle is used or not. Alternatively, a carless household pays only when a car share vehicle is used.

Table 93. Illustrative Comparison of Costs[43,44]

	Owning a Car	Modo	Zipcar	car2go
Fixed costs per day	$17.00	$0.00	$0.00	$0.00
Variable costs per day[45]	$1.40	$7.90	$12.40	$7.90
Total	**$18.40**	**$7.90**	**$12.40**	**$7.90**

[41] In fall 2012, Metro Vancouver surveyed a set of apartment sites and nearby streets for the parking demand and supply. The study findings will be finalized in late 2014.
[42] TransLink currently does not have a policy for allocating spaces for car share providers on its properties.
[43] Fixed costs based on 2013 Canadian Automobile Association figures for a 2013 Honda Civic LX accumulating 12,000km. Variable costs are also based on national figures for a 2013 Honda Civic LX, with adjustments for higher gasoline prices in Metro Vancouver, and assuming the same VKT as accumulated by Modo and Zipcar in this example (see next footnote).
[44] Modo and Zipcar usage calculations assume 15 km per roundtrip, 2 hours per roundtrip, and 4 roundtrips per week. Calculations for car2go assume 4 one-way trips per week and 0.5 hour per one-way trip.
[45] Unit variable costs based on "The Co-op Membership Plan" by Modo, "The Monthly Driving Plan" by Zipcar, and standard rates set by car2go. Applicable monthly administrative fees are included in calculations. One-time registration fees have been excluded from calculations.

The second set of affordability benefits is associated with any developer savings in construction costs from not having to build the full required number of apartment residential parking stalls. The average cost of a below-grade parkade can be as high as $45,000 per stall.

In order for these savings to affect affordability, the cost savings must be returned to consumers in the form of price or rent reductions, or to municipalities for reinvestment in expanded mobility options or housing affordability initiatives in the immediate neighbourhood or broader community. One possibility is for the developer to fund the provision of on-site car share vehicles, discounted or free car share memberships to all new residents of the apartment site for the duration of the car share and strata agreement (typically three years), or to fund any revenue shortfall. These actions may help to establish and sustain the demand for the on-site car share and allow households to choose to shed private personal vehicles.

7.4 Car Share and the Air Emissions Interest

The regional interest in air quality and greenhouse gas mitigation is grounded in provincial statutes and current practice. Metro Vancouver has delegated authority from the Province to manage air quality in the region. Metro Vancouver has also been at the forefront of climate mitigation efforts, such as the promotion of electric vehicles and development of carbon credit protocols.

The study does not provide sufficient evidence to determine whether car share yields a net emissions reduction or increase. A high proportion of households with vehicles prior to joining car share drive less now, and on average 5-11 private vehicles have been removed for every car share vehicle. If those kilometres being replaced were previously driven on older polluting vehicles, then there is a net environmental benefit, all else being equal. However, households that were carless prior to joining car share drive more now. So, whether the net change in vehicle kilometres travelled is positive or negative will require trip diary surveys for confirmation, including the make, model, and year of the car share vehicles and private vehicles, and whether the shed vehicle is still in the active fleet.

7.5 Considerations for Regional Growth Management and Community Planning

There is great interest throughout the region to see car share expand and provide additional transportation choices for residents. The popularity of car share has grown and car share vehicles have become fixtures in many neighbourhoods. While car share is not the remedy for all of the region's transportation problems, it can confer benefits in certain contexts and with appropriate public policy and private industry support. Some of the strategic and operational considerations around the role of car sharing in regional growth management and community planning are described below.

Strategic Considerations

1. **Complexity of Household Decisions:** Transportation demand management measures have long been identified as ways to reduce auto dependence. These measures, whether investments in transportation services or infrastructure, implicitly assume households will respond accordingly and change travel behaviour. This study presents additional evidence to support these ongoing policy efforts.

According to the study findings, households that shed a vehicle or reduced the amount of driving both cited "reduce pollution and fuel consumption" and "cost savings of car share compared to owning/leasing a vehicle" more frequently as top reasons for joining car share. The former reason is a personal belief or preference, and the latter is to some degree a circumstance of a household's economic situation (income and expenses). So, whether or not this combination of personal belief and household circumstance must be present in order to actualize vehicle shedding or VKT reduction illustrates the latent complexity of public policy efforts to lessen our collective dependence on private personal vehicles. It also remains to be determined whether such personal beliefs change with duration of car share membership and different household stages; and the role, if any, that car share may play in reinforcing or changing these and other personal beliefs.

The implication is that it may be difficult to project out or extrapolate the transportation choices and behaviour of future car share households without first having a better understanding of the role that personal beliefs, in conjunction with other household circumstances, play in travel behaviour. What this study shows is that consideration should be made to personal beliefs and recognition must be made to household financial burden, in addition to aspects of the built environment and transportation services and infrastructure.

2. **Relationship with Transit:** The relationship that car share has with transit deserves further investigation. The study findings suggests that car share could in certain cases be an alternative to taking transit. When households were asked what they would do if car share programs were discontinued permanently, one of the most frequently cited response was "use transit more".

   The study findings also point to car share as an additional mobility choice. The most commonly cited trips made with car share were discretionary, non-work trips. These trips are generally the most difficult to serve by transit in a cost-effective manner given the wide distribution of activity destinations throughout the region and travel demand throughout the day. The majority of transit trips (61%) today serve work or post-secondary purpose. In contrast, the majority of auto trips (68%) serve non-work purposes. Also, trips that require carrying heavy or large items, such as groceries, furniture, building supplies, limit the utility of transit. Further investigation is warranted on how people use car share to connect to the transit system, or how car share is used to connect transit to first or final destinations (the "first kilometre" or "last kilometre" link). This research would be timely as car share expands into transit station areas in the more suburban parts of the region.

3. **Suburban Expansion:** The near term potential utilization and benefits of car share in lower density areas are unlikely to approach the levels seen in higher density urban areas today. In suburban areas, walkability and the abundance of transit remain short of the levels seen in the Metro Core (downtown Vancouver, including Central Broadway) and its adjoining neighbourhoods. For these reasons, the redevelopment and intensification of established frequent transit corridors and new rapid transit station areas in suburban municipalities represent some of the best opportunities to

create the built environment conditions for car share to thrive as a complement to transit, walking, cycling, and carpooling. Developers can play a role in supporting the marketing of car share vehicles, whether those vehicles are on-site or on nearby streets, in the first few years to improve utilization and affect travel behaviour.

4. **Affordability:** Car share confers affordability benefits to member households directly and potentially to residents of apartment sites with on-site car share and reduced parking. The first set of affordability benefits is achieved when private personal vehicles are shed and payments for fixed costs (insurance, depreciation, and financing expense) and variable costs (gasoline and maintenance) are eliminated. Carless households also avoid having to make payments to buy or lease a car. The cost of using car share is the fee charged per kilometre or per unit of time by the car share provider, plus one-time registration fees.

   The second set of affordability benefits, associated with any developer savings in construction costs from not having to build the full complement of apartment residential parking stalls, is only achieved if the cost savings are returned to consumers in the form of price or rent reductions, or to municipalities for reinvestment in expanded mobility options or housing affordability initiatives in the immediate neighbourhood or broader community. One possibility is for the developer to fund the provision of on-site car share vehicles, or discounted car share memberships to all new residents of the apartment site for the duration of the car share and strata agreement (typically three years), or to fund any revenue shortfall. These actions may help to establish and sustain the demand for the on-site car share and encourage vehicle reductions. Further investigation may be warranted to confirm whether reduced parking, whether related to on-site car share provision or not, has improved affordability in market-based apartment developments.

5. **Better Information to Manage Uncertainty and Risk:** Car sharing is a relatively young and dynamic industry. A great deal about car sharing and transportation decisions remains to be unveiled. For example, the introduction of one-way sharing in the region has complemented the established two-way sharing services. Further investigation is warranted on the longer term correlations between these two different sharing models with household decisions on trip purposes, vehicle shedding and avoidance, and changes in VKT.

   Rapid advancements in technology can abruptly make current models of practice obsolete, and bring forth new or adapted models. The next stage of car sharing may be peer-to-peer sharing, whereby an individual owner makes his or her vehicle available for others to rent for short periods of time. In this dynamic environment, where private enterprises are competing to service the travel demand of residents and workers, new players may enter the market, while others may exit. The car share industry in a few years' time could look either very similar or vastly different than today, both in terms of business models and number of competitors.

   Where car share vehicles are now located in neighbourhoods and apartment buildings in transit-oriented locations, ensuring that these vehicles and any additional vehicles remain stable over a

long period of time is important. If the car share market becomes unstable and service types change or service levels are reduced, then the gains in mobility, affordability, and environment performance may regress. Car share providers, developers, and municipalities should jointly contemplate these risks and appropriate risk mitigation measures.

These discussions can be informed by third party assessments of car share household travel patterns, preferably surveying the same households and/or neighbourhoods over a number of years. In addition, methods to forecast car share utilization and feasibility should be developed and shared amongst local governments, just like acceptable methods have been established to forecast local and regional demand for driving, carpooling, and transit. Metro Vancouver could help facilitate these dialogues and/or provide updated data as appropriate.

Operational Considerations

6. **Parking Allocation and Fees:** As car share expands across the region, municipalities and TransLink will establish related policies, regulations, and fee structures to manage car share and the demand for scarce parking spaces. To a large degree, it comes down to managing the supply of parking – a scarce good – from competing demands by multiple car share providers and other users (e.g., resident and visitor vehicles, taxi vehicles, loading trucks, etc.) through parking allocation and fees. Some considerations are:

   Allocation of Reserved/Designated Parking Spaces on Public Right-of-Way:

   For public on-street or off-street (e.g. municipal-owned parkades) parking, municipalities should consider:

   - whether the number of reserved/designated spaces will be capped per neighbourhood or citywide when allocating/converting these spaces for car share vehicles;
   - whether to allocate reserved/designated spaces for some or all car share providers, or allocate spaces on a first come-first serve basis; and,
   - whether to allow car share vehicles to be exempted from parking restrictions in locations with residents-only signage or other restrictions.

   In existing and new rapid transit station areas or park-and-ride lots owned or managed by TransLink, TransLink may wish to make similar judgments on the allocation of car share vehicles and providers. If so, consideration should be made, in conjunction with municipalities, to incorporate parking capacity for car share vehicles at these public transit sites at the facility design stage.

   Fees:

   Municipalities and TransLink can consider levying fees on car share providers for the right to use reserved/designated spaces on public streets and parkades based on:

   - a cost recovery model (e.g., lost meter revenue and expenses related to the installation and maintenance of signage and street markings);

- an incentives-based model whereby fees are set below regulated rates subject to performance conditions such as duration of operation and number of vehicles assigned to the neighbourhood or municipality;
- a revenue-maximizing model; or
- reduced or waived fees, and no performance conditions.

Municipalities and TransLink should also consider whether cooperative/non-profit and for-profit car share providers should be treated the same or differently in terms of parking space allocation and fees. Municipalities and TransLink can consider levying fees on car share providers for the right to use reserved/designated spaces on public streets and parkades based on a cost recovery model or reduced/waived fees.

Ultimately, the relative benefits and costs of aiding a private service provider, whether for profit or non-profit, based on assumed and demonstrated community benefits (social, economic, and environmental) must be weighed against the equitable and efficient management of public assets (street spaces and public lots).

7. **Access:** The successful utilization of car share is in part dependent on good visibility and ease of access to the vehicles. Many car share households cited the availability of a car share vehicle on a nearby street as a reason for joining a program. Car share providers prefer to have their vehicles located on streets or on private or public surface lots. However, whether in Vancouver or other municipalities in the region, the demand for street parking spaces can be high. In some cases, it will be a challenge to convince local residents of the merits of reserving street parking spaces for car share vehicles only or allowing car share vehicles to be parked in 'residents parking only' or 'resident permit parking' street areas. Also, neighbourhoods near major destinations (e.g., hospitals, fairgrounds, and sporting venues) may experience significantly higher flows of general traffic and car share vehicles entering than are leaving the neighbourhoods.

   The provision of car share vehicles within new or existing apartment sites (on a surface lot or in a parkade) may be the most acceptable way to introduce car share into a neighbourhood, but limited visibility and barriers to access may adversely affect recruitment and utilization rates, and long-term financial sustainability. These issues could potentially be addressed and resolved by the involvement of car share providers early on during the development design stage of new apartment projects.

8. **Apartment Parking Reductions:** Decisions to reduce minimum parking requirements for new apartment developments in return for the provision of one of more car share vehicles and dedicated car share parking stalls should ideally be made based on a consideration of two factors. First, parking supply should be rationalized relative to current demand, in particular for sites close to the Frequent Transit Network. Second, the potential vehicle reduction effect within a building must account for both the on-site car share vehicle and the availability of nearby car share vehicles, whether in other apartment sites or on nearby streets. In the absence of considering these two

factors fully, parking reductions granted to developers may not truly reflect the anticipated demand for parking. Hence, parking may still be oversupplied, or parking may be undersupplied.

Municipalities may stipulate that developers provide more than one new car share vehicle, one to be placed on-site, and a second or third vehicle to be made available on nearby streets in order to qualify for parking reductions. Alternatively, rather than use car share as a tool for negotiating variances to parking supply, municipalities could add car share to the list of potential "amenities" required in new apartment developments. Another possibility is to link the provision of car share with "parking unbundling", whereby a prospective apartment customer is provided the option to buy or rent an apartment unit without a parking stall (and the option to have a stall for an extra fee).

APPENDIX 1: References and Resources

CBC News. (20141). Gas Prices at 5-year Low and Dropping. *CBC News.* Retrieved from http://www.cbc.ca/news/business/gas-prices-at-5-year-low-and-dropping-1.2799300

City CarShare. (2012). Getting more with less: Managing Residential Parking in Urban Developments with Carsharing and Unbundling – Best Practices. City CarShare. Retrieved from https://www.citycarshare.org/wp-content/uploads/2012/06/CITY-CARSHARE-best-practices-010212_lowres.pdf

Crawford, T. (2014). Gas Prices in Vancouver Hit Record High. *The Vancouver Sun*. Retrieved from *http://www.vancouversun.com/news/metro/Vancouver+hits+record+high/9959000/story.html*

Engel-Yan, J., and Passmore, D. (2013). Carsharing and Car Ownership at the Building Scale, *Journal of the American Planning Association*, 79:1, 82-91.

IBI Group. (2009). *Parking Standards Review: Examination of Potential Options and Impacts of Car Share Programs on Parking Standards*. City of Toronto, Ontario.

IBI Group. (2000). *Greenhouse Gas Emissions from Urban Travel: Tool for Evaluating Neighbourhood Sustainability*. Healthy Housing and Communities Series (p. 74). Report prepared for the Canada Mortgage and Housing Corporation and Natural Resources Canada.

Kamrussaman, M., Baker, D., Washington, S., and Turrell, Gavin. (2013) Residential Dissonance and Mode Choice. *Journal of Transport Geography*, 33, pp. 12-28.

Litman, T. (2014). "Land Use Impacts on Transport: How Land Use Patterns Affect Travel Behaviour". Retrieved from *http://www.vtpi.org/tdm/tdm20.htm#_Toc119886788*

Martin, E., and Shaheen, S.A. (2011). Greenhouse Gas Emissions Impacts of Carsharing in North America. *IEEE Transactions on Intelligent Transportation Systems*, December 2011.

Martin, E., Shaheen, S.A., and Lidicker, J. (2010). Impact of Carsharing on Household Vehicle Holdings: Results from a North American Shared-Use Vehicle Survey. *Transportation Research Record*, 2143/2010, 150-158.

McIntyre, D.A. (2014). Gas Prices Slide Lower, Threat of $4 Disappears. *Yahoo! Finance*. Retrieved from *http://finance.yahoo.com/news/gas-prices-slide-lower-threat-104038881.html*

Metro Vancouver. (2012). *The Metro Vancouver Apartment Parking Study Technical Report*. Burnaby, British Columbia. Available at *www.metrovancouver.org* (search for 'apartment parking study')

Millard-Ball, A., Murray, G., ter Schure, J., Fox, C., and Burkhardt, J. (2005). *Carsharing: Where and How It Succeeds* (Transit Cooperative Research Report 108). Washington, DC: Transportation Research Board of the National Academies.

Nagel, J. (2014). Gas Prices to Approach $1.50 Record in Metro Vancouver. *Surrey North Delta Leader*. Retrieved from *http://www.surreyleader.com/news/253407021.html*

Rodier, C. (2009). A Review of the International Modeling Literature: Transit, Land Use, and Auto Pricing Strategies to Reduce Vehicle Miles Traveled and Greenhouse Gas Emissions. Prepared for the California Air Resources Board and the California Department of Transportation.

Shaheen, S.A., Cohen, A., and Chung, M. (2009). North American Carsharing: 10-Year Retrospective. *Transportation Research Record*, 2110, 35-44.

Shaheen, S.A., and Cohen, A. (2014). Innovative Mobility Carsharing Outlook: Carsharing Market Overview, Analysis, and Trends, Summer 2014. Transportation Sustainability Research Center – University of California, Berkeley. Retrieved from *http://tsrc.berkeley.edu/sites/tsrc.berkeley.edu/files/Summer%202014%20Outlook.pdf*

Shaheen, S.A., and Cohen, A. (2013). Innovative Mobility Carsharing Outlook: Carsharing Market Overview, Analysis, and Trends, Summer 2013. Transportation Sustainability Research Center – University of California, Berkeley. Retrieved from *http://tsrc.berkeley.edu/node/629*

Shaheen, S.A., Rodier, C., Murray, G., Cohen, A., and Martin, Elliot. (2010). Carsharing and Public Parking Policies: Assessing Benefits, Costs, and Best Practices in North America. Mineta Transportation Institute, San Jose State University.

ter Schure, J., Napolitan, F., and Hutchinson, R. (2011). Cumulative Impacts of Carsharing and Unbundled Parking on Vehicle Ownership and Mode Choice. *Transportation Research Record*, 2319/2012, 96-104.

TransLink. (2013). 2011 Metro Vancouver Regional Trip Diary Survey – Analysis Report. Retrieved from: http://www.translink.ca/~/media/Documents/customer_info/translink_listens/customer_surveys/trip_diaries/2011%20Metro%20Vancouver%20Regional%20Trip%20Diary%20%20Analysis%20Report.ashx

APPENDIX 2: Car Share Household Survey

Car Share Household Survey

Metro Vancouver (the Greater Vancouver Regional District) is conducting a study about car share program usage and the effects on household vehicle ownership and parking demand. As a member of a car share program, your household has been included in this important survey. The survey results will be summarized in a study by Metro Vancouver to provide valuable information to municipalities, developers, and car share organizations on the appropriate levels of car share vehicles and parking supply for new residential developments.

We appreciate your participation in this survey, and all responses will be kept confidential. If your household received the same survey from multiple sources, please complete only one. Responses should reflect the entire household. Thank you.

Upon completing the survey, you will have the option to enter your contact information for a chance to win 1 of 2 prize bundles (approximate value of $50 each).

☐ Prize Bundle 1: Milestones restaurant gift card

☐ Prize Bundle 2: Cineplex movie theatre gift card

Notes:

a. *It is normal to see some skipped questions due to the survey logic. Please proceed to respond to the remaining survey questions.*
b. *Metro Vancouver is conducting a separate survey of apartment residents only. If you received an invitation for that survey, please also complete that survey for your household.*
c. *Input contained in this survey may be compiled with other public responses and included in a report to the Metro Vancouver Board of Directors. Such reports are available to the public. All submissions will be treated with confidentiality by Metro Vancouver staff and contractors; however, information may be publicly available if a Freedom of Information request is made under the Freedom of Information and Protection of Privacy Act.*
d. *If you have any questions about the survey, please contact Eric Aderneck, Senior Regional Planner, at eric.aderneck@metrovancouver.org or by phone at 778-452-2626*

To ensure an accurate survey assessment, please enter your home municipality and the first three digits of your home postal code.

Postal Code _____

Municipality_____

1. What type of dwelling unit does your household live in? (select only one) *A household refers to a person or a group of persons who occupy a private dwelling unit.*

- ☐ Apartment (strata/condo or rental)
- ☐ Townhouse
- ☐ Single-detached house
- ☐ Duplex
- ☐ Suite in house
- ☐ Laneway house
- ☐ Other (please specify_____)

2. How many bedrooms are in your dwelling unit? (select only one)

- ☐ 0 bedroom (bachelor suite)
- ☐ 1 bedroom
- ☐ 2 bedrooms
- ☐ 3 bedrooms
- ☐ 4+ bedrooms

Car Share Household Survey

3. Does your household own or rent this dwelling unit? (select only one)

- ☐ Own
- ☐ Rent

4. How long has your household lived in this dwelling unit? (select only one)

- ☐ Less than 1 year
- ☐ 1 to 2 years
- ☐ 3 years or more

5. How many people in your household, including yourself, are in the following age groups?

- ☐ ___ 0-15 years old
- ☐ ___ 16-24 years old
- ☐ ___ 25-34 years old
- ☐ ___ 35-44 years old
- ☐ ___ 45-54 years old
- ☐ ___ 55-64 years old
- ☐ ___ 65+ years old

6. How many people in your household, including yourself, are employed full-time or part-time? (select only one)

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

7. Of the employed people in your household, how many usually work outside of home? (select only one)

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

8. How many vehicles does your household own or lease (select only one)? *Please include all insured personal or corporate cars, vans or light trucks that are brought home and parked overnight, but not motorcycles, scooters, bicycles, or car share vehicles.*

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

9. Where does your household typically park the vehicle(s) overnight?

- ☐ ___ in the building parkade (e.g. on-site parkade or surface parking lot)
- ☐ ___ on a nearby street
- ☐ ___ in a nearby parking facility (e.g. parkade or surface parking lot)
- ☐ ___ elsewhere

10. How many assigned parking spaces does your household have in the building complex, and how are they charged to your household? (select all that apply)

- ☐ ___ parking spaces are included in the home purchase price / rent
- ☐ ___ parking spaces are rented separately
- ☐ ___ parking spaces are purchased separately

11. What new or improved amenities near your HOME would make it possible for your household to give up a privately-owned/leased vehicle or postpone getting one? (select all that apply)

- ☐ Bicycle parking / storage
- ☐ Bicycle routes separated from vehicle traffic
- ☐ Wide and connected sidewalks
- ☐ Shops and services like grocery stores, daycare, restaurants
- ☐ Parks and recreational facilities
- ☐ Availability of car share vehicles
- ☐ Availability of carpooling options
- ☐ Frequent and direct transit service
- ☐ Other (please specify_____)
- ☐ None (please explain_____)

Car Share Household Survey

12. What new or improved amenities near your WORK would make it possible for your household to give up a privately-owned/leased vehicle or postpone getting one? (select all that apply)

- ☐ Bicycle parking / storage
- ☐ Bicycle routes separated from vehicle traffic
- ☐ Wide and connected sidewalks
- ☐ Shops and services like grocery stores, daycare, restaurants
- ☐ Parks and recreational facilities
- ☐ Availability of car share vehicles
- ☐ Availability of carpooling options
- ☐ Frequent and direct transit service
- ☐ Other (please specify_____)
- ☐ None (please explain_____)

13. Does your household belong to the any of the following car share programs?

- ☐ Modo
- ☐ Zipcar
- ☐ car2go
- ☐ None
- ☐ Other (please specify_____)

14. How long has your household been a member of a car share program (for the person with the longest membership)? (select only one)

- ☐ Less than 1 year
- ☐ 1-2 years
- ☐ 3 or more years
- ☐ Don't know

15. What type of car share membership does your household have? (select all that apply)

- ☐ Personal
- ☐ Residential building (strata/condo or rental)
- ☐ Employer
- ☐ Don't know

16. How often does your household use a car share vehicle? (select only one)

- ☐ Very often (more than four times per month)
- ☐ Often (more than once per month)
- ☐ Rarely (less than once per month)
- ☐ Never

17. Excluding the membership fee, approximately how much in car share fees does your household typically spend per month? (select only one)

- ☐ $0-24
- ☐ $25-49
- ☐ $50-74
- ☐ $75-99
- ☐ $100-149
- ☐ $150-199
- ☐ $200+
- ☐ Don't know

18. Where does your household typically access a car share vehicle? (select all that apply)

- ☐ Within apartment/townhouse complex
- ☐ Street near home
- ☐ Other building/parking facility near home
- ☐ Location close to work or school
- ☐ Location close to shopping mall
- ☐ Location close to transit station
- ☐ Other (please specify_____)

19. How does your household typically travel to access a car share vehicle? (select all that apply)

- ☐ Walk
- ☐ Cycle
- ☐ Bus
- ☐ SkyTrain / SeaBus
- ☐ West Coast Express
- ☐ Get a ride with someone else (carpool)
- ☐ Taxi
- ☐ Other (please specify_____)

Car Share Household Survey

20. What are the top 5 trips for which your household use car share vehicles? (select up to 5)

- ☐ Travelling to work
- ☐ Travelling to school
- ☐ Shopping and errands
- ☐ Visiting friends / family
- ☐ Going to a restaurant or bar
- ☐ Medical appointments
- ☐ Recreational activities
- ☐ Vacation trips
- ☐ Other (please specify_____)

21. Compared to the 12 months BEFORE joining a car share program, has your household's TOTAL NUMBER OF OWNED/LEASED VEHICLES changed? (select only one) *Please include all insured personal or corporate cars, vans or light trucks that are brought home and parked overnight, but not motorcycles, scooters, bicycles, or car share vehicles.*

- ☐ Decreased by ___ vehicles
- ☐ No change
- ☐ Increased by ___ vehicles

22. Compared to the 12 months BEFORE joining a car share program, has your household's TOTAL KILOMETRES driven per year (car share and personal vehicles) changed? (select only one)

- ☐ Increased by___kilometres
- ☐ Stayed about the same
- ☐ Decreased by___kilometres
- ☐ Don't know

23. Has your household moved homes or work locations since joining a car share program? (select only one)

- ☐ No
- ☐ Yes, our household changed home locations
- ☐ Yes, our household changed work locations
- ☐ Yes, our household changed both home and work locations

24. What would you say has contributed more to your household's change in the NUMBER OF VEHICLES: the move (of home or work) OR the availability of car sharing? (select only one)

- ☐ Mostly car sharing
- ☐ More car sharing than the move
- ☐ Equally car sharing and the move
- ☐ More the move than car sharing
- ☐ Mostly the move

25. What would you say has contributed more to your household's overall change in KILOMETRES DRIVEN: the move (of home or work) OR the availability of car sharing? (select only one)

- ☐ Mostly car sharing
- ☐ More car sharing than the move
- ☐ Equally car sharing and the move
- ☐ More the move than car sharing
- ☐ Mostly the move

26. If car share programs were discontinued permanently, would your household: (select up to 5)

- ☐ Take fewer trips
- ☐ Drive household-owned/leased vehicle more often
- ☐ Use transit more often
- ☐ Get rides with someone else (carpool) more often
- ☐ Use taxis more often
- ☐ Walk more often
- ☐ Cycle more often
- ☐ Borrow a vehicle from friend / family more often
- ☐ Rent a vehicle more often
- ☐ Buy/lease a vehicle
- ☐ Buy a motorcycle/scooter

27. If car share programs were discontinued permanently, would your household: (select only one)

- ☐ Definitely buy/lease ___ vehicles
- ☐ Likely buy/lease ___ vehicles
- ☐ Maybe buy/lease ___ vehicles
- ☐ Likely not buy/lease any vehicles
- ☐ Definitely not buy/lease any vehicles

Car Share Household Survey

28. What are the top 3 reasons your household joined a car share program? (select up to 3)

- ☐ Free or discounted membership
- ☐ Car share vehicle is conveniently located in our apartment/townhouse complex
- ☐ Car share vehicle is conveniently located on a street near home
- ☐ Additional mobility option
- ☐ Convenient compared to transit
- ☐ Convenient compared to walking
- ☐ Convenient compared to cycling
- ☐ Convenient compared to getting a ride with someone else (carpooling)
- ☐ Convenient compared to private vehicle ownership and use
- ☐ Cost savings compared to owning/leasing a car
- ☐ Household-owned vehicle stopped working
- ☐ Cost savings compared to car rental
- ☐ Cost savings compared to using taxis
- ☐ Reduce pollution and fuel consumption
- ☐ Free or better parking options
- ☐ The philosophy of sharing
- ☐ Other (please specify_____)

29. What are the top 3 improvements to car share programs that would encourage your household to use car share vehicles more often? (select up to 3)

- ☐ More car share vehicles near home
- ☐ More car share vehicles near work
- ☐ More car share vehicles near transit stations
- ☐ More sport-utility vehicles, minivans, or pick-up trucks
- ☐ More fuel-efficient/electric vehicles
- ☐ Lower membership fees
- ☐ Lower usage fees (by hour or km)
- ☐ Improved access to vehicles (on-street parking, signage, reservation systems)
- ☐ Greater flexibility to pick up and drop off vehicles at different locations
- ☐ Improved walk/cycle access to and from car share locations
- ☐ Improved transit service to and from car share locations
- ☐ Other (please specify_____)
- ☐ None

30. What is your household's overall level of satisfaction with car share programs?

- ☐ Very satisfied
- ☐ Somewhat satisfied
- ☐ Neutral
- ☐ Somewhat dissatisfied
- ☐ Very dissatisfied

31. How would you describe the quality of transit near your home? (select only one)

- ☐ Very good
- ☐ Good
- ☐ Neutral
- ☐ Poor
- ☐ Very poor

32. Any additional comments...

_____

_____

APPENDIX 3: Apartment Household Survey

Apartment Household Survey

Metro Vancouver (the Greater Vancouver Regional District) is conducting a study about parking demand and car share usage. Both car share members and non-members are being surveyed. The survey results will be summarized in a study by Metro Vancouver to provide valuable information to municipalities, developers, and car share organizations on the appropriate levels of car share vehicles and parking supply for new apartment developments.

We appreciate your participation in this survey, and all responses will be kept confidential. Please complete this survey even if you are NOT a car share member. Upon completing the survey, you will have the option to enter your contact information for a chance to win 1 of 2 prize bundles (approximate value of $50 each).

☐ Prize Bundle 1: Milestones restaurant gift card

☐ Prize Bundle 2: Cineplex movie theatre gift card

Notes:

a. *Car sharing generally refers to membership-based services that offer qualified members access to a network of shared vehicles 24-hours, 7 days a week at unattended self-service locations. Modo, Zipcar, and Car2go are examples of car share providers in Metro Vancouver.*
b. *It is normal to see some skipped questions due to the survey logic. Please proceed to respond to the remaining survey questions.*
c. *Metro Vancouver is conducting a separate survey of car share members only. If you received an invitation for that survey, please also complete that survey for your household.*
d. *Input contained in this survey may be compiled with other public responses and included in a report to the Metro Vancouver Board of Directors. Such reports are available to the public. All submissions will be treated with confidentiality by Metro Vancouver staff and contractors; however, information may be publicly available if a Freedom of Information request is made under the Freedom of Information and Protection of Privacy Act.*
e. *If you have any questions about the survey, please contact Eric Aderneck, Senior Regional Planner, at eric.aderneck@metrovancouver.org or by phone at 778-452-2626.*

1. How many bedrooms are in your apartment/townhouse unit? (select only one)

- ☐ 0 bedroom (bachelor suite)
- ☐ 1 bedroom
- ☐ 2 bedrooms
- ☐ 3 bedrooms
- ☐ 4+ bedrooms

2. Does your household own or rent this apartment/townhouse unit? (select only one)

- ☐ Own
- ☐ Rent

3. How long has your household lived in this apartment/townhouse unit? (select only one)

- ☐ Less than 1 year
- ☐ 1 to 2 years
- ☐ 3 years or more

4. How many people in your household, including yourself, are in the following age groups?

- ☐ ___ 0-15 years old
- ☐ ___ 16-24 years old
- ☐ ___ 25-34 years old
- ☐ ___ 35-44 years old
- ☐ ___ 45-54 years old
- ☐ ___ 55-64 years old
- ☐ ___ 65+ years old

Apartment Household Survey

5. How many people in your household, including yourself, are employed full-time or part-time? (select only one)

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

6. Of the employed people in your household, how many usually work outside of home? (select only one)

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

7. How many vehicles does your household own or lease (select only one)? *Please include all insured personal or corporate cars, vans or light trucks that are brought home and parked overnight, but not motorcycles, scooters, bicycles, or car share vehicles.*

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

8. Where does your household typically park the vehicle(s) overnight?

- ☐ ___ in the building parkade (e.g. on-site parkade or surface parking lot)
- ☐ ___ on a nearby street
- ☐ ___ in a nearby parking facility (e.g. parkade or surface parking lot)
- ☐ ___ elsewhere

9. How many assigned parking spaces does your household have in the building complex, and how are they charged to your household?

- ☐ ___ parking spaces are included in the home purchase price / rent
- ☐ ___ parking spaces are rented separately
- ☐ ___ parking spaces are purchased separately

10. What new or improved amenities near your HOME would make it possible for your household to give up a privately-owned/leased vehicle or postpone getting one? (select all that apply)

- ☐ Bicycle parking / storage
- ☐ Bicycle routes separated from vehicle traffic
- ☐ Wide and connected sidewalks
- ☐ Shops and services like grocery stores, daycare, restaurants
- ☐ Parks and recreational facilities
- ☐ Availability of car share vehicles
- ☐ Availability of carpooling options
- ☐ Frequent and direct transit service
- ☐ Other (please specify_____)
- ☐ None (please explain_____)

11. What new or improved amenities near your WORK would make it possible for your household to give up a privately-owned/leased vehicle or postpone getting one? (select all that apply)

- ☐ Bicycle parking / storage
- ☐ Bicycle routes separated from vehicle traffic
- ☐ Wide and connected sidewalks
- ☐ Shops and services like grocery stores, daycare, restaurants
- ☐ Parks and recreational facilities Availability of car share vehicles
- ☐ Availability of carpooling options
- ☐ Frequent and direct transit service
- ☐ Other (please specify_____)
- ☐ None (please explain_____)

12. Are there any car share vehicles within your apartment site?

- ☐ Yes
- ☐ No
- ☐ Don't Know

Apartment Household Survey

13. Are there any car share vehicles in your neighbourhood?

- ☐ Yes
- ☐ No
- ☐ Don't Know

14. Does your household belong to the any of the following car share programs (select all that apply)

- ☐ Modo
- ☐ Zipcar
- ☐ car2go
- ☐ None
- ☐ Other

15. Prior to receiving this survey, did your household consider joining a car share program in the past 12 months? (select only one)

- ☐ Yes
- ☐ No
- ☐ Inactive member or cancelled membership (please explain_____)
- ☐ Not sure

16. What would encourage your household to join a car share program? (select up to 5)

- ☐ More car share vehicles near home
- ☐ More car share vehicles near work
- ☐ More car share vehicles near transit stations
- ☐ More sport-utility vehicles, minivans, or pick-up trucks
- ☐ More fuel-efficient/electric vehicles
- ☐ Lower membership fees
- ☐ Lower usage fees (by hour or km)
- ☐ Improved access to vehicles (on-street parking, signage, reservation systems)
- ☐ Greater flexibility to pick up and drop off vehicles at different locations
- ☐ Improved walk/cycle access to and from car share locations
- ☐ Improved transit service to and from car share locations
- ☐ Other (please specify_____)
- ☐ None

17. If your household were to consider joining a car share program, which of the following modes would your household be willing to use to access a car share vehicle from home? (select all that apply)

- ☐ Walk
- ☐ Cycle
- ☐ Bus
- ☐ SkyTrain / SeaBus
- ☐ West Coast Express
- ☐ Get a ride with someone else (carpool)
- ☐ Taxi
- ☐ Other (please specify_____)

18. How long would you be willing to walk to access a car share vehicle from? (select only one)

- ☐ Up to 2 minutes
- ☐ Up to 5 minutes
- ☐ Up to 10 minutes
- ☐ Other (please specify_____)

19. How would you describe the quality of transit near your home? (select only one)

- ☐ Very good
- ☐ Good
- ☐ Neutral
- ☐ Poor
- ☐ Very poor

20. Any additional comments...

_____

_____

APPENDIX 4: Apartment Household Survey Sites

Name	Municipality	Units	Tenure
Altaire	Burnaby	73	Strata
Arcadia West	Burnaby	178	Strata
Aurora	Burnaby	103	Strata
Burnaby Green	Burnaby	325	Strata
Cortina	Burnaby	81	Strata
Crystal Residences	Burnaby	214	Strata
Emerson	Burnaby	200	Strata
Esprit	Burnaby	171	Strata
Jewel	Burnaby	130	Strata
MacPherson Walk	Burnaby	484	Strata
Memento	Burnaby	87	Strata
Motif at Citi	Burnaby	153	Strata
One University Crescent	Burnaby	103	Strata
Patterson Park	Burnaby	29	Strata
Perspectives	Burnaby	215	Strata
Presidia	Burnaby	160	Strata
Sandlewood	Burnaby	136	Strata
Silhouette	Burnaby	504	Strata
The Union	Burnaby	53	Strata
Tramonto	Burnaby	42	Strata
Verdant	Burnaby	61	Strata
Watercolours	Burnaby	174	Strata
Encore	Coquitlam	157	Strata
Anvil	New Westminster	101	Strata
Azure at Plaza 88	New Westminster	408	Strata
Carnarvon Towers	New Westminster	150	Strata
Copperstone	New Westminster	231	Strata
Quantum	New Westminster	119	Strata
The Point	New Westminster	146	Strata
The Royalton	New Westminster	75	Strata
Atrium at the Pier	North Vancouver City	163	Strata
Avondale	North Vancouver City	59	Strata
Esplanade West	North Vancouver City	92	Strata
Mira in the Park	North Vancouver City	77	Strata
Pinnacle Residences	North Vancouver City	79	Strata
Premier	North Vancouver City	131	Strata
Sky	North Vancouver City	151	Strata
The Drive	North Vancouver District	64	Strata
The Grande	North Vancouver City	86	Strata
The Landing at the Pier	North Vancouver City	59	Strata
Time	North Vancouver City	265	Strata
Touchstone	North Vancouver City	120	Strata
Vista Place	North Vancouver City	279	Strata
Acqua	Richmond	183	Strata

Name	Municipality	Units	Tenure
Camino	Richmond	126	Strata
Emporio	Richmond	92	Strata
Modena	Richmond	50	Strata
Nova_Richmond	Richmond	99	Strata
Paloma 1	Richmond	122	Strata
Prado	Richmond	255	Strata
Seasons	Richmond	289	Strata
The Capris	Richmond	168	Strata
Access 1 and 2	Surrey	198	Strata
Access 3	Surrey	55	Strata
Agenda	Surrey	135	Strata
Aura 2	Surrey	107	Strata
CityPoint	Surrey	452	Strata
Cornerstone	Surrey	278	Strata
D'Corize	Surrey	180	Strata
Element	Surrey	71	Strata
Ethical Gardens at Central City	Surrey	63	Strata
Pacifica	Surrey	112	Strata
Quattro 2 and 3	Surrey	280	Strata
The Observatory	Surrey	126	Strata
Coast	UBC	67	Strata
Corus	UBC	60	Strata
Pacific	UBC	91	Strata
Spirit	UBC	62	Strata
33	Vancouver	64	Strata
33 and Main	Vancouver	36	Strata
66 West Cordova	Vancouver	108	Strata
700 West 8th	Vancouver	117	Strata
80 WALTER HARDWICK	Vancouver	61	Market Rental
Atelier	Vancouver	202	Strata
Brava Towers	Vancouver	383	Strata
Bridge	Vancouver	82	Strata
Canadian	Vancouver	213	Strata
Crossroads	Vancouver	88	Strata
Dolce	Vancouver	202	Strata
Electra	Vancouver	243	Strata
Electric Avenue	Vancouver	456	Strata
Foundry	Vancouver	90	Strata
H-H	Vancouver	175	Strata
Hub	Vancouver	42	Strata
Kayak	Vancouver	60	Strata
King Edward Village	Vancouver	197	Strata
Koret	Vancouver	100	Strata
L'Aria	Vancouver	81	Strata
L'Hermitage	Vancouver	184	Strata
Loft 495	Vancouver	36	Strata

Name	Municipality	Units	Tenure
Magnolia	Vancouver	38	Strata
Maynards Block	Vancouver	236	Strata
Montreux	Vancouver	81	Strata
Nova_Vancouver	Vancouver	158	Strata
Now on Fraser	Vancouver	18	Strata
Paris Block	Vancouver	47	Strata
Residences on 7th	Vancouver	98	Market Rental
Robson and Richards	Vancouver	106	Strata
Social	Vancouver	111	Strata
Stella	Vancouver	96	Strata
Stella Del Fiordo	Vancouver	32	Strata
Terminus	Vancouver	45	Strata
The Capitol	Vancouver	372	Strata
The Donovan	Vancouver	142	Strata
The Rise	Vancouver	92	Market Rental
The Vita (Dolce Tower)	Vancouver	146	Strata
Uno	Vancouver	96	Strata
Wall Centre Downtown	Vancouver	213	Strata
Woodward's	Vancouver	170	Mixed

APPENDIX 5: Vehicle Reduction Calculations

There are different approaches to calculating vehicle reductions. For example, the 2008 UC Berkeley study chose a top-down approach by combining data from all surveyed car share providers in the United States and Canada and estimating vehicle reduction rates in the aggregate. Alternatively, vehicle reductions for individual car share providers could have been calculated first, taking into account local differences in vehicle shedding and avoidance rates, then aggregated as appropriate. The following approach is a hybrid of the two that responds to the availability of disaggregated data and known data gaps.[46]

Whenever data gaps exist, it is necessary to make assumptions to fill these gaps. The first gap is the Zipcar household universe. Both Modo and car2go provided estimates of membership numbers upon request, but Zipcar was unable to do the same. Since Zipcar is a two-way service and provides a similar mix of vehicles as does Modo, the Zipcar membership was derived by using Modo's membership-to-vehicle ratio. The actual ratio for Zipcar may either be higher or lower, but equivalency was assumed in the absence of additional information.

Table 94. Derivation of Membership (as of Fall 2013)

Car Share Provider	Membership	Vehicles in Fleet	Members:Vehicle Ratio
Modo	7,900	303	26
Zipcar	*3,337 (derived)*	128	*26 (assumed same as Modo)*
car2go	37,400	550	68

The next step is to convert the membership numbers into households. In the 2008 UC Berkeley study, 81% of survey respondents were in households with 1 car share member only and 19% in households with 2 car share members only. Modo also advised that their membership shares a similar pattern (78% and 22%). Given the information at hand, and absent of other information that may differentiate between the three car share providers, the Modo values were applied to all three car share providers for the household conversion calculation.

Table 95. Derivation of Households

Car Share Provider	Membership	Households	Note
Modo	7,900	7,031	The sum 10,001 is used as a control value to determine subgroup population estimates in the Modo and Zipcar universe.
Zipcar	*3,337 (derived)*	2,970	
car2go	37,400	33,286	The 33,286 number is used as a control value to determine subgroup population estimates in the car2go universe.

[46] Michiko Namazu (PhD candidate) and fellow researchers at UBC's Institute of Resources, Environment and Sustainability provided invaluable suggestions to improve the thoroughness of the vehicle reduction estimates. The approach presented herein incorporates some of their suggestions.

Car share households could be subscribers to more than one provider. There are seven possible combinations. Given the low survey response rate of Zipcar households and the relatively overrepresentation of car2go households in the survey, the seven combinations were collapsed into three combinations.

Table 96. Derivation of Survey Membership Combinations

Membership Combinations	Survey Respondents	Modified Membership Combinations	Survey Respondents
Modo Only	1,009	Modo/Zipcar	1,042
Zipcar Only	9		
Modo+Zipcar	24		
Modo+Zipcar+car2go	61	Modo/Zipcar +car2go	1,046
car2go+Modo	753		
car2go+Zipcar	232		
car2go Only	1,317	car2go Only	1,317
Aggregate	**3,405**	**Aggregate**	**3,405**

The next step is to translate the survey distribution of car share households to the estimates of the household population. Given that the response rate of Modo households was higher than that of car2go (relative to their respective memberships), it was assumed that the Modo membership was appropriate to be used as the first control as shown in the table below.[47]

Table 97. Derivation of Population Household Estimates

Membership Combinations	Modo/Zipcar Survey Household Universe	Modo/Zipcar Distribution	Modo/Zipcar Population Household Estimate	car2go Population Household Estimate
Modo/Zipcar	1,042	49.9%	*4,991 (10,001x0.499)*	
Modo/Zipcar+ car2go	1,046	50.1%	*5,010 (10,001x0.501)*	*5,010 (control)*
car2go Only				*28,276 (33,286-5,010)*
Aggregate	**2,088**	**100%**	***10,001 (control)***	***33,286 (control)***

With the population household estimates now calculated, the next step is to estimate the vehicle reduction rates. First, it is necessary to include only active user households. The car share household survey suggests only 2% of respondents are members but have yet to use the service that they have joined. A 98% active rate is unrealistically high. It can be expected that the active rate is likely to be lower since free or discounted memberships are often advertised to attract prospective customers who may not actually use the service.

[47] Estimated Modo household response rate = 1847 / 7031 = 26%
car2go response rate = 2363 / 33286 = 7%

For the purposes of demonstrating the methodology, an 80% active was assumed for all three car share groups. Other active rates are tested as shown in the final table.

Vehicle reduction comprises vehicles that were shed by households (sold or transferred) after joining car share, and vehicles that households avoided having to acquire after joining car share.

The "vehicle shed per household" was derived using the survey dataset and applied to the estimated active household population. The vehicle shed rate is calculated as shown in the table below. In this example, about 3 private personal vehicles were shed for every car share vehicle in the aggregate.

Table 98. Sample Derivation of Vehicle Shed Rate (Active Rate = 80%)

Membership Combinations	Households	Active Rate	Active Households (A)	Vehicle Shed per Household (B)	Vehicles Shed (C=AxB)	Fleet (D)	Vehicle Shed Rate (C/D)
Modo/Zipcar	4,991	0.80	3,993	0.19	759	431	
Modo/Zipcar +car2go	5,010	0.80	4,008	0.22	874	981	
car2go Only	28,276	0.80	22,621	0.05	1,116	550	
Aggregate	--	--	--	--	**2,750**	**981**	**2.8**

To estimate the vehicle avoidance rate, only those households that will neither increase nor decrease the number of private personal vehicles should be included in the calculation. These household shares were derived using the survey dataset and applied to the estimated active household population. The number and rate of vehicle avoidance are shown as ranges because the survey revealed a spread in likelihood by car share households to buy a vehicle if car share programs were discontinued. The vehicle avoidance rate is calculated as shown in the table below. In this example, between 2 and 9 private personal vehicles were avoided for every car share vehicle.

Table 99. Derivation of Vehicle Avoidance Rate (Active Rate = 80%)

Membership Combinations	Active HHLDs	Survey Households that did not change # vehicles	If car share programs were discontinued permanently…			Vehicles Avoided	Vehicle Avoidance Rate
			Definitely Will Buy a Vehicle	Likely Buy a Vehicle	Definitely + Likely Buy a Vehicle		
Modo/Zipcar	3,993	0.70	10%	29%	39%	278 to 1,083	
Modo/Zipcar +car2go	4,008	0.71	13%	33%	46%	372 to 1,321	
car2go Only	22,621	0.91	8%	22%	30%	1,606 to 6,176	
Aggregate	--	--				**2,256 to 8,580**	**2.3 to 8.7**

For completeness, a schedule of active rate combinations was identified and applied to derive the vehicle shed rate and vehicle avoidance rate. Combining the two rates yield the total vehicle reduction rate. By inspecting the table below, it is likely that between 5 and 11 private personal vehicles have been removed from the use of car share households for every car share vehicle.

Table 100. Sensitivity Analysis of Vehicle Shedding, Avoidance, and Reduction

Active Rate Combination	Active Rate			Vehicle Shed Rate (A)	Vehicle Avoidance Rate (B)	Vehicle Reduction Rate (A+B)
	Modo/Zipcar	Modo/Zipcar + car2go	car2go Only			
1	60%	60%	60%	2.1	1.7 to 6.6	3.8 to 8.7
2	70%	70%	70%	2.5	2.0 to 7.7	4.5 to 10.1
3	75%	75%	65%	2.5	2.0 to 7.4	4.4 to 9.9
4	80%	80%	60%	2.5	1.9 to 7.2	4.4 to 9.7
5	75%	75%	75%	2.6	2.2 to 8.2	4.8 to 10.8
6	80%	80%	70%	2.7	2.1 to 8.0	4.8 to 10.6
7	80%	80%	75%	2.7	2.2 to 8.4	4.9 to 11.1
8	80%	80%	80%	2.8	2.3 to 8.7	5.1 to 11.5
9	85%	85%	85%	3.0	2.4 to 9.3	5.4 to 12.3
10	90%	90%	90%	3.2	2.6 to 9.8	5.7 to 13.0

APPENDIX 6: Additional Statistical Analyses

Linear Regression Details

The following table compares the relative contribution that each independent variable has to explaining the dependent variable, all else being constant. The availability of car share, in this instance, provided the strongest unique contribution. In addition, the Variance Inflation Factors (all less than 5) indicate that multicollinearity was not an issue.

Table 101. Detail Information about Model 1

	Coefficient	Beta Coefficient	Variance Inflation Factor	Comments
Constant	0.387	-	-	CS800 makes the strongest unique contribution to explaining the dependent variable (vehicles per household). Since VIF < 5, there is no measurable collinearity between the independent variables.
ASSESSMENT	0.000000543	0.273	1.094	
LGFTNBUS	0.133	0.216	1.051	
LGFTNSTN	0.115	0.220	1.075	
CS800	-0.00702	-0.716	1.109	

Heteroskedasticity

One of the basic assumptions of ordinary least squares multiple regression is that the variance of the error term (between the observed and predicted value of the dependent variable) is constant. If this condition is violated, then heteroskedasticity exists and any significant results could be spurious. Two tests for heteroskedasticity were performed on Model 1. No evidence of heteroskedasticity was found. Background information about heteroskedasticity is found here: http://www.ats.ucla.edu/stat/stata/webbooks/reg/chapter2/statareg2.htm

Table 102. Heteroskedasticity Tests for Model 1

Heteroskedasticity Test	Test Statistic	Comments
Breusch-Pagan / Cook-Weisberg Test	p = 0.9406 (>0.05)	No evidence of heteroskedasticity
White's Test	p = 0.5628 (>0.05)	No evidence of heteroskedasticity

Bivariate Correlations

One of the first steps in constructing linear multiple regression relationships is to examine the bivariate correlations between the dependent variable (such as the vehicles per household) and a long list of independent variables, and between the independent variables. The first set of correlations will give an indication of strong candidate independent variables to put into a multiple regression equation. The second set of correlations will provide an indication of collinearity between independent variables. This is important because a multiple regression equation should not contain independent variables that are collinear with one another. Otherwise one or more of these independent variables will have to be removed from analysis or combined into one new variable.

Table 103. List of Variables Tested

Characteristics	Variables	Description
Dependent Variable	VEHPHH	Average vehicles per household
Car Share Availability	CS400	Number of Modo and Zipcar vehicles within 400 metres (including on-site vehicles)
	CS800	Number of Modo and Zipcar vehicles within 800 metres (including on-site vehicles)
	CSDIST	Distance to nearest Modo or Zipcar vehicle
	CSSITENUM	Number of on-site car share vehicles
	CSSITE	Building has on-site car share
Apartment Building	BEDROOMS	Average number of bedrooms
	ASSESSMENT	Average 2013 property assessment value
Built Environment around Apartment Building	WALKSCORE	Walk score for each apartment site (www.walkscore.com)
	POP400	2011 population within 400 metres
	POP800	2011 population within 800 metres
	LGFTNSTOP	Logarithm of distance to nearest FTN bus stop (as the crow flies)
	LGFTNSTN	Logarithm of distance to nearest FTN station (as the crow flies)
	GRODIST	Distance to nearest large format grocery store
	GRO800	Number of large format grocery stores within 800 metres
Household	EMPPER	Average number of employed persons per household
	P0_19	Average number of children under 20 years per household
	P25_54	Average number of adults 25 to 54 years per household

Table 104. Bivariate Correlation Matrix

	VEHPHH	CS400	CS800	CSDIST	CSSITENUM	CSSITE	BEDROOMS	ASSESSMENT	WALKSCORE	POP400	POP800	LGFTNSTOP	LGFTNSTN	GRODIST	GRO800	EMPPER	P0_16	P25_54
VEHPHH		-.638**	-.725**	.434**	-.233	-.033	.624**	.176	-.379**	-.467**	-.584**	.380**	.403**	.160	-.565**	.153	.496**	.205
CS400			.882**	-.505**	.425**	.181	-.483**	.232	.602**	.600**	.738**	-.090	-.094	-.300*	.771**	.079	-.335*	.069
CS800				-.414**	.328*	.096	-.475**	.208	.569**	.656**	.831**	-.150	-.152	-.328*	.840**	.034	-.290*	.002
CSDIST					-.392**	-.395**	.243	.055	-.103	-.219	-.285*	.073	.266	.032	-.252	.041	.211	.024
CSSITENUM						.780**	-.146	.053	.030	.123	.287*	.115	-.033	-.059	.267	-.035	-.151	-.007
CSSITE							-.192	-.181	-.217	-.014	.113	.246	.103	.073	.025	-.069	-.130	.013
BEDROOMS								.315*	-.299*	-.203	-.274	.156	.075	.082	-.325*	.061	.641**	.150
ASSESSMENT									.393**	.366**	.283*	.085	.150	-.388**	.380**	.006	.173	.036
WALKSCORE										.495**	.549**	-.324*	.107	-.627**	.525**	.106	-.139	.057
POP400											.877**	-.145	-.078	-.425**	.705**	-.181	-.237	-.129
POP800												-.159	-.007	-.436**	.741**	-.150	-.286*	-.116
LGFTNSTOP													.151	.270	-.201	.164	.185	.085
LGFTNSTN														-.051	-.269	.142	.249	.219
GRODIST															-.470**	.031	.099	-.044
GRO800																-.008	-.309*	.022
EMPPER																	.361*	.855**
P0_16																		.470**
P25_54																		

Correlation is significant at the 0.01 level (2-tailed)
Correlation is significant at the 0.05 level (2-tailed)