Consumer response to new mobility innovations in Canada

Final report for TransLink

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About the Sustainable Transportation Action Research Team (START)

We take an interdisciplinary approach to low-carbon transportation solutions, integrating relevant insights from quantitative and qualitative research methods, such as statistical analyses, energy-economy modeling, consumer and citizen surveys, stakeholder interviews, media analysis and policy analysis. Our current research focus centers around four main themes:

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Executive Summary

There is much optimism around the potential for various transport technologies and innovations to help meet climate goals. We consider three categories of innovations in particular:

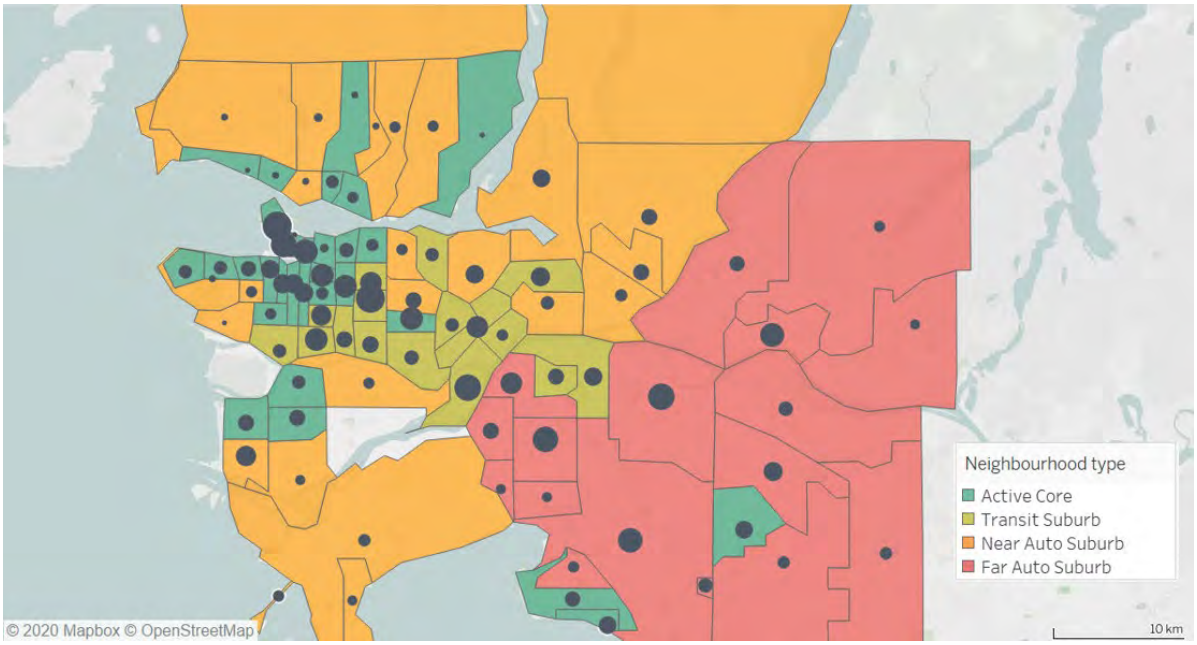
- Shared mobility: including forms of ride-hailing (e.g., Uber and Lyft) and car-sharing (e.g., Evo and Zipcar);
- Automated vehicle technology: including a range of vehicle features such as self-parking, adaptive cruise control, lane centering steering, and full (self-driving) vehicle automation;
- Electric vehicle technology: including pure battery electric vehicles and plug-in hybrid electric vehicles.

There is considerable uncertainty about how consumers will adopt and use these "new mobility" innovations. This study evaluates the current state of consumer awareness, adoption (purchase or past usage), interest in future usage, and perceptions regarding several versions of shared, automated, and electric mobility using a representative survey of Canadians.

Method

We implemented a survey in May-June 2020 to a total of 3658 respondents across Canada. This analysis focuses on Metro Vancouver respondents (n = 993), with comparisons to Greater Toronto Area respondents (n = 794) and Metropolitan Montreal Area respondents (n = 819). Within each metro area, we categorize respondents into four neighbourhood types that differ in their population density and residents' primary commute mode: active cores, transit suburbs, near auto suburbs, and far auto suburbs (shown for Metro Vancouver in ES-Figure 1). Most results in this report focus on descriptions of responses to survey questions. We also estimate several linear regression models to explore consumer characteristics associated with adopting and interest in adopting the technologies.

ES-Figure 1: Respondents in Metro Vancouver sample in each neighbourhood type. Larger dot sizes correspond to larger numbers of respondents sampled in a given census tract.



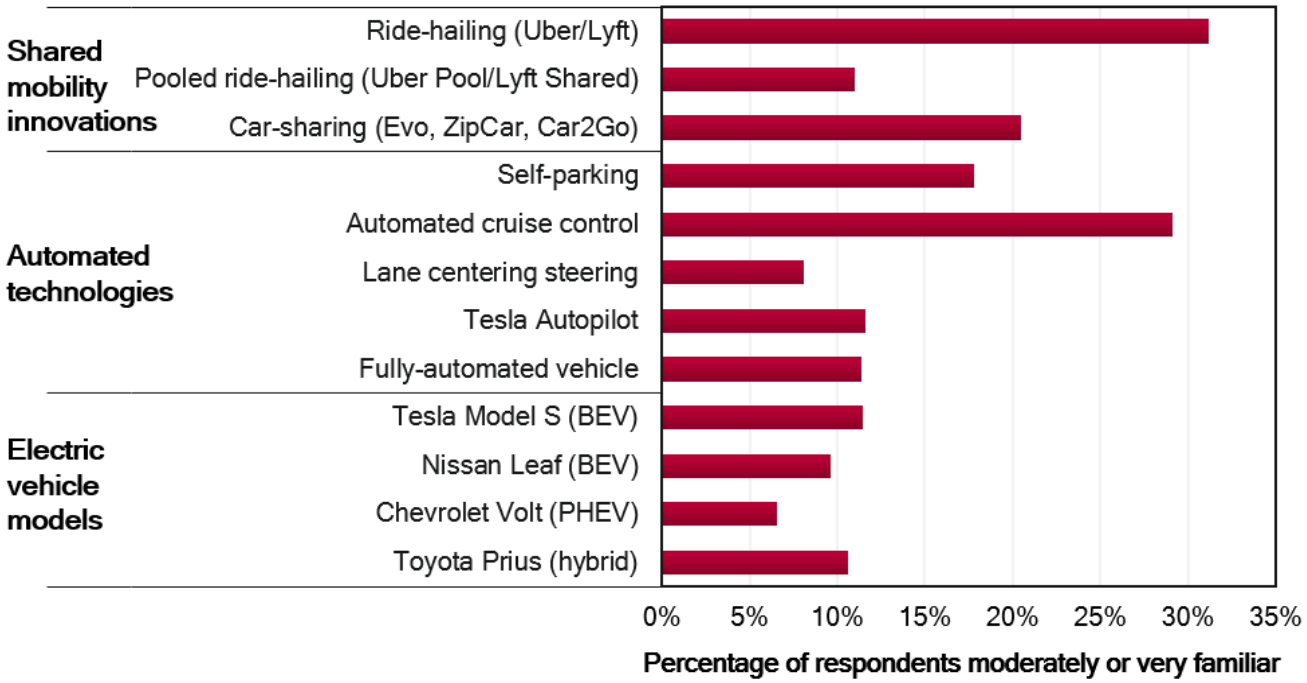
Travel patterns

We assess Metro Vancouver respondents' baseline travel patterns in the winter and summer (before the COVID-19 pandemic), as well as expected future travel patterns. Before the pandemic (in February 2020), the most frequently used travel modes in the winter were driving alone (71% of respondents use this at least once a week), driving with passengers (67%), walking (67%), and public transit (34%). Summer mode usage (also before the pandemic) follows similar patterns, with slightly higher usage of active travel modes. When asked about a future without social distancing respondents report a number of potential changes, such as: 25% of respondents expect to increase walking frequency, 13% expect to increase cycling frequency, 33% expect to decrease or stop using public transit, 22% expect to decrease or stop using rides from friends or family members, and 20% expect to decrease or stop using taxis.

Overall familiarity with new mobility innovations

Respondent familiarity with new mobility innovations is varied (ES-Figure 2). Of the shared mobility types, self-reported familiarity is highest for ride-hailing (Uber/Lyft) – with one-third of respondents considering themselves to be "moderately" or "very familiar". Among the automated technologies, familiarity is highest for "automated cruise control" (29% of respondents report being familiar) and is lower for other automated technologies. Around 10% of respondents consider themselves familiar with the electric vehicle models that the survey inquired about.

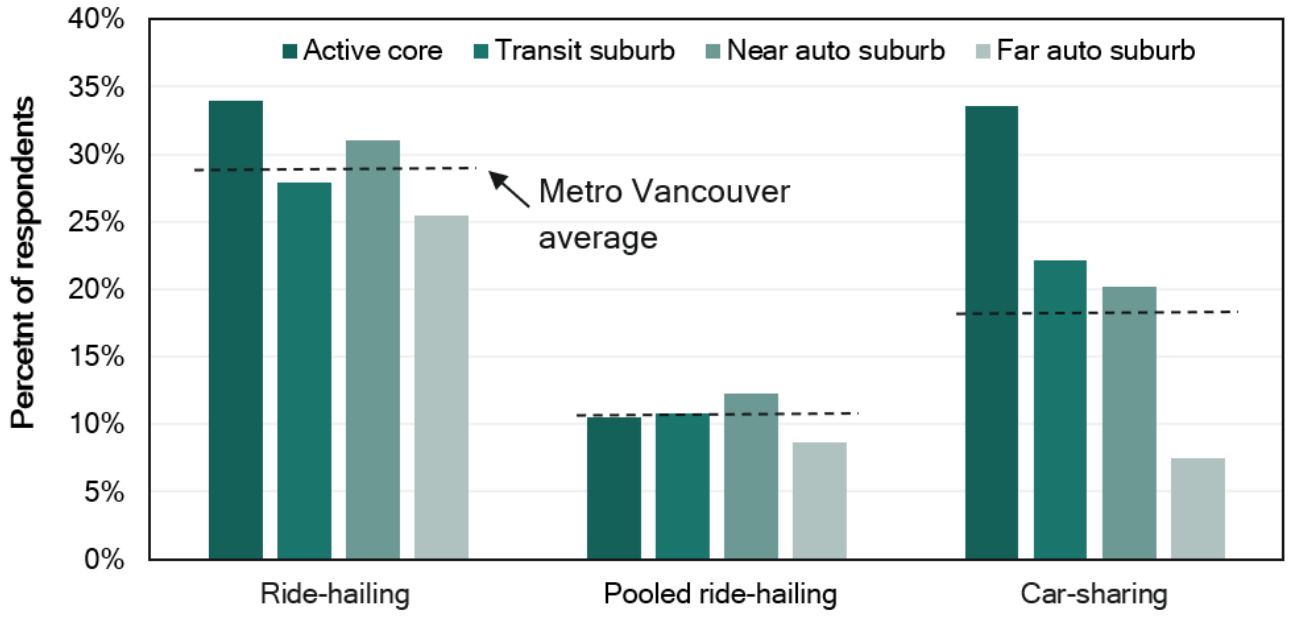
ES-Figure 2: Respondent familiarity ("moderately familiar" and "very familiar") with shared, automated, and electric mobility innovations (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



Shared mobility innovations

Shared mobility innovations include ride-hailing (such as Uber and Lyft) and car-sharing services (such as Evo and ZipCar). Overall, adoption (past usage) of ride-hailing is highest among these innovations. Around 40% of Metro Vancouver respondents have used some form of ride-hailing at least once. Adoption of ride-hailing is highest among those in active cores (30%) and lowest among those in far auto suburbs (14%). We see a similar pattern for car-sharing adoption (41% in active cores vs. 7% in far auto suburbs). Among all respondents, interest is higher for ride-hailing and similar between neighbourhood types (29% are interested in ride-hailing overall) (ES-Figure 3). Interest in car-sharing is just as high among those in active cores (34%) and much lower among those in far auto suburbs (8%). Most respondents (87%-95%) generally report that they do not expect the availability of shared mobility innovations to have significant impacts on their travel patterns, vehicle ownership, or residence location.

ES-Figure 3: Percent of respondents "moderately interested" or "very interested" in using shared mobility innovations in the future by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).

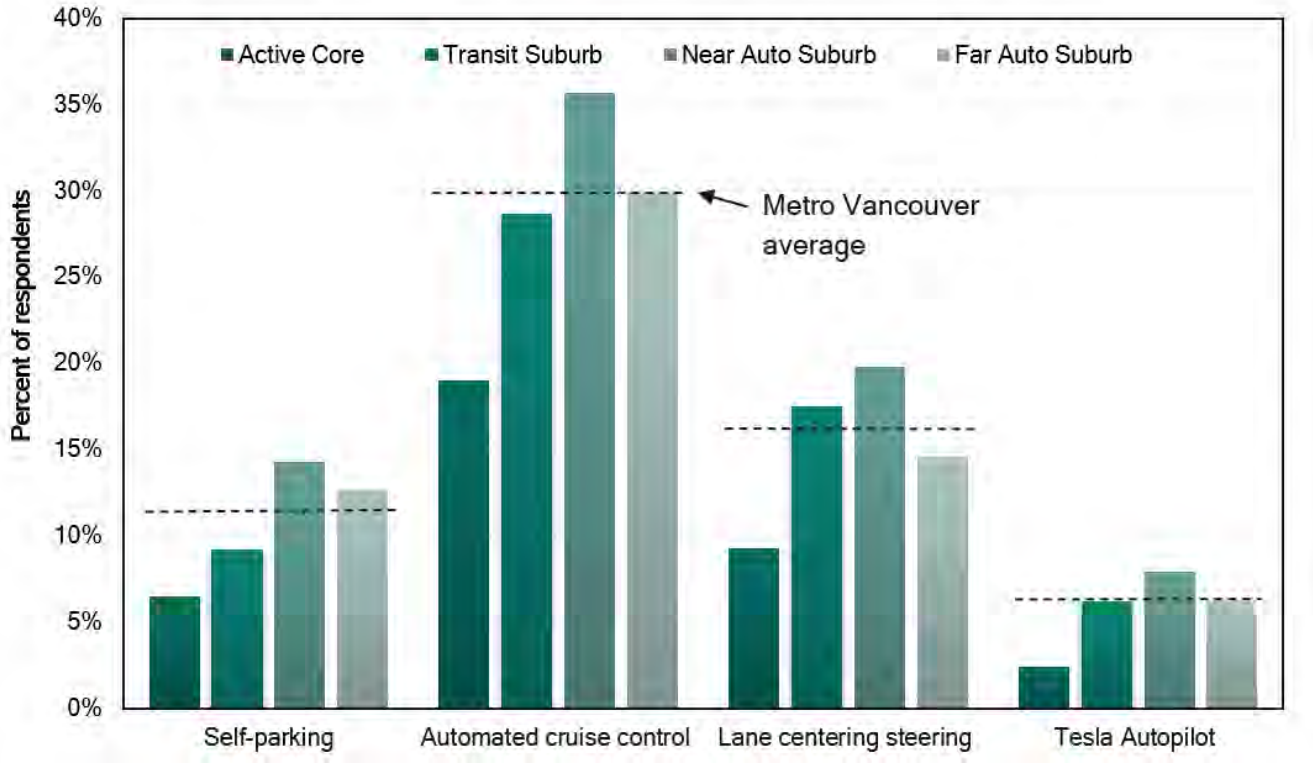


Automated mobility innovations

We explored consumer interest regarding several increment automation technologies (self-parking, automated cruise control, lane-centering steering, and Tesla Autopilot) as well as fully-automated vehicles. Of these technologies, rates of current or past ownership are highest for automated cruise control (30% of respondents, ES-Figure 4). Generally, experience with automated features is highest among those in near and far auto suburbs and lowest among those in active cores. One-fifth to one-third of respondents express interest in purchasing some form of fully-automated vehicle in the future. Most respondents (77%-94%) report that they do not expect

the availability of fully-automated vehicles to significantly impact their travel patterns, vehicle ownership, or residence location.

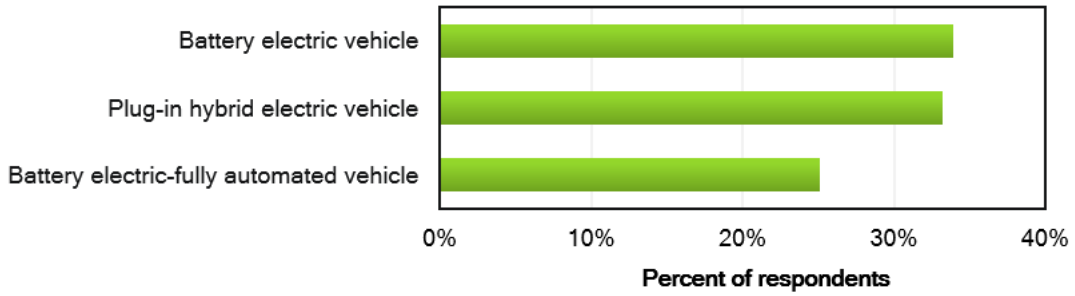
ES-Figure 4: Current or past ownership of automation technologies by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



Electric mobility innovations

The survey considered two electric mobility innovations: battery electric vehicles and plug-in hybrid electric vehicles. Only 4% of respondents own some type of electric vehicle, which is consistent with actual market share in BC. Ownership tends to be slightly lower among those in active cores. Over one-third of respondents are interested in purchasing some type of electric vehicle in the future (ES-Figure 5).

ES-Figure 5: Percent of respondents that are "moderately interested" or "very interested" in purchasing a fully-automated vehicle in the future (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).

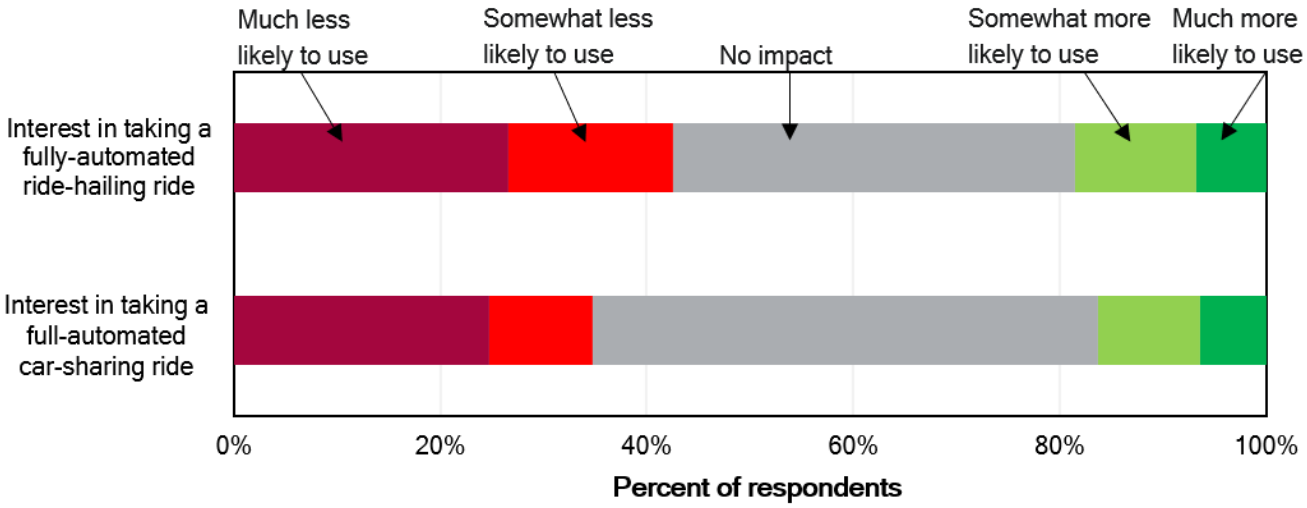


Combining new mobility innovations

Many researchers and policymakers are interested in potential combinations of these three new mobility innovations (shared, automated and electric mobility). The survey included several questions on such combinations. As examples:

- Adding *fully-automated* options to shared mobility services: fewer than 20% of respondents indicated they would be more likely to use ride-hailing or car-sharing if a fully-automated vehicle was an option for the trip (ES-Figure 6). Up to 40% would be *less likely* to use shared mobility services if a fully-automated vehicle was an option.
- Adding *electric* options to shared mobility services: nearly one-third of respondents express that they would be more likely to use ride-hailing or car-sharing if an electric vehicle were available as an option for their trip (not shown).

ES-Figure 6: Percent of respondents interested in combining fully-automated vehicles with ride-hailing and car-sharing. Respondents reported the impact on their likelihood of using of ride-hailing and car-sharing if a fully-automated vehicle were an option for their trips (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



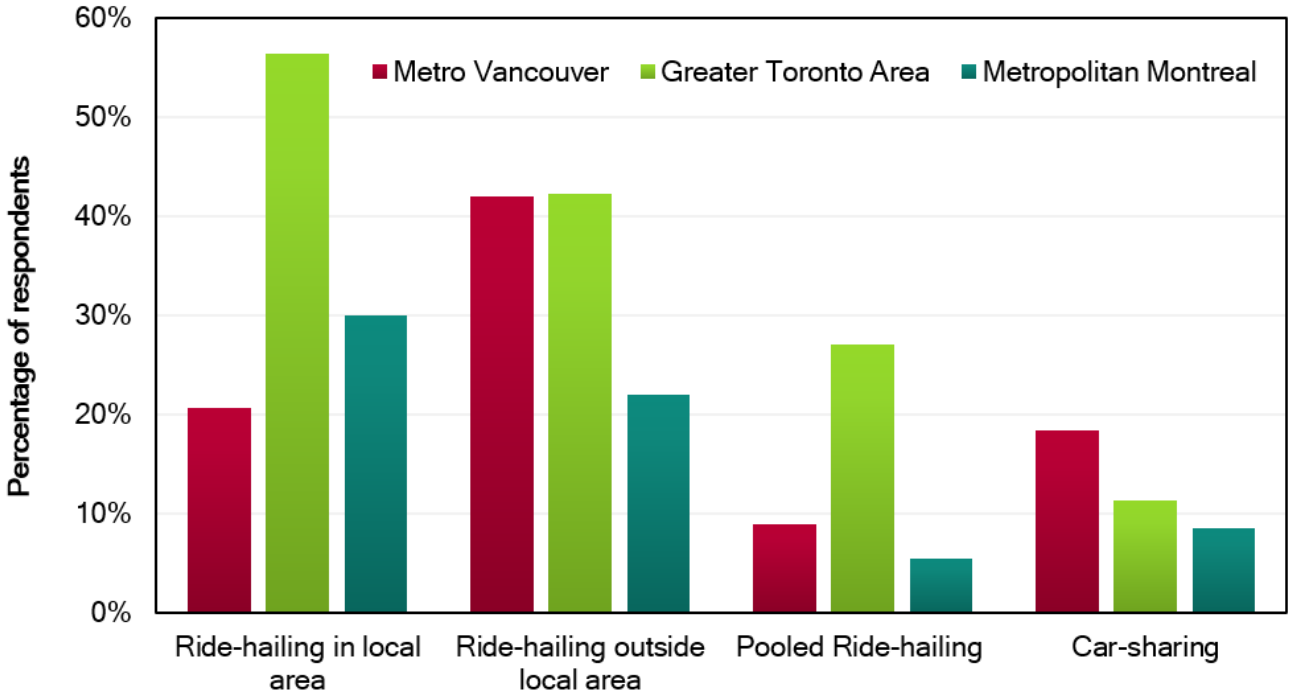
Perceptions of new mobility innovations

The survey instrument also assessed respondent perceptions of various attributes of these innovations. When asked about their perceptions of ride-hailing and car-sharing, over 55% respondents agreed with statements that these innovations are convenient, require trust, and are part of the future. Regarding fully-automated vehicles, over 58%respondents perceive fully-automated vehicles as requiring trust, being part of the future, helping people with mobility challenges to get around, and changing how people think about the mobility system. For electric vehicles, over 71% respondents view BEVs as being good for local air quality and helping climate change, as well as being part of the future.

Comparing metro areas

Most of these patterns are similar when comparing Metro Vancouver, the Greater Toronto Area, and Metropolitan Montreal. We note two particular exceptions. First, we observe higher adoption (usage) of ride-hailing among Greater Toronto respondents (56% of Toronto respondents have used it, compared to 30% in Metro Vancouver and 21% in Metropolitan Montreal, ES-Figure 7). Second, we observe higher adoption (usage) of car-sharing among Metro Vancouver respondents (18% of Metro Vancouver respondents have used it, compared to 11% in Greater Toronto and 9% in Metropolitan Montreal). Otherwise, the three regions are generally similar in rates of respondent familiarity with, adoption of, and interest in adopting the new mobility innovations.

ES-Figure 7: Percentage of respondents that have adopted each shared mobility (i.e., having used a ride-hailing app or car-sharing vehicle at least once) in each metro area (Metro Vancouver n=993, weighted, Greater Toronto Area n=794, weighted, and Metropolitan Montreal Area n=819, weighted). Note that "local area" refers to use in respondents' approximate residential area whereas "outside local area" refers to use when away (e.g., on a vacation or business trip).



Consumer characteristics associated with new mobility innovation adoption

We use statistical analyses (linear regressions) to identify respondent characteristics associated with adoption of ride-hailing and car-sharing, and interest in adopting ride-hailing, car-sharing, fully-automated vehicles, and battery electric vehicles. Results indicate that adoption of and interest in these innovations are associated with a number of factors, including: engagement in technology- and environment-oriented lifestyles, intention to purchase a vehicle in the future, younger ages, higher education levels, higher incomes, and being male. Additionally, living in active core, transit suburb, and near auto suburb neighbourhood types is associated with

adoption of (and higher interest in adopting) ride-hailing and car-sharing (compared to the baseline of living in far auto suburbs).

Policy support and opposition

Last, we evaluate support for several policies related to transport, climate, and new mobility innovations. Overall, among Metro Vancouver respondents we observe strong support for new mobility technology regulations and transport-focused climate policies (over 50% support), with low opposition (18% or less oppose). However, opposition is higher and support lower for road-pricing policies and a carbon tax (nearly half of respondents oppose such policies, and around 30% support).

1. Introduction

Transportation contributes to nearly one-quarter of total greenhouse gas (GHG) emissions in Canada –up to 40% in British Columbia (Environment and Climate Change Canada, 2019), and up to 45% in Metro Vancouver (Metro Vancouver, 2019). To help stem emissions and achieve other societal goals, policymakers and other stakeholders are envisioning future scenarios involving emerging transport technologies and innovations. Three categories of innovations are considered in particular:

- *Shared mobility:* including forms of ride-hailing (e.g., Uber and Lyft) and car-sharing (e.g., Evo and Zipcar);
- *Automated vehicle technology*: including a range of vehicle features such as self-parking, adaptive cruise control, lane centering steering, and full (self-driving) vehicle automation; and
- *Electric vehicle technology*: including pure battery electric vehicles and plug-in hybrid electric vehicles.

These categories of innovations have been referred to as the "three revolutions" (Sperling, 2018), "ACES" (automated, connected, electric, and shared), or "new mobilities" (Sheller & Urry, 2016) of transport due to their potential to transform the sector. A societal and technical transition to one or some combination of these innovations could play an important role in achieving sustainable transport goals, substantially impacting the environment, energy use, and social well-being.

Much of the outlook for these innovations has been optimistic. Hopeful, "Heaven"-like scenarios have been predicted for widespread adoption of each new mobility innovation, as well as combinations of all three. These best case scenarios hinge upon consumers shifting away from private vehicle ownership and embracing a system of shared, automated, and electric mobility – which could improve road safety and accessibility, as well as provide substantial reductions in energy use and GHG emissions (Milakis, van Arem, & van Wee, 2017; Sperling, 2018). For example, some future-looking models predict that a fleet of shared, automated, and electric vehicles could reduce GHG emissions by up to 94% to 97% compared to a conventional vehicle (Greenblat & Saxena, 2015). Such a fleet would also have positive impacts on traffic congestion, air quality, and land-use. Another study finds that a fleet of shared, automated, electric vehicles could meet travelers' requirements with 97% fewer vehicles, 95% less parking spaces, 37% fewer vehicle kilometers, and much lower operating costs (Viegas, Martinex, & Crist, 2016).

While these visions of the new mobility innovations are inspiring, they mostly focus on the potential extreme positive consequences and neglect the negative and uncertain outcomes regarding consumer usage. To illustrate some of the potential uncertainty, in scenarios with a fleet of shared, automated, and electric vehicles, one study finds that energy use and GHG impacts could range from half to double present day emissions depending on consumer uptake and usage of the technology (Wadud, MacKenzie, & Leiby, 2016). In more "Hell"-like, worst case scenarios involving the new mobility innovations, consumers' private purchase of fully-automated vehicles increases private vehicle ownership and vehicle kilometers traveled, which adds to low-density

sprawl, reduces public and active mode usage, and increase GHG emissions (Milakis et al., 2017; Sperling, 2018). As another example, others find substantial rebound effects from widespread ride-hailing use, where reductions in travel costs and times lead to switching away from transit, driving longer distances, and relocating residences further from urban centers (Viegas et al., 2016). Evidently there is still much ambiguity around how the technologies will be accepted by consumers and the resulting systemic impacts they will have on the transport system.

This study is motivated by the need to better understand the current and potential future users of new mobility innovations. Such uncertainty about the extent of eventual new mobility impacts remains in part because it is not well understood how consumers will adopt the innovations and shift their current habits. More research is needed on consumer preferences and expectations of the new mobility innovations to better anticipate the impact of these technologies in isolation and in combination. To begin to address some of these gaps, this study broadly evaluates the state of *awareness*, *interest in*, and *adoption* of several new mobility innovations, including various forms of shared, automated, and electric technologies (and combinations of the three) through a survey of Canadians. In this report, we concentrate on consumers in Metro Vancouver (n = 993).

1.1 The new mobility innovations defined

We focus on several forms of shared, automated, and electric innovations (summarized in Figure 1). We define **shared** mobility types as including "ride-hailing", "pooled ride-hailing", and "car-sharing"[1]:

- *Ride-hailing* is a form of on-demand ride-service where riders request drivers and pay for their ride using a smartphone app. The driver picks up riders at their origins and drops them off at their destinations, similar to taxi services but often at a lower price and with the added convenience in the apps. Uber and Lyft are the two largest ride-hailing companies, together providing millions of rides worldwide.
- In the *pooled* form of ride-hailing, the app matches riders with similar routes and destinations such that the rides are shared among strangers, often for a reduced rate. Uber Pool and Lyft Shared are examples of this service provided by Uber and Lyft.
- *Car-sharing* refers to systems of short-term car rentals (ranging from minutes to one day) where members drive themselves in vehicles that are shared across a given company or network. Users must locate the vehicles and often park them in designated areas or

[1] While there are many differences, benefits, and challenges between the shared mobility types, we remain agnostic and use simplified definitions to describe them. For more discussion comparing shared mobility types see:
Clewlow, R.R., Mishra, G.S. 2017. Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-hailing in the United States. Research Report UCD-ITS-RR-17-07. *UC Davis Institute of Transportation Studies.* Available at: https://usa.streetsblog.org/wp-content/uploads/sites/5/2017/10/2017_UCD-ITS-RR-17-07.pdf
Novikova, O. 2017. The Sharing Economy and the Future of Personal Mobility: New Models Based on Car Sharing. *Technology Innovation Management Review,* 7(8): 27-31. Available at http://doi.org/10.22215/timreview/1097

parking spots when they are finished. Examples of car-sharing services include Share Now (formerly car2go), Evo, and Modo.

Automated mobility can also take a variety of forms. We consider a range of automated technologies including four types of lower level automation systems, and two forms of full vehicle automation. With lower level automation forms, the driver and the automated system share control of the vehicle, the automated system has no sustained control of the vehicle, and the driver must always be paying attention. Examples of these forms that we consider include:

- *Self-parking*, where steering is automated and speed is controlled by the driver when parking a vehicle;
- *Adaptive cruise control,* where the driver controls steering and the automated system maintains and varies vehicle speed (on highways only);
- *Lane centering steering*, where the automated system controls steering to keep the vehicle centered in a lane (on highways only)*;* and
- *Tesla Autopilot*, a feature offered in Tesla vehicles that includes self-parking, adaptive cruise control, lane centering steering, automated navigation on highways, automated lane changing, and the ability to summon the vehicle from a parking spot.

All forms considered here are available in the vehicle market.

With *full automation*, the driver does not need to be paying attention at any time and all forms of driving are operated by the automated system. We consider a form of fully-automated vehicle (FAV) in which no steering wheel is present – inhibiting any human driving – and a version where a steering wheel is present such that the driver can "switch off" the automation feature and drive the vehicle normally. Currently there are no FAVs available for private purchase (though testing among manufacturers is underway).

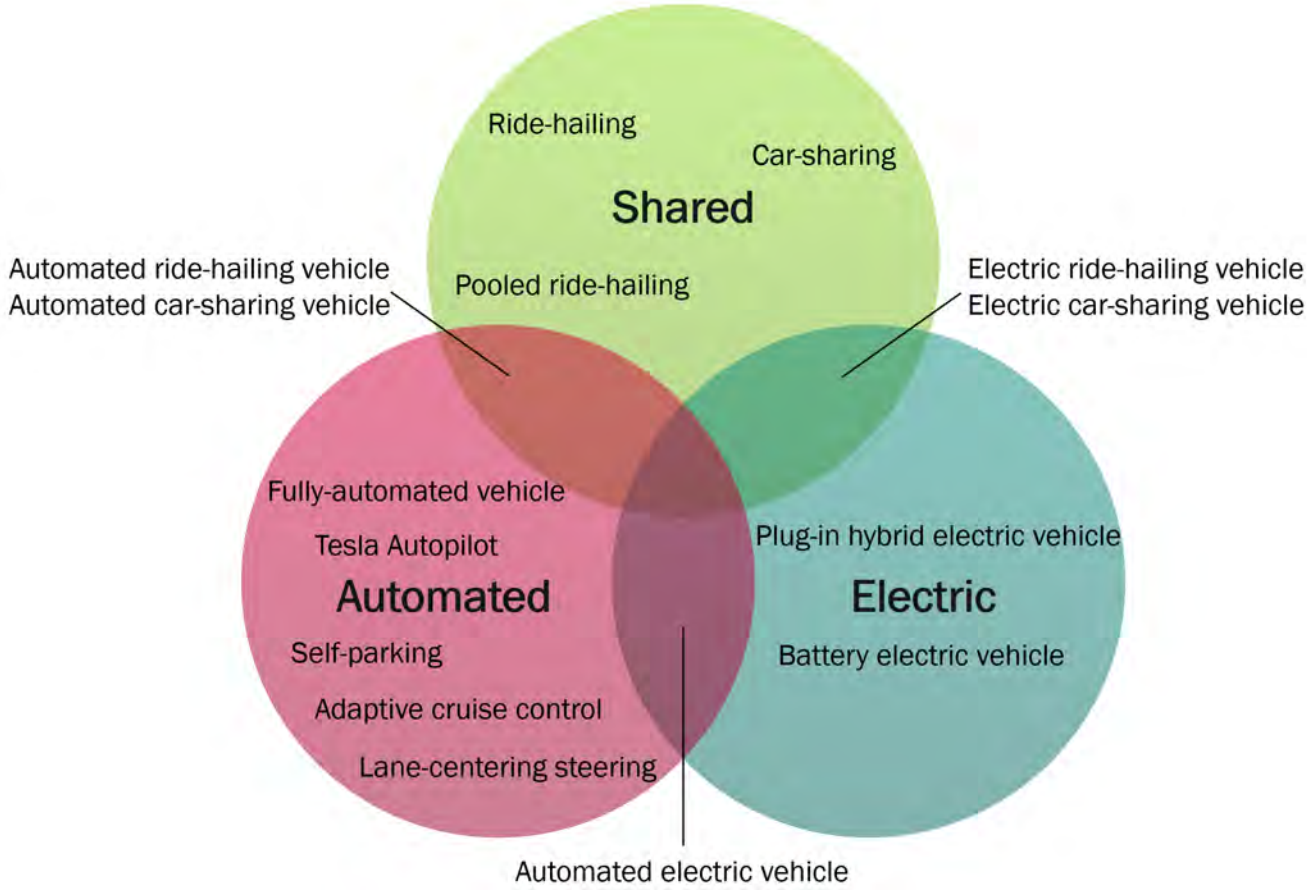
We consider two types of electric mobility:

- *Battery electric vehicles (BEVs*) are powered only by batteries that must be plugged in to recharge. Examples include the Nissan Leaf, Chevrolet Bolt, and all Tesla vehicles (e.g., Model S, Model 3, Model X).
- *Plug-in hybrid electric vehicles (PHEVs)* are powered by an internal combustion engine as well as a battery that can be plugged in to recharge. Examples include the Chevrolet Volt, Mitsubishi Outlander PHEV, and Toyota Prius Prime.

For comparison we also consider hybrid vehicles – which are powered by an internal combustion engine only – such as the Toyota Prius.

Though out of the scope of this study, we note the potential for these innovations to "overlap" and to be connected, such that vehicles share data with other vehicles as well as road infrastructure. Future scenarios might involve deploying a fleet of vehicles that is automated, connected, electric, and shared (or ACES).

Figure 1: Summary of new mobility innovations and technologies considered in this study.

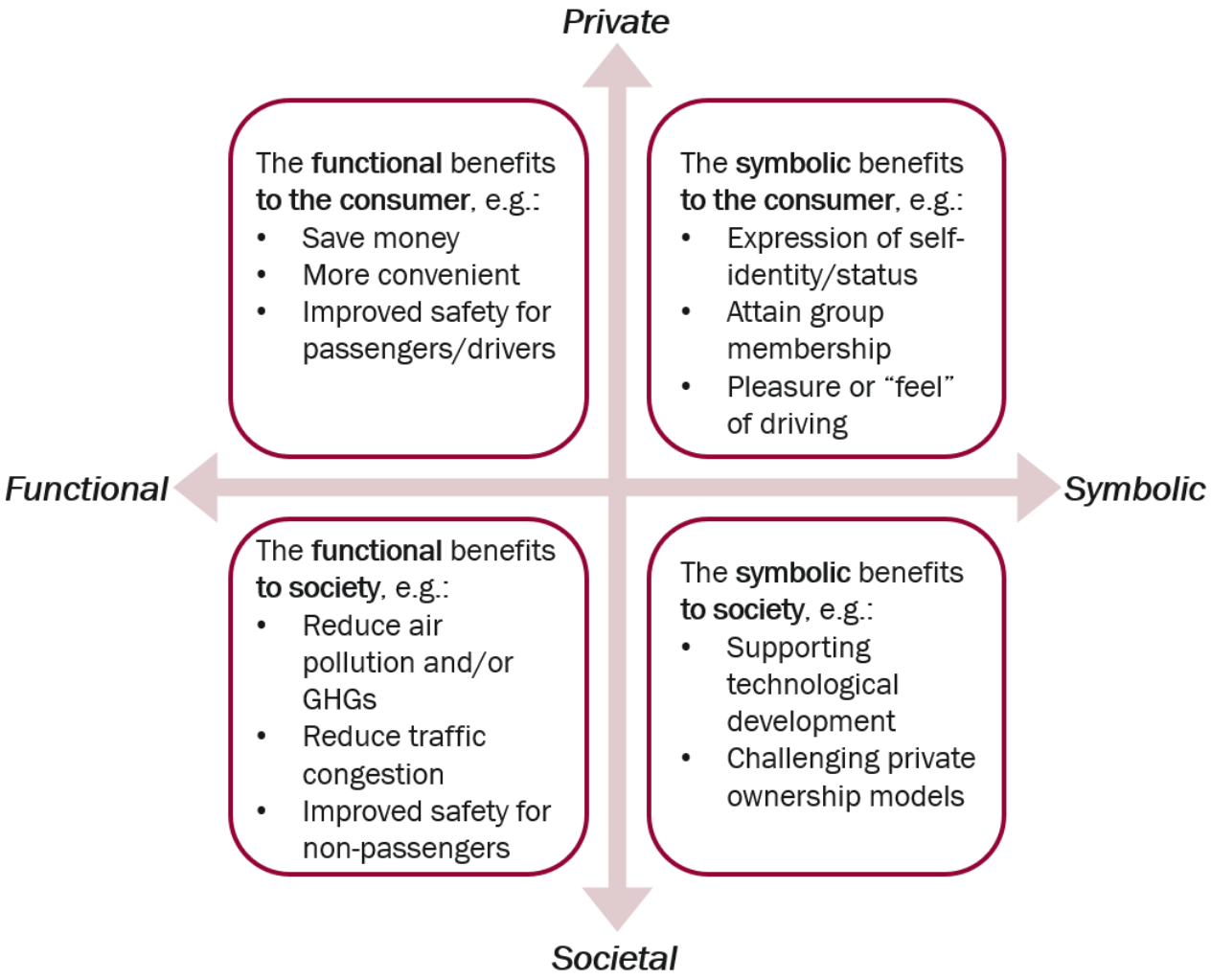


1.2 Conceptual framework of consumer perceptions

To help organize different dimensions of consumer perceptions of the new mobility innovations, we use a framework that categorizes the attributes of innovations (or perceived benefits and drawbacks of innovations) along two dimensions: functional versus symbolic aspects and private versus societal aspects. This framework has been used in several studies to explore the complexities for consumer perceptions towards transport technologies (Axsen, Cairns, Dusyk, & Goldberg, 2018; Axsen & Kurani, 2012; Axsen, Langman, & Goldberg, 2017). The *private-functional* category addresses what the innovation does for the consumer, such as financial costs or savings, performance, convenience, and reliability. The *private-symbolic* category acknowledges that forms of mobility can express self-identity, convey personal status, or signal membership in a particular group (Heffner, Kurani, & Turrentine, 2007; Steg, 2005). The *societal-functional* category includes the innovation's direct societal impacts, including environmental and land-use impacts, energy usage, and safety impacts to society more broadly. Lastly, the *societal-symbolic* category relates to the innovation's ability to inspire other uses and stakeholders (e.g., drivers, companies, governments) to engage in activities that in turn impact society more broadly, such as supporting further technological advancement and connectivity or challenging conventional vehicle ownership models – or even challenging the incumbent system of automobility (Sovacool

& Axsen, 2018). This category can include perceptions of contributing to formal social movements, as well as less formal messaging or social negotiation of norms and values. We use this framework (summarized in Figure 1) to help differentiate types of perceptions that consumers might associate with the various forms of shared, automated, and electric mobility innovations. We expect attribute perceptions associated with each mobility type will differ in each category.

Figure 2: Conceptual framework categorizing private vs. societal and functional vs. symbolic perceptions towards the new mobilities.



1.3 Case study context

To provide context, we provide a brief overview of our focal regions of Metro Vancouver, the Greater Toronto Area, and the Metropolitan Montreal Area. We highlight population characteristics and key trends specific to the new mobility technologies.

Metro Vancouver

Metro Vancouver is a federation of twenty-one local governments, with a total population of around 2.5 million. The population has been growing by about 30,000 residents per year and is expected to reach 3.6 million by 2050. Cars and trucks alone contribute around one-third of Metro Vancouver's overall GHG emissions, which is the largest source of emissions in the region (Metro Vancouver, 2019). Key trends regarding the new mobility innovations specifically are as follows:

Shared mobility

- Ride-hailing became available in Metro Vancouver beginning in early 2020, following a lengthy regulatory process. Uber and Lyft are the largest operational ride-hailing companies in the region, with some smaller, regional services emerging (e.g., Kater).
- Metro Vancouver has been referred to as the "car-sharing capital" of North America, with over 5,000 car-sharing vehicles and over 300,000 members in the region as of January 2018 (Movmi, 2019). The largest car-sharing networks in Metro Vancouver are Evo and Modo. ShareNow (formerly known as Car2Go) also had a large presence, though the company ceased operations in Metro Vancouver in February 2020.

Automated mobility

- While there are no private FAVs available in Canada, the City of Vancouver and the City of Surrey have partnered to pilot a fully-automated shuttle trial that can transport 12 passengers along a fixed route[2].

Electric mobility

- Electric vehicle market share in BC is the highest in the country, with BEVs and PHEVs accounting for around 10% of new vehicle market share in 2019 (Electric Mobility Canada, 2019). In BC, electric vehicle sales are bolstered by a suite of provincial electric vehicle-supportive policies, including incentives, a zero-emissions vehicle mandate and low-carbon fuel standard, and numerous public outreach programs.

Greater Toronto Area

The Greater Toronto Area (which we will call Greater Toronto) is the largest urban region in Canada, with a population of around 6.5 million. Key trends related to the new mobility innovations are:

Shared mobility

- Ride-hailing has been available in Greater Toronto since Uber began operations in 2012. Lyft started operating in Greater Toronto in 2017.
- Greater Toronto has several car-sharing services in operation, including Enterprise CarShare, Zipcar, and Communauto. As of 2017, there are just over 1600 car-sharing vehicles in Greater Toronto (Vancity, 2018).

[2] http://www.ridewithela.ca/

Automated mobility

- Uber has been testing automated driving and navigation (with a driver and employee in the vehicles) in Toronto since 2017[3]. Further, the City of Toronto plans to begin a fully-automated shuttle trial in fall 2020 to transport passengers between subway stations during peak congestion[4] (note: it is unclear if COVID-19 will impact the schedule of this trial).

Electric mobility

- Ontario had an electric vehicle market share of around 2% in 2019 – which is the third highest in Canada (Electric Mobility Canada, 2019). Sales of BEVs and PHEVs in Ontario have decreased following the removal of provincial incentives in 2018.

Metropolitan Montreal Area

The Metropolitan Montreal Area (which we will call Metro Montreal) consists of 82 municipalities, with over 4 million residents. As in Vancouver, transport is the largest sources of GHG emissions in the region, where road transport contributes to 31% of total emissions. Key trends regarding the new mobility innovations include:

Shared mobility

- Ride-hailing has been available in Metro Montreal since 2014 when Uber launched operations. Lyft began operating in Metro Montreal in 2019.
- Car-sharing in Metro Montreal is dominated by a service called Communauto (Car2Go had a similarly large presence until it ceased operations in February 2020). As of 2017, there are over 2,000 car-sharing vehicles available in Metro Montreal (Vancity, 2018).

Automated mobility

- The City of Montreal recently completed (in 2019) a pilot project to test two, 12-passenger fully-automated shuttles between the Olympic Stadium and the metro system[5].

Electric mobility

- The Province of Quebec had an electric vehicle market share of 7% in 2019 - the second highest in the country after BC (Electric Mobility Canada, 2019). Quebec has several strong policies for supporting electric vehicles, including incentives, the country's first zero-emissions vehicle mandate, as well as public outreach initiatives.

Given these differing contexts, we expect that awareness, adoption, and interest in adopting the new mobility innovations will vary among respondents in each metro region.

[3] https://www.uber.com/ca/en/atg/
[4] https://www.toronto.ca/services-payments/streets-parking-transportation/automated-vehicles/automated-vehicles-pilot-projects/automated-shuttle-trial/
[5] https://electricautonomy.ca/2019/09/17/canadas-autonomous-vehicle-pilots/

1.4 Research objectives

The objectives of this study are to:

1. Describe consumer *awareness*, *adoption, interest* in adopting, and *perceptions* of shared, automated, and electric mobility innovations;
2. Compare these responses across metro regions (Metro Vancouver, Greater Toronto Area, and Metropolitan Montreal Area);
3. Identify the characteristics of consumers that are more likely to adopt each innovation (e.g., demographic details, values, and lifestyle); and
4. Describe consumer support (or opposition) to policies that may guide the deployment of new mobility innovations.

This report is organized as follows. Section 2 provides an overview of our method, including survey design and sampling strategy. The bulk of the report (Sections 3-10) then showcases our results, largely organized the objectives listed above. Results first begin by highlighting travel patterns of Metro Vancouver respondents and general familiarity with all new mobility innovations. We then focus on assessing Metro Vancouver responses for each of the new mobility categories in turn and exploring characteristics associated with adoption/interest in adoption, before turning to a comparison with the other metro areas. Results end with policy support and opposition results. We then provide conclusions and key takeaways in Sections 11 and 12.

2. Method

2.1 Survey design

We designed and implemented an online survey to a sample of Canadians aged 19 years and older. The survey consisted of nine sections, as shown in Figure 3:

Figure 3: Overview of survey sections.

Section A: Vehicle ownership details

- Number and type of vehicles owned

Section B: Travel patterns

- Modes used in summer and winter; frequency of modes used
- Types of trips; modes used for different trip types

Section C: Ride-hailing

- Awareness, adoption, interest in using

Section D: Car-sharing

- Awareness, adoption, interest in using

Section E: Automated Vehicles

- Awareness, adoption, interest in purchasing/using

Section F: Electric vehicles

- Awareness, adoption, interest in purchasing
- Interest in combining with shared and automated vehicles

Section G: Perceptions of new mobilities

- Perceptions of attributes
- Image associations

Section H: Policy support

- New mobility technology regulations
- Road pricing
- Other low-carbon transport policies

Section I: Respondent details

- Demographics
- Lifestyle engagement
- Values

2.2 Sampling and data collection

The survey was administered to a total of 3658 respondents in all Canadian provinces aged 19 and older in May and June 2020. Respondents were recruited by a market research company, who provided respondents with a $4.50 incentive for completing the survey. We oversampled the Metro Vancouver, Greater Toronto Area, and Metropolitan Montreal Area regions. In this report we focus on the Metro Vancouver sample (*n* = 993) and provide key comparisons to the Greater Toronto (*n* = 794) and Metropolitan Montreal Areas (*n* = 819) (in Section 8).

We also oversampled respondents who live in four neighbourhood types that differ in their population density and residents' primary commuting mode: active cores, transit suburbs, near auto suburbs, and far auto suburbs (Gordon & Janzen, 2013). Figure 4 depicts Metro Vancouver respondents sampled in each neighbourhood type. This urbanization classification system categorizes each census tract[6] in a region considering the population's main travel mode to commute to work (relative to the Metro Vancouver and Canadian population as a whole), population density, and distance from the City of Vancouver (Gordon, Hindrichs, & Williams, 2018; Gordon & Janzen, 2013). We defined these categories as follows:

- ***Active cores*** are defined as areas where a higher proportion of residents use active transport (walking or cycling) to commute to work. Specifically, active cores include census tracts with a 150% higher rate of active travel than the overall Metro Vancouver average and a 50% greater rate of active travel than the national average for the journey to work.
- ***Transit suburbs*** are defined as areas where a higher proportion of residents commute by transit. Specifically, transit suburbs include census tracts with a 150% higher rate of transit use than the Metro Vancouver average, a 150% lower rate of active transit than the Metro Vancouver average, and a 50% higher rate of transit use than the national average for the journey to work.
- **Auto suburbs** are defined as areas where almost all residents commute by car and there is negligible active transport or public transit use. Specifically, auto suburbs include census tracts with a 150% lower rate of transit use than the Metro Vancouver average and a 150% lower rate of active transport than the Metro Vancouver average for the journey to work. We split the auto suburbs into roughly equal sub-categories based on distance from the City of Vancouver and population density.
    - ***Near auto suburbs*** are census tracts located north of the Fraser River and west of the Pitt River, with population densities of at least 150 people/km^2. This includes parts of Vancouver, West Vancouver, North Vancouver, Richmond, Coquitlam, Port Moody, and New Westminster.

[6] Census Canada defines census tracts as "small, relatively stable geographic areas that usually have a population between 2,500 and 8,000 persons. They are located in census metropolitan areas and in census agglomerations that had a core population of 50,000 or more in the previous census." (https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/geo/ct-sr/def-eng.htm)

- *Far auto suburbs* are census tracts located south of the Fraser River and east of the Pitt River (including Surrey, Delta, Langley, White Rock, Pitt Meadows, and Maple Ridge). Far auto suburbs also include census tracts with population densities less than 150 people/km^2.

Sample sizes for each neighbourhood type in Metro Vancouver are (adding up to 993 for the region):

- Active core *n* = 247 (actual N in 2016 = 335,929)
- Transit suburb *n* = 240 (actual N in 2016 = 321,652)
- Near auto suburb *n* = 252 (actual N in 2016 = 885,451)
- Far auto suburb *n* = 254 (actual N in 2016 = 758,068)

Note that we also applied this neighbourhood-type sampling protocol in the Greater Toronto Area and Metropolitan Montreal Area, though we do not show those results here.

As noted below in Section 2.4, any analyses at the Metro level apply corrective weighting to mitigate any biases introduced by these oversamples (i.e., so respondents in neighbourhoods that are over-represented and under-represented do not systematically impact results).

Figure 4: Respondents in Metro Vancouver sample in each neighbourhood type. Larger dot sizes correspond to larger numbers of respondents sampled in a given census tract.

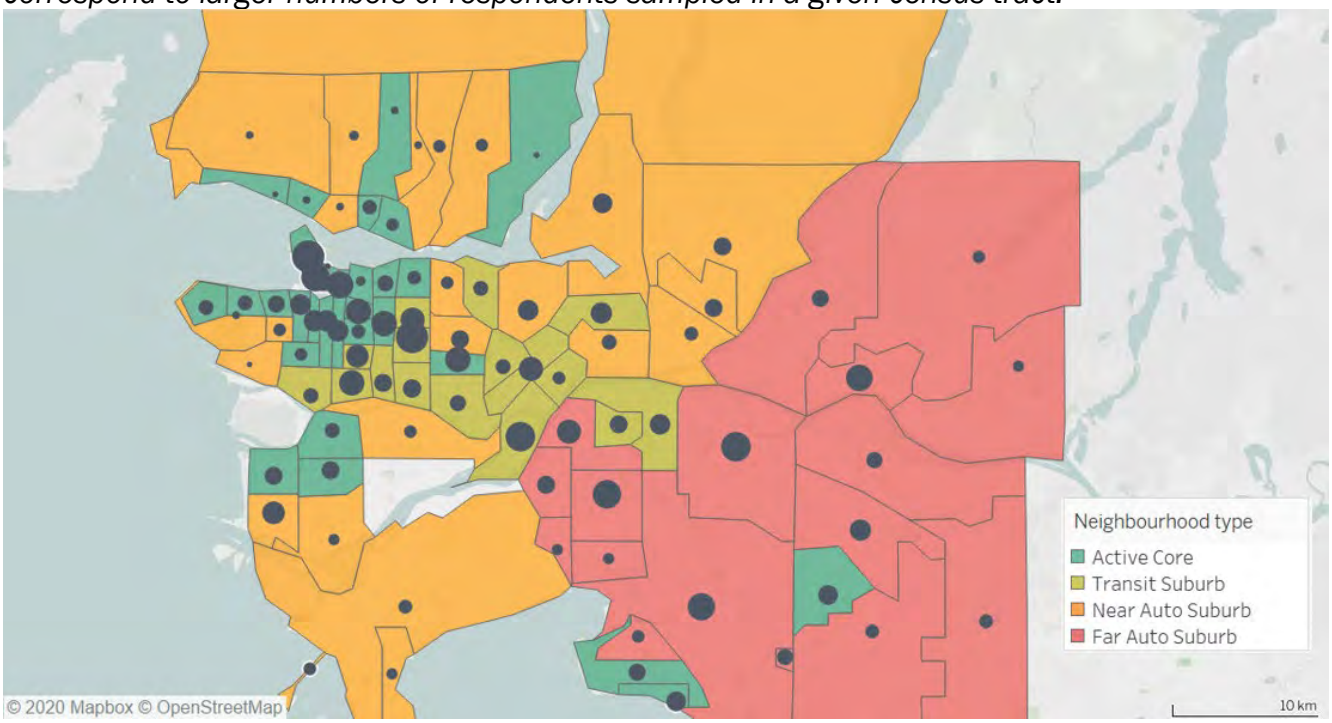


Table 1 displays the demographic details of the Metro Vancouver sample, compared to the Metro Vancouver population. In general, the survey sample tends to be slightly more educated and higher income earning compared to the population.

Table 1: Metro Vancouver sample (weighted to correct for neighbourhood oversamples) and population demographic characteristics (from the 2016 Canadian census).

	Metro Vancouver sample	Metro Vancouver population
Size	993	1,990,405
Age		
19-24	10%	10%
25-34	19%	18%
35-44	18%	17%
45-54	15%	19%
55-64	17%	17%
65 or older	22%	19%
Education		
High school or less	20%	39%
Some university, college diploma, or trades certificate	34%	28%
Bachelor's degree	27%	21%
Graduate or professional degree	20%	11%
Income (pre-tax)		
Less than $40,000	19%	27%
$40,000-$59,999	16%	15%
$60,000-$89,999	22%	19%
$90,000-$124,999	25%	16%
$125,000 or more	18%	24%
Gender		
Male	46%	49%
Female	54%	51%
Neighbourhood type		
Active core	16%	16%
Transit suburb	15%	15%
Near auto suburb	36%	36%
Far auto suburb	33%	33%

2.3 Addressing COVID-19

As we collected data during the COVID-19 pandemic, the survey instrument specifically addressed how the pandemic has impacted respondents' travel patterns (i.e., due to social distancing, not commuting to work or school, etc.). In survey Section B (travel patterns), we repeatedly reminded respondents that "*We know there are disruptions to your usual movement outside of your home due to social distancing. Please answer about your usual patterns, before social distancing.*"

Throughout the survey, when questions were asked about future use of transport modes, the survey included reminders that "*we mean once social distancing measures are fully removed*". We also asked several questions to explore if respondents expect that the impacts of COVID-19 might influence their travel behaviour once social distancing measures are lifted (with results shown in Section 3.2).

2.4 Analytical methods

Most of this report focuses on descriptions of responses to survey questions. We calculate proportions of responses to survey questions in each section of the survey. To correct for any biases introduced by the neighbourhood type oversamples, we calculate and apply corrective weighting to all analyses. Weights are calculated by comparing the survey sample neighbourhood type proportions to the Metro Vancouver population neighbourhood type proportions (such that respondents in under-represented neighbourhoods receive a weight greater than one and respondents in over-represented neighbourhoods receive a weight less than one). Weights are applied when examining the overall Metro Vancouver sample.

To identify consumer characteristics associated with adopting new mobility innovations, we estimate several multiple linear regression models. We explore characteristics of respondents who have adopted and those who are interested in adopting (dependent variables) ride-hailing, car-sharing, FAVs, and BEVs. For ride-hailing and car-sharing, we estimate two models per innovation, one for those who have already adopted the innovation and one for those who are interest in using the innovation. We estimate one model for interest in purchasing a FAV with a steering wheel (where the automation feature can be switched off) and one model for interest in purchasing a BEV (the sample size of BEV adoption was too small for a separate regression model). Independent variables relate to respondents' psychological constructs, contextual characteristics, neighbourhood type, travel patterns, and demographics.

Psychological constructs consist of values, lifestyles, and environmental concern, assessed in the survey as follows:

- Values were assessed via Stern et al.'s (1998) 15-item value scale derived from the Schwartz Value Survey, which asks respondents to rate the importance of biospheric, altruistic, traditional, egoist, and openness to change values on a four-point scale ranging from 1 (*"not at all important"*) to 4 (*"extremely important"*). Biospheric value questions include statements about respecting and protecting the earth and unity with nature. Altruistic value questions include statements about social justice and equality. Traditional value questions focus on family security, self-discipline, and showing respect, while egoist value questions include statements about the role of authority, social power, and wealth. Openness to change values focus on attraction to novelty, new experiences, and curiosity (Stern et al., 1998).
- Lifestyle engagement was measured via a 10-item scale developed by Axsen, TyreeHageman, and Lentz (2012), which consists of questions about how often

respondents engage in ten activities (five each for technology- and environment-oriented lifestyle) on a five-point scale ranging from 1 (“never”) to 5 (“very frequently”). The five technology-orientation measures include activities such as researching new technology and working on tinkering with technology, while the environmental-orientation measures included activities such as promoting environmental conservation and attending environmental meetings.

- Environmental concern was measured via an eight-item version of the New Environmental Paradigm (NEP) scale (Cordano, Welcomer, & Scherer, 2003). Examples of the items from the scale include “the balance of nature is very delicate and easily upset,” “humans were meant to rule over the rest of nature” (reverse coded), and “humans are severely abusing the environment,” where response options range from 1 (“strongly disagree”) to 5 (“strongly agree”).

3. Travel characteristics

In this section we provide key results relating to Metro Vancouver respondents' travel characteristics. This section of the survey helped respondents to think about how and why they get around. This section provides background to understand the primary modes and types of trips respondents take, and how they expect these to change (or not) in light of the COVID-19 pandemic.

Key takeaways include:

- Before the pandemic (in February 2020), the most frequently used modes were driving alone (71% of respondents use this at least once a week), driving with passengers (67%), walking (67%), and public transit (34%). Summer mode usage (also before the pandemic) follows similar patterns, with slightly higher usage of active travel modes.
- When asked about a future without social distancing respondents report a number of potential changes, such as: 25% of respondents expect to increase walking frequency, 13% expect to increase cycling frequency, 33% expect to decrease or stop using public transit, 22% expect to decrease or stop using rides from friends or family members, and 20% expect to decrease or stop using taxis.

3.1 Travel patterns in Metro Vancouver

Here we summarize some basic patterns of respondents' travel behaviour, including winter and summer mode usage and modes used for trip types.

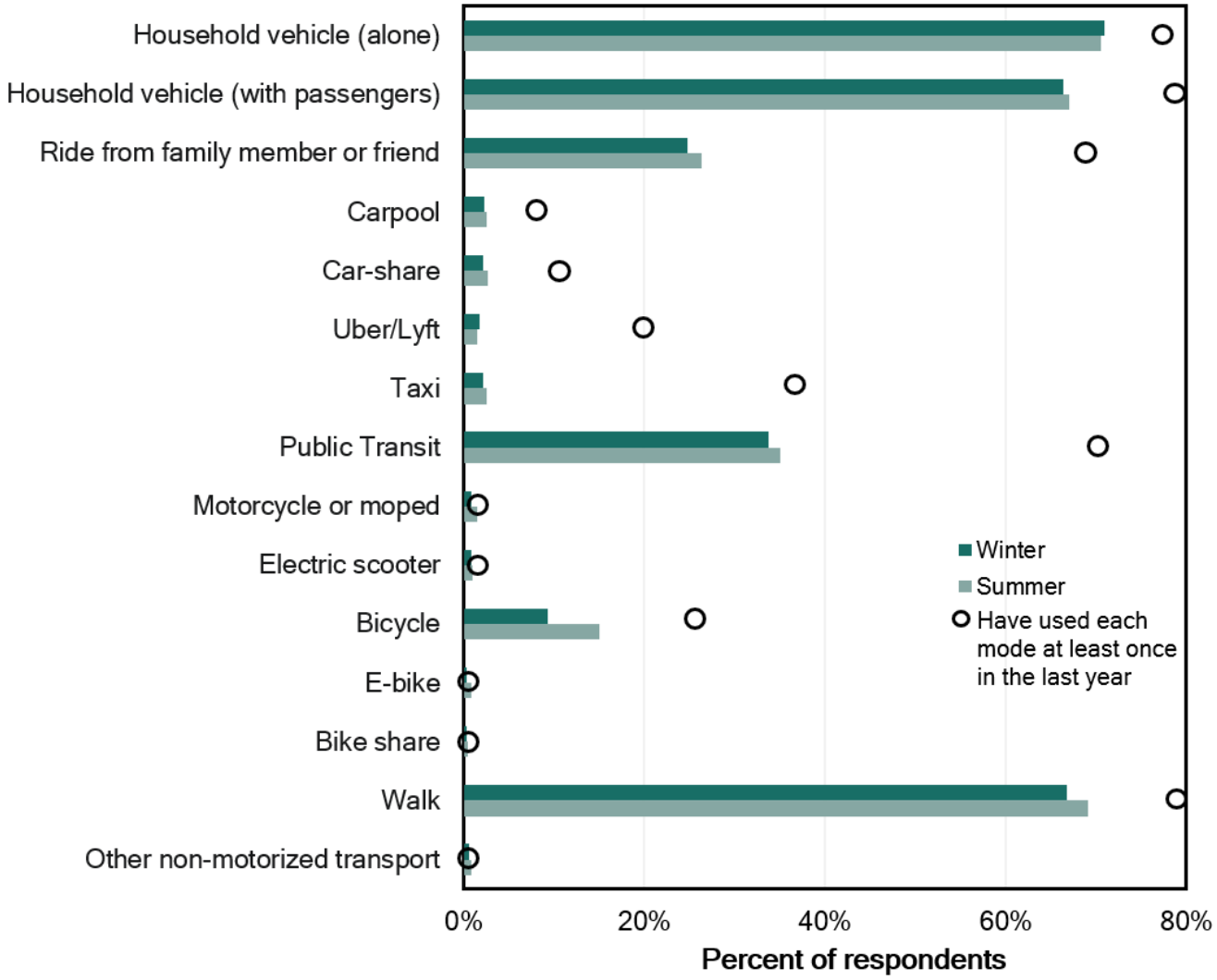
The survey asked respondents to report which modes they regularly use to get around in their everyday lives. We framed this in multiple ways, asking mostly about past mode usage, before the COVID-19 pandemic. Figure 5 depicts the proportions of respondents that use various modes at least once a week, in the winter (e.g., February 2020) and summer (e.g., June 2019). The survey asked respondents to indicate how frequently they used each mode during a typical week in February 2020 (to represent winter patterns) and June 2019 (to represent summer patterns). For comparison, the open circles in Figure 5 show the proportion of respondents that used each mode at least once on the last year. Generally, modes used in the winter and summer are very similar (aside from cycling, which is used by a greater proportion of respondents in the summer). Other observations include:

- The most frequently used mode is the household vehicle: 71% of respondents use a household vehicle alone at least once a week (in winter and summer), and 67% of respondents use their household vehicle with other passengers
- The next most common mode used is walking – used by 69% of respondents at least once a week in the summer and 67% of respondents in the winter.
- Public transit is used by 34%-35% of respondents at least once a week.
- 15% of respondents cycle at least once a week in the summer, while only 9% do so in the winter.

- Regarding shared modes, only 2%-3% of respondents use an organized carpool, car-sharing network, ride-hailing service, or taxi at least once a week.

The order of modes used at least once a week that we observe is consistent with patterns of mode shares in Metro Vancouver. The largest mode share is private vehicle driver, followed by being a private vehicle passenger, walking, taking transit, and cycling (Metro Vancouver, 2017).

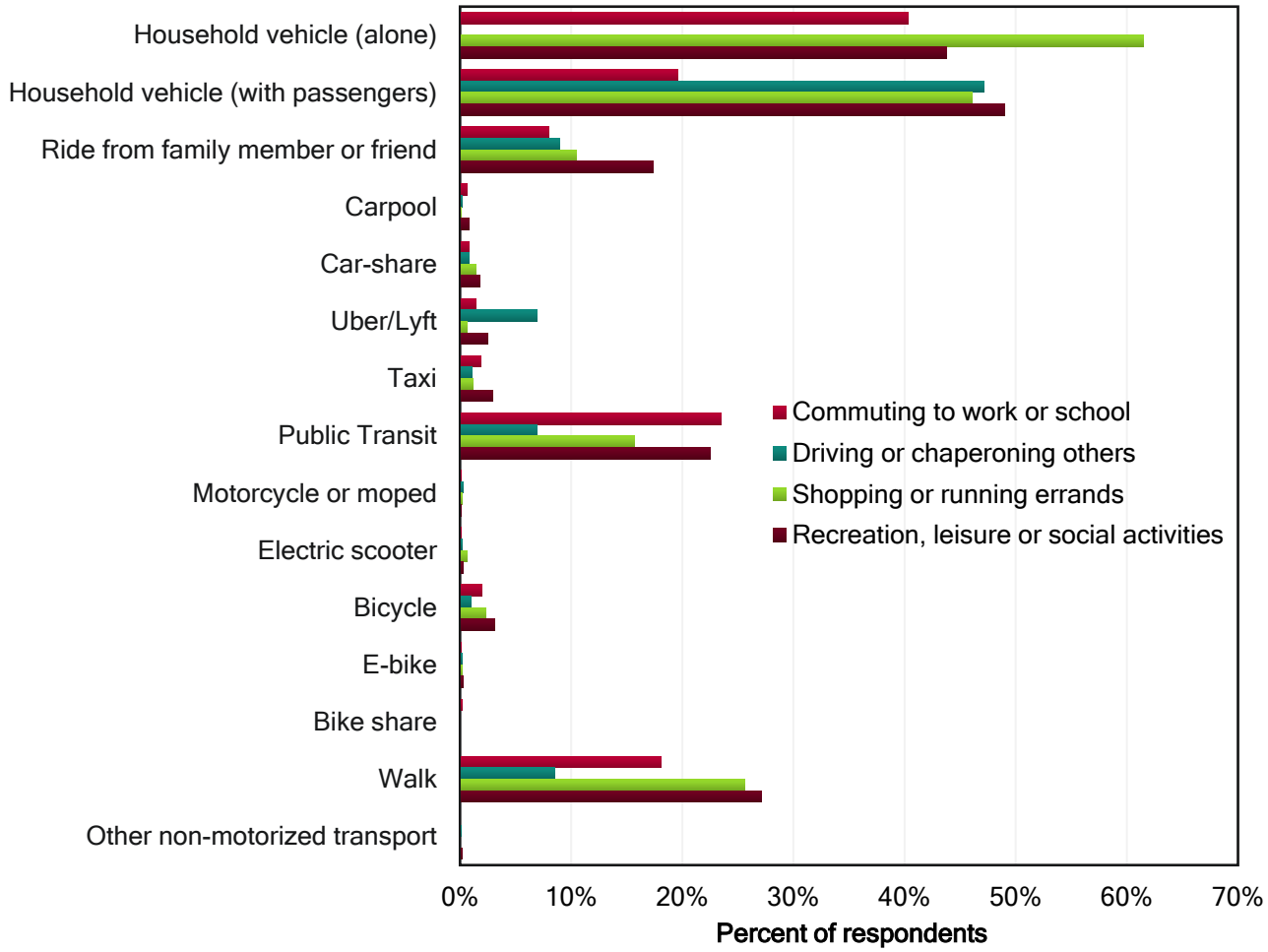
Figure 5: Percent of respondents that use each mode at least once a week in winter (February 2020) and summer (June 2019), and at least once in the last year (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



We also asked respondents which modes they use for a variety of trip types (again, before the COVID-19 pandemic). Figure 6 displays modes respondents use for different trip types: commuting to work or school, driving or chaperoning others, shopping or running errands, and recreation, leisure, or social activities. Patterns mostly mirror those observed in Figure 5, where the most used modes (for all trip types) are household vehicles (alone and with passengers), walking, and public transit. Regarding each trip type:

- Respondents *commute to work or school* mostly by household vehicle alone (40% of respondents), followed by public transit (24%), household vehicle with other passengers (20%), and walking (18%).
- Respondents *drive or chaperone others* predominantly by a household vehicle with passengers (47% of respondents), with a smaller share of respondents using a ride from a friend/family member (9%), walking (9%), and public transit (7%).
- Trips for *shopping or running errands* are also mostly done by household vehicle alone (62% of respondents), followed by a household vehicle with other passengers (46%), walking (26%), and public transit (16%).
- Respondents travel for *recreation, leisure, or social activities* predominantly by household vehicles, both with other passengers (49% of respondents) and alone (44%). Walking (27%) and public transit (23%) are also frequently used modes for recreation, leisure, and social activity trips.

Figure 6: Percent of respondents that use each mode for various trip types (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).

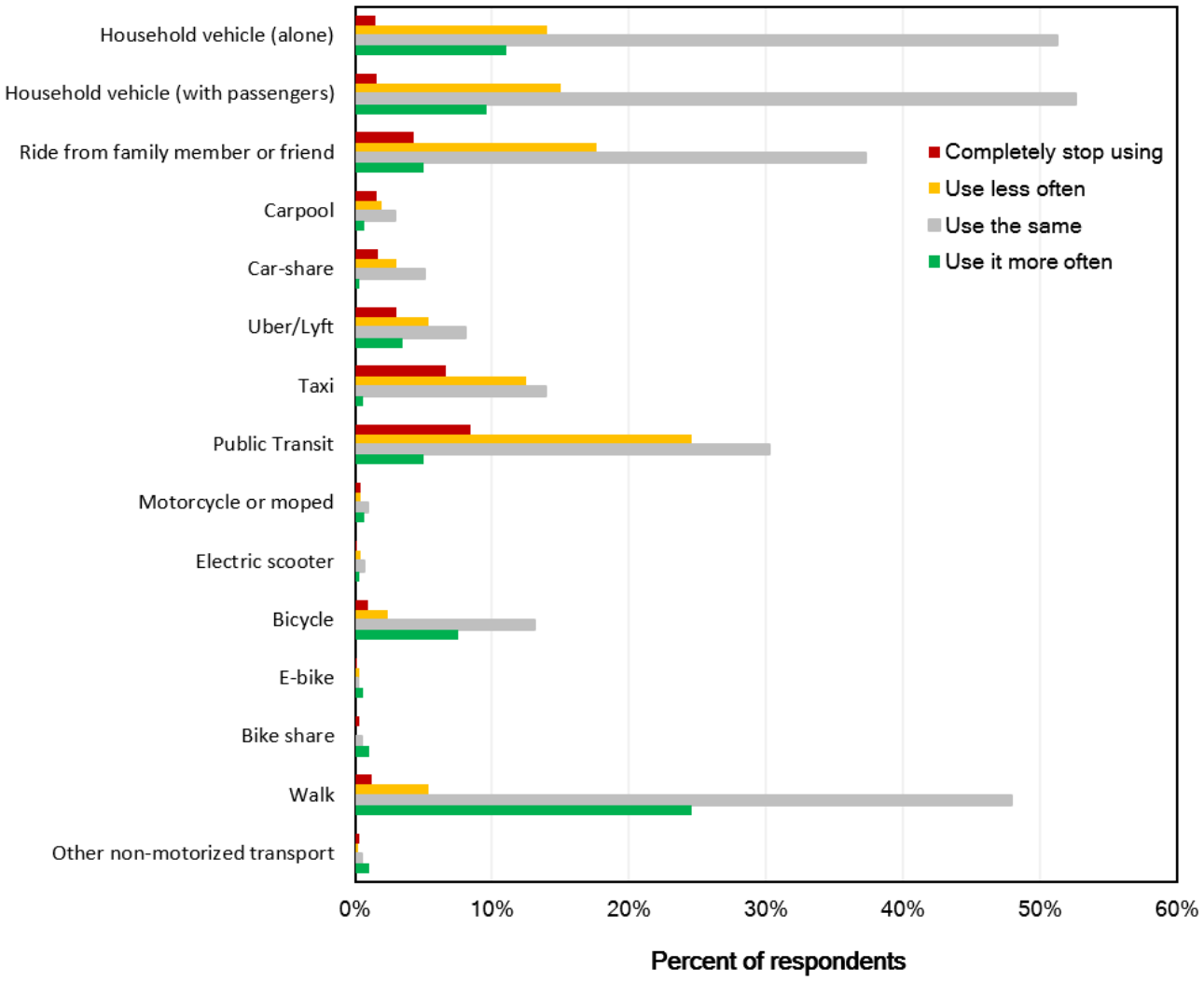


3.2 Anticipated impacts of COVID-19 on travel patterns

As the survey was implemented while measures to control the spread of COVID-19 (e.g., social distancing) were in effect (June 2020), the survey asked respondents how the pandemic might impact their future travel patterns. The survey showed respondents a list of modes they currently use (at least one in the last year) and asked respondents *"We would like to know if your future travel patterns will differ from your past travel patterns. In a future world without social distancing, do you anticipate that you will use any transportation types more or less frequently?",* with response options of "*completely stop using this travel type", "use it less often", and "use it more often".* Overall, many respondents expect to use modes the same as currently, active modes more often, while expecting to use public transit, taxis, Uber/Lyft, as well as household vehicles and rides from friends or family members to some extent, less often or not at all (Figure 7). More specifically:

- When it comes to *maintaining* mode use, 51%-53% of respondents expect to use household vehicles (alone and with other passengers), 48% expect to walk, and 30% expect to use public transit the same amount as they currently do.
- When it comes to *increasing* mode use, 25% of respondents expect to walk more often, 13% expect to cycle more, and 10% expect to use household vehicles alone or with other passengers more often.
- Many respondents expect to *reduce or completely stop* using some modes, such as public transit (33%), taxis (20%), rides with friends or family members (22%), and surprisingly private vehicles with passengers (17%) and alone (16%).

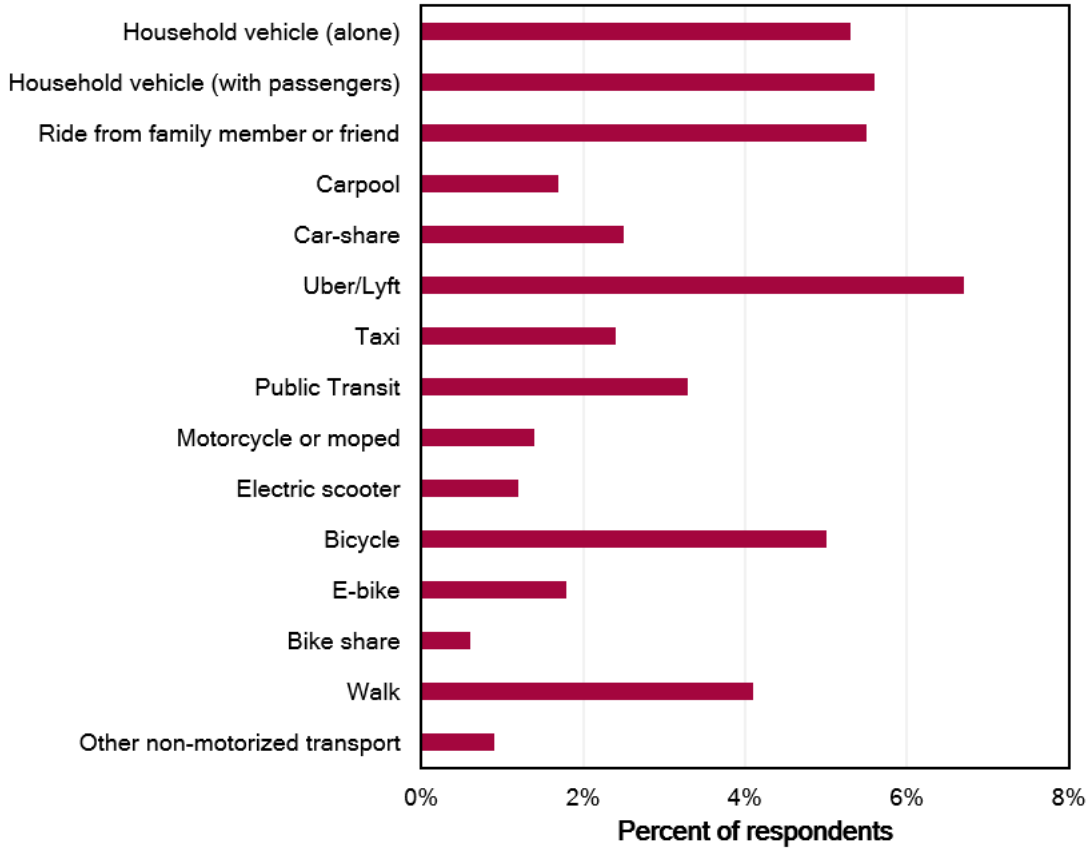
Figure 7: Expected changes in mode usage after social distancing measures are removed (full Metro Vancouver samples, n=993, with corrective weighting for neighbourhood oversamples).



The survey then showed respondents a list of modes they do not currently use and asked them to indicate modes they plan to start using in the following year, after social distancing measures are removed (Figure 8). Specific observations are:

- Almost 7% of respondents plan to start using Uber or Lyft.
- Around 5% of respondents plan to start using a household vehicle (alone and with other passengers) and to get a ride with friends or family members.
- 5% of respondents plan to start cycling.
- 4% of respondents plan to start walking.
- 3.5% plan to start using public transit.
- Only a minority of respondents (less than 3%) plan to start carpooling, car-sharing, using taxis, or any other mode.

Figure 8: Percentage of respondents that plan to start using each mode in the following year once social distancing measures are removed (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



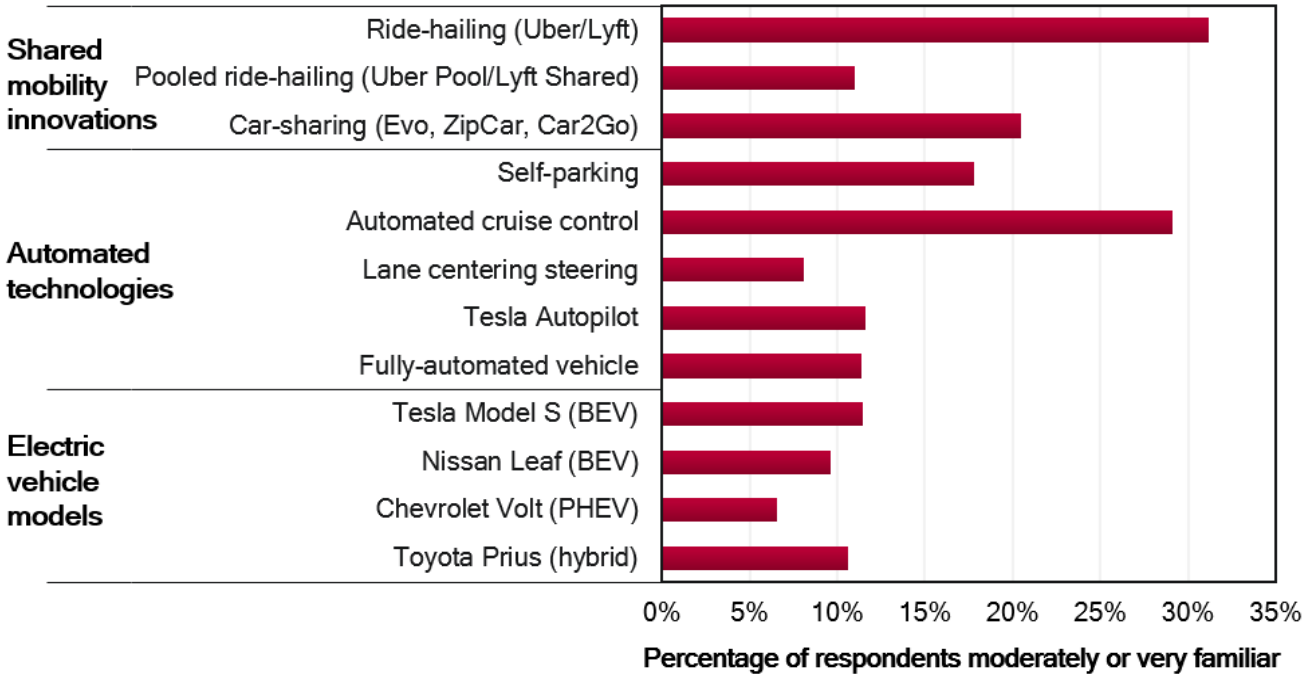
4. Overall familiarity with new mobility innovations

The survey assessed how familiar respondents are with each new mobility innovation, where we define "familiar" as those that selected "moderately familiar" or "very familiar" in the survey. Generally, familiarity with shared mobility innovations tends to be higher than with the other new mobility innovations (*Figure 9*).

Key takeaways include:

- Out of the shared innovations, familiarity is highest with ride-hailing (31% of respondents are "moderately" or "very familiar"), while 21% are familiar with car-sharing, and 11% are familiar with pooled ride-hailing.
- Among the automated technologies, familiarity is highest for automated cruise control (29% are familiar), followed by self-parking (18%), Tesla Autopilot (12%), fully-automated vehicles (11%), and then lane centering steering (8%).
- For electric mobility innovations, the survey asked respondents about specific electric vehicle models. Familiarity with the most common BEVs (the Tesla Model S and Nissan Leaf) are similar, with 12% considering themselves familiar with the Tesla Model S and 10% with the Nissan Leaf. Familiarity with the Chevrolet Volt (PHEV) is lower, with only 7% of respondents considering themselves familiar with it. By comparison, 11% are familiar with the Toyota Prius hybrid.

Figure 9: Respondent familiarity ("moderately familiar" and "very familiar") with shared, automated, and electric mobility innovations (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



5. Shared mobility innovations

This section displays results related specifically to the shared mobility innovations: ride-hailing and car-sharing. We assess respondent *awareness* with shared mobility types, *adoption* of these innovations, *interest* in adopting them, *expected impacts* of the shared mobility innovations on travel and residence choices, and general *perceptions* of shared mobility.

Key takeaways include:

- *Awareness* (having heard of these services and believing are available in local areas) is generally highest among respondents in active cores and lowest among respondents in far auto suburbs. For example, 78% of those in active cores think the car-sharing company Evo (a car-sharing service in Metro Vancouver) is available where they live, whereas 19% of respondents in far auto suburbs think Evo is available where they live.
- More respondents have heard of Uber and Lyft than the pooled forms of these services – 88%-97% of respondents have heard of Uber and Lyft whereas only 31%-43% have heard of Uber Pool and 30%-36% have heard of Lyft Shared.
- *Adoption* (past usage) of ride-hailing is highest among those in active cores (30%) and lowest among those in far auto suburbs (14%) – the same is true of car-sharing adoption (41% in active cores vs. 7% in far auto suburbs).
- Of those who use ride-hailing, over two-thirds use it only once a month or less. Of those who use car-sharing, less than one-third use it a few times a month or more. With both ride-hailing and car-sharing, those in far auto suburbs use them the least frequently.
- *Interest* in (among those who have and have not adopted) the shared mobility innovations is highest for ride-hailing and similar between neighbourhood types (29% are interested in ride-hailing overall). Interest in car-sharing is just as high among those in active cores (34%) and much lower among those in far auto suburbs (8%).
- 87%-95% of respondents perceive that being able to use shared mobility will not impact their use of cars, transit, active travel, or proximity to downtown cores.
- *Perceptions* toward ride-hailing and car-sharing are largely similar, with 60% of respondents or more perceiving the services as convenient, requiring trust, and being part of the future.

5.1 Awareness of shared mobility innovations

For shared mobility innovations (ride-hailing and car-sharing), the survey asked respondents if they have "heard of" several common ride-hailing and car-sharing companies, and then followed up by asking respondents if they think that each company or service is available where they live. Figure 10 shows the proportions of respondents that have heard of ride-hailing and car-sharing companies, split up by neighbourhood type. Generally, proportions of respondents that have heard of the ride-hailing services are similar across each neighbourhood type. Almost all respondents have heard of Uber and Lyft (88%-97%), though fewer have heard of the pooled versions of these services (31%-43% have heard of Uber Pool and 30%-36% have heard of Lyft Shared).

In terms of car-sharing services, awareness is consistently highest among those in active cores and lowest among those in far auto suburbs. Looking at Evo, for example, 88% of respondents in active cores have heard of it, while only 60% of respondents in far auto suburbs have heard of it. Patterns are similar for Car2Go and Modo. Interestingly, only 15% or fewer respondents in each neighbourhood type have heard of Share Now (which is what Car2Go is now called).

Figure 10: Respondents who have "heard of" various ride-hailing and car-sharing companies in each neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).

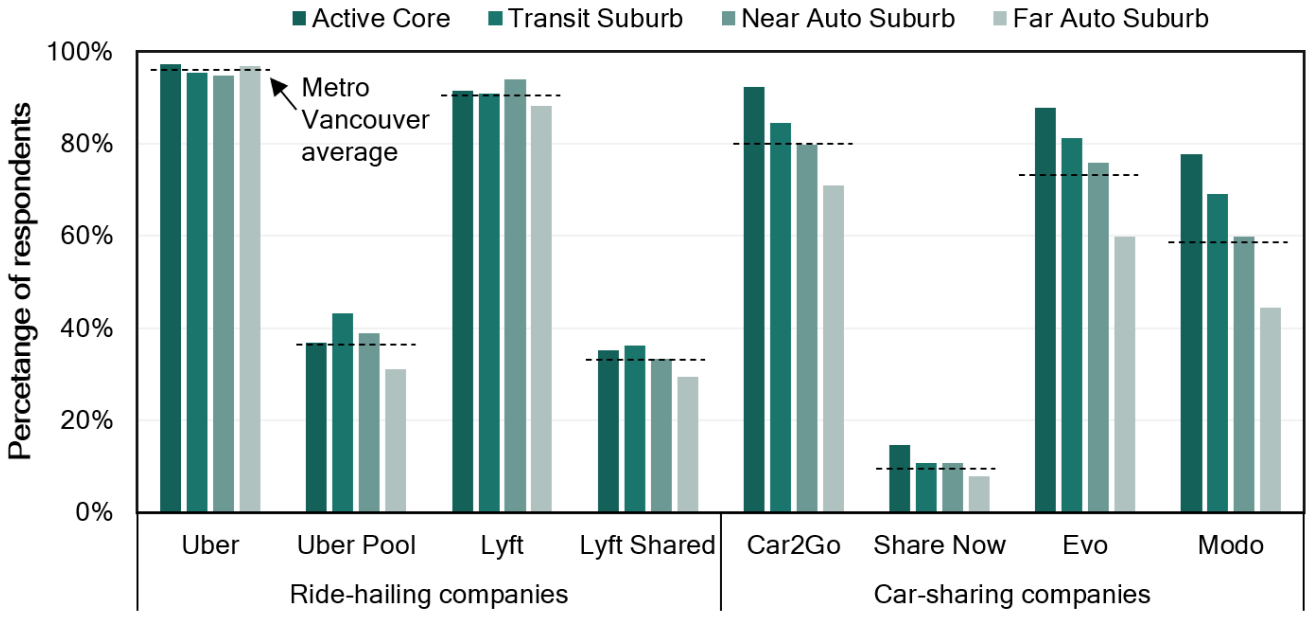
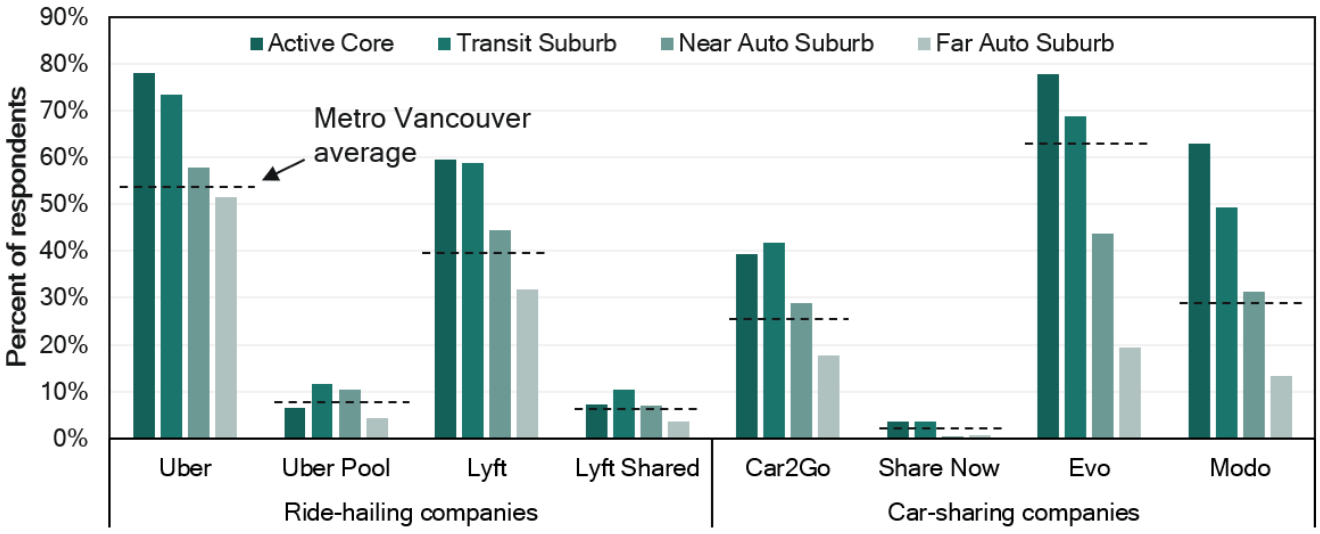


Figure 11 displays the proportions of respondents that think each ride-hailing and car-sharing company is available where they live. In general, those in active cores and transit suburbs are more likely to think that a given service is available where they live compared to those in near and far auto suburbs. This may be a somewhat "accurate" awareness, as such services are more likely to be found in denser, more populous regions of Metro Vancouver. Regarding ride-hailing specifically, again respondents are more likely to think that Uber and Lyft are available where they live (52%-78% for Uber and 32%-60% for Lyft) compared to the pooled versions of these services (4%-12% for Uber Pool and 4%-10% for Lyft Shared).

Of the car-sharing services, Evo receives the highest proportion of respondents that think it is available where they live, though there are large differences between neighbourhood types: 78% of those in active cores think Evo is available where they live, compared to only 19% in far auto suburbs. Perceptions of Modo's availability is similar to Evo. Fewer respondents think Car2Go or ShareNow is available across neighbourhood types – which again could be an accurate perception, as these services ceased operations in Metro Vancouver in February 2020.

Figure 11: Perceptions of ride-hailing and car-sharing companies being available where respondents live in each neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).

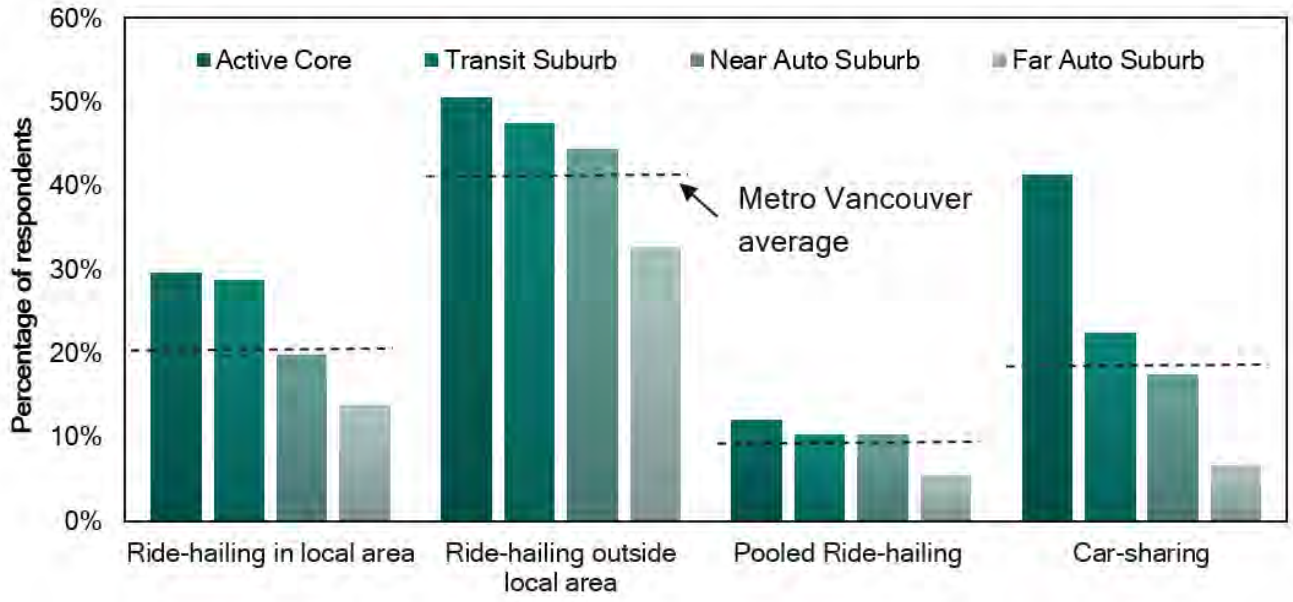


5.2 Adoption of shared mobility innovations

We define "adoption" of ride-hailing as a respondent having used a ride-hailing app (either in respondents' local area or outside their local areas) to arrange a ride at least once in their lives. Overall, 21% of Metro Vancouver respondents reported having used ride-hailing at least once in their local areas (i.e., close to home) and 42% have used it outside their local area (i.e., when out of town on a vacation or business trip), shown by the dashed lines in Figure 12. Adoption of ride-hailing in local areas and outside local areas is similar among those in active cores and transit suburbs (above the overall Metro Vancouver average), with lower adoption among those in near and far auto suburbs. Adoption of pooled ride-hailing specifically is low (12% of respondents or less) and largely similar among neighbourhood types.

We define "adoption" of car-sharing as having become a member of a car-sharing service and using a vehicle at least once. 18% of respondents overall have used car-sharing, with much higher adoption among respondents in active cores (41%) and lowest adoption among those in far auto suburbs (7%).

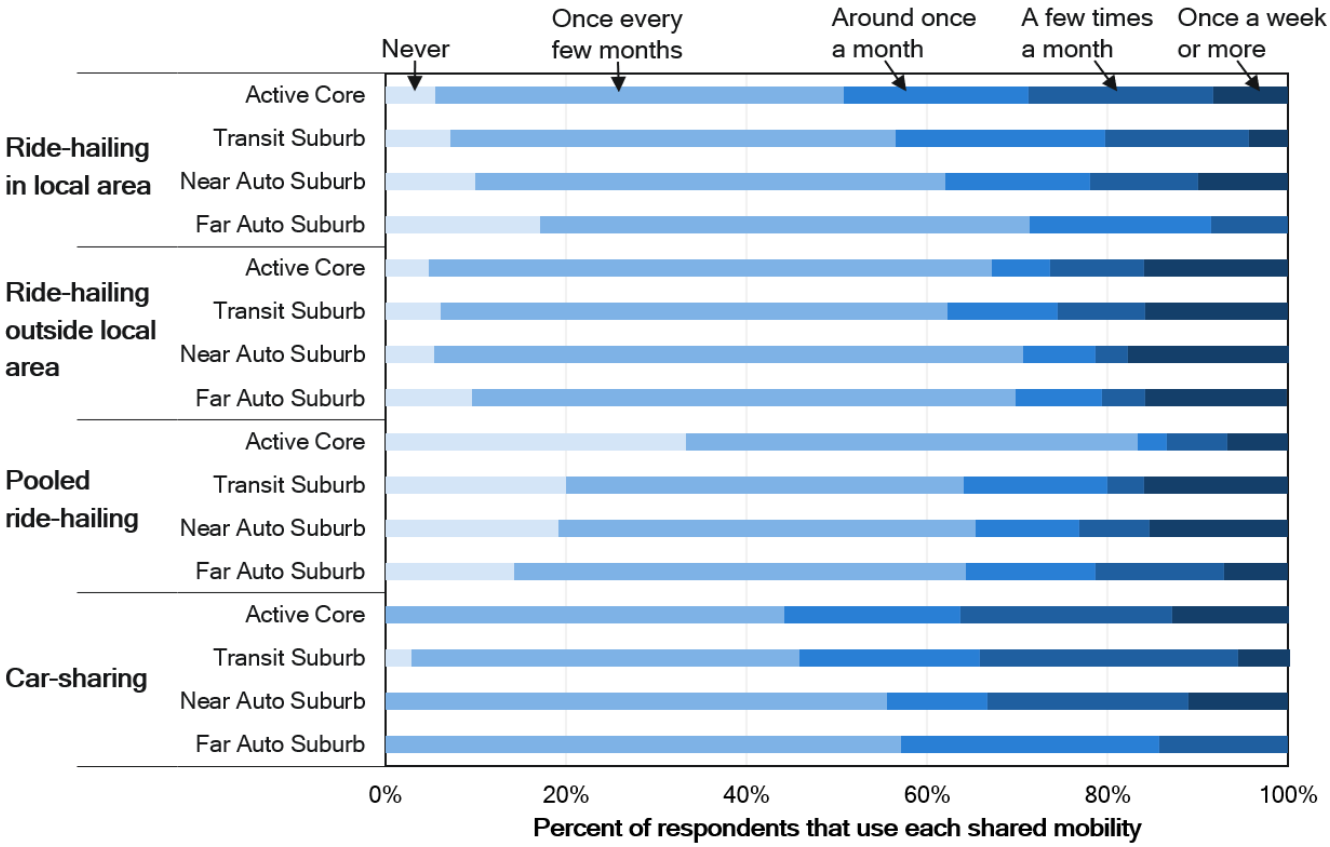
Figure 12: Percentage of respondents that have used each form of shared mobility at least once, by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254). Note that "local area" refers to use in respondents' approximate residential area whereas "outside local area" refers to use when away (e.g., on vacation or business trip).



Respondents who reported having used ride-hailing and car-sharing were then asked how often they use it and for what purpose. Of those who have adopted shared mobility innovations, the majority use any form of it around once a month or less frequently (Figure 13). In general, less than one-third of ride-hailing users use some form of it a few times a month or more. Interestingly, 16%-18% of respondents use ride-hailing outside their local areas once a week or more, such as when on a vacation or business trip.

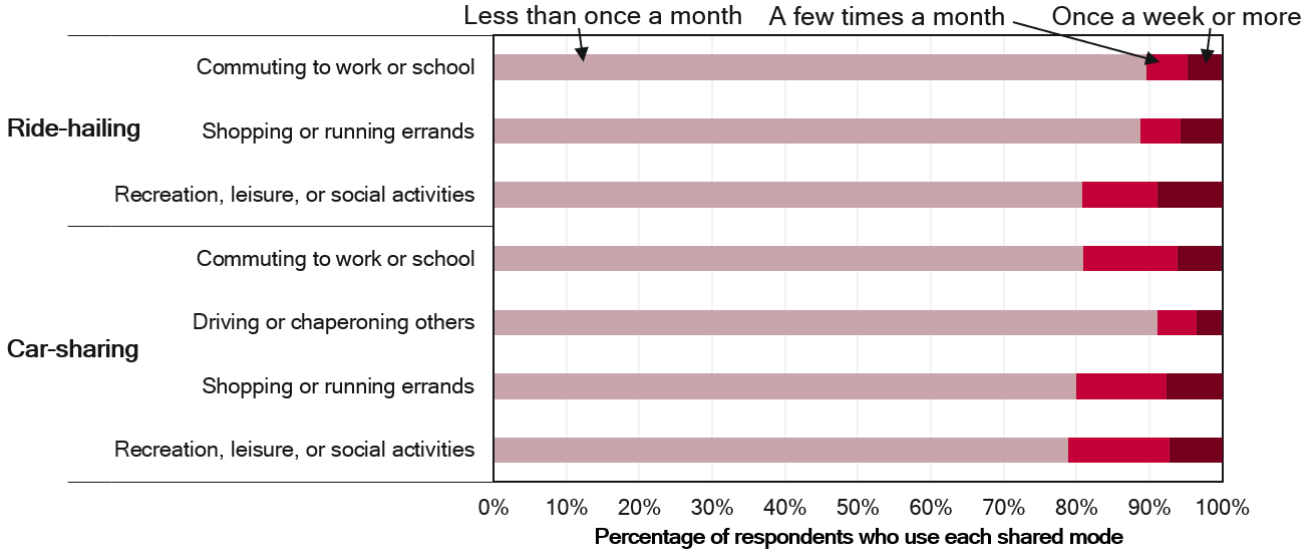
Car-sharing is used slightly more frequently than ride-hailing (especially among those in active cores, transit suburbs, and near auto suburbs), with over one-third of car-sharing adopters using it a few times a month or more (except for those in far auto suburbs).

Figure 13: Frequency of using shared mobility types by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



Regarding the purpose of shared mobility trips for the overall Metro Vancouver sample (Figure 14), ride-hailing is more frequently used for traveling for recreation leisure and social activities (19% of ride-hailing adopters use it for this a few times a month or more) compared to commuting to work or school and shopping or running errands (11% and 12%, respectively, use ride-hailing for these trips a few times a month or more). On the other hand, car-sharing is used similarly as frequently for commuting to work or school (19% use it a few times a month or more), for shopping or running errands (20%), and for recreation, leisure, or social activities (21%). However, car-sharing is used less frequently for chaperoning or driving others (8% use it a few times a month or more for this).

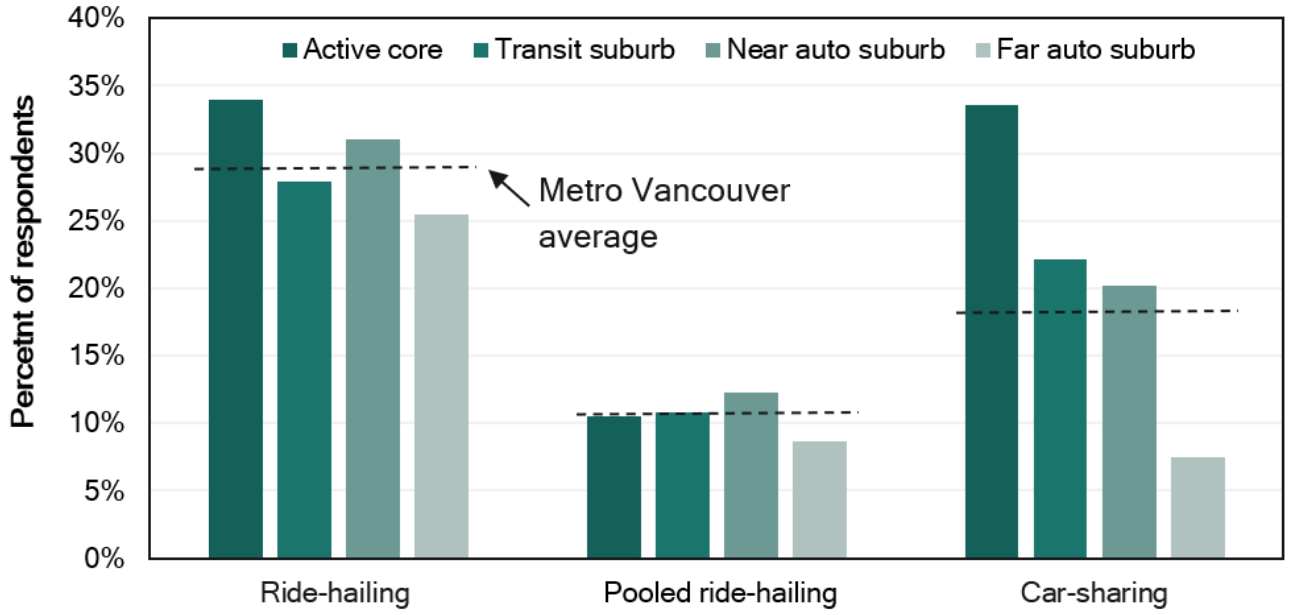
Figure 14: Frequency of using shared mobility types for different trip types (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



5.3 Interest in using shared mobility innovations

All respondents (regardless of whether they have or have not previously used shared mobility forms) were asked how interested they are in using (or continuing to use) ride-hailing, pooled ride-hailing, and car-sharing in the future (Figure 15). Overall, interest in ride-hailing is highest, with 29% of the overall Metro Vancouver sample expressing they are “moderately interested” or “very interested” in using or continuing to use ride-hailing (dashed line in Figure 13). Interest is highest among those in active cores (34%) and lowest among those in far auto suburbs (26%). By comparison, only 11% overall are interested in using pooled ride-hailing, with interest levels being similar among neighbourhood types. 18% of respondents overall are interested in using car-sharing – though interest is quite varied among neighbourhood types. Among those in active cores, 34% are interested in using or continuing to use car-sharing, while only 8% of respondents in far auto suburbs are interested in using car-sharing.

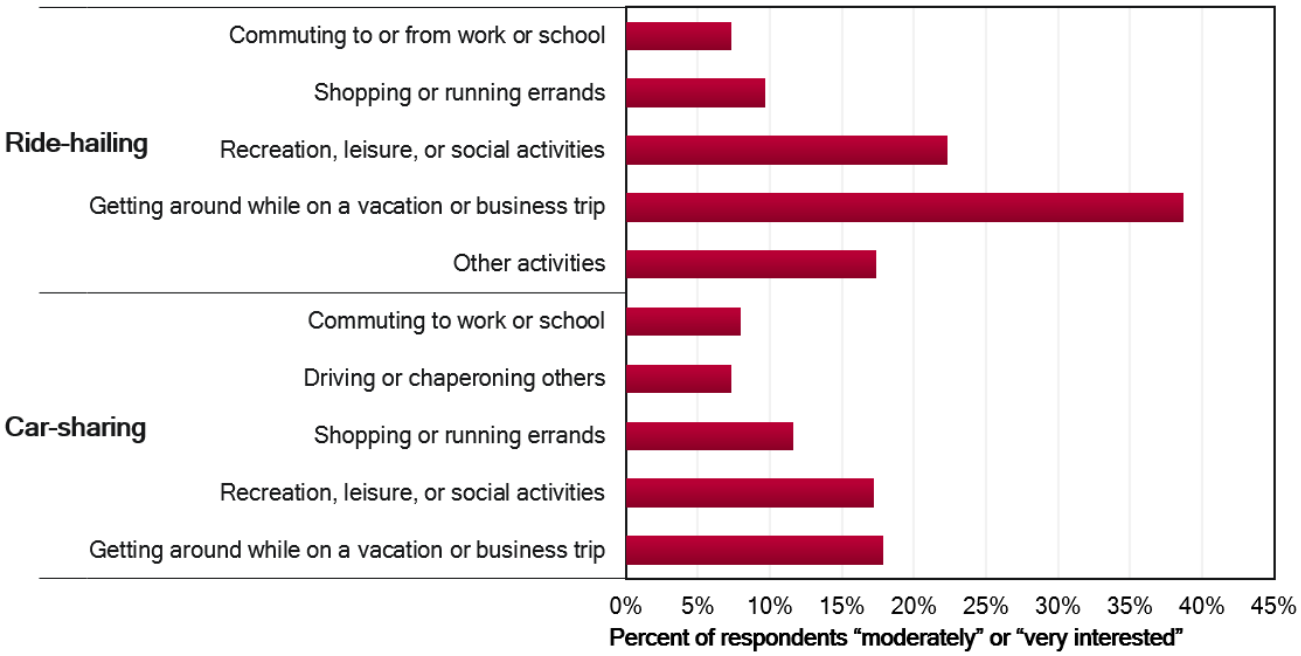
Figure 15: Percent of respondents "moderately interested" or "very interested" in using shared mobility innovations in the future by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



Regarding how respondents want to use shared mobility innovations, generally respondents are most interested in using ride-hailing for getting around while on a vacation or business trip (39% of those interested in using or continuing to use ride-hailing) (Figure 16). Respondents are also interested in using ride-hailing for recreation, leisure, and social activities (22%). Only 7%-10% are interested in using ride-hailing for commuting to work or school or for shopping or running errands. For car-sharing, respondents are similarly most interested in using it for getting around

on a vacation or business trip (18%) and for getting to recreation, leisure, or social activities (17%). Interest in using ride-hailing for shopping or running errands (12%), for commuting to work or school (8%), and for driving or chaperoning others (7%) is relatively lower.

Figure 16: Percent of respondents "moderately interested" or "very interested" in using ride-hailing and car-sharing for different trip types (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



5.4 Anticipated impacts of shared mobility on travel patterns and residence

Respondents were asked to evaluate the impact (or expected impact) of ride-hailing and car-sharing on their travel and residence choices. First, the survey asked respondents if the availability of ride-hailing and car-sharing services in their region *impacts* (if the respondent perceives the services as being available, assessed earlier in the survey) or *would impact* (if the respondent does not perceive the services as being available) their use of cars, transit and active travel.

Figure 17 and Figure 18 combine responses of both impacts and expected impacts of ride-hailing and car-sharing on mode usage. Respondents largely answered that the availability of ride-hailing and car-sharing does not or would not impact their usage of cars, transit, and active travel, with 87%-93% of respondents answering that they use or would use each mode the same, regardless of the availability of ride-hailing and car-sharing. 10% or fewer respondents use or would use cars, transit, and active travel less often, while only 4% or less would use these modes more often.

Figure 17: Impacts and expected impacts of the availability of ride-hailing on respondents' use of cars, transit, and active travel (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples). Note that responses to questions about impacts (if respondents perceive ride-hailing as being available) and expected impacts (if respondents do not perceive ride-hailing as being available) are combined, as both versions of the question had the same response options.

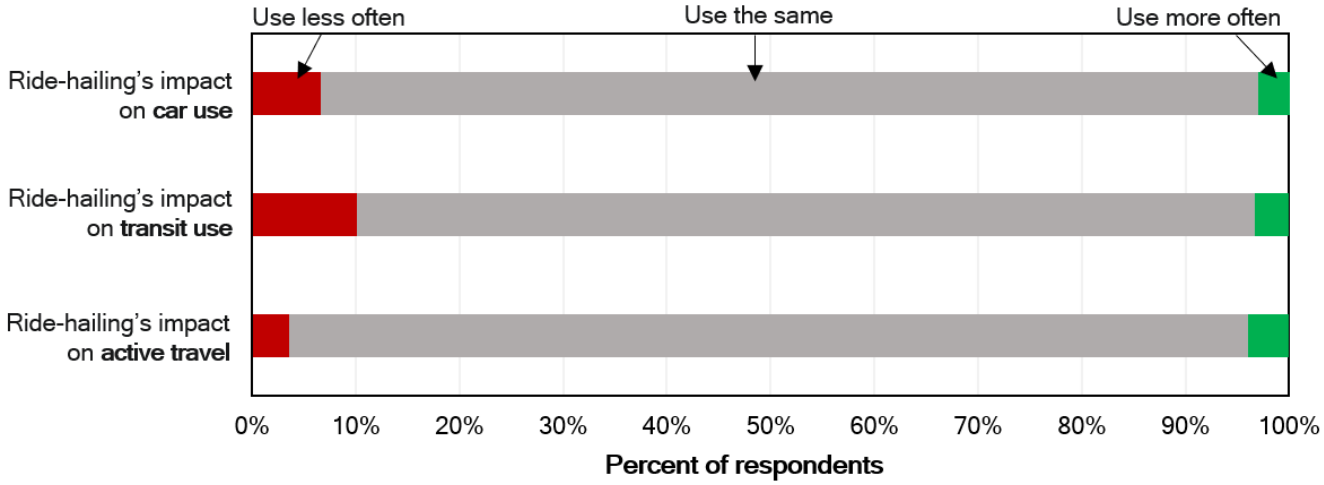
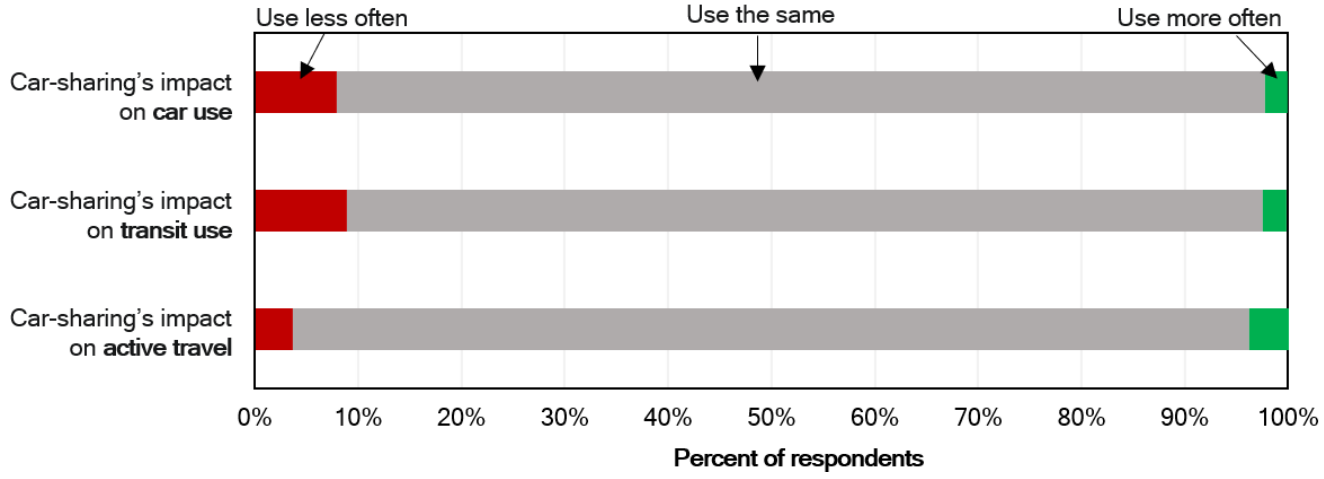
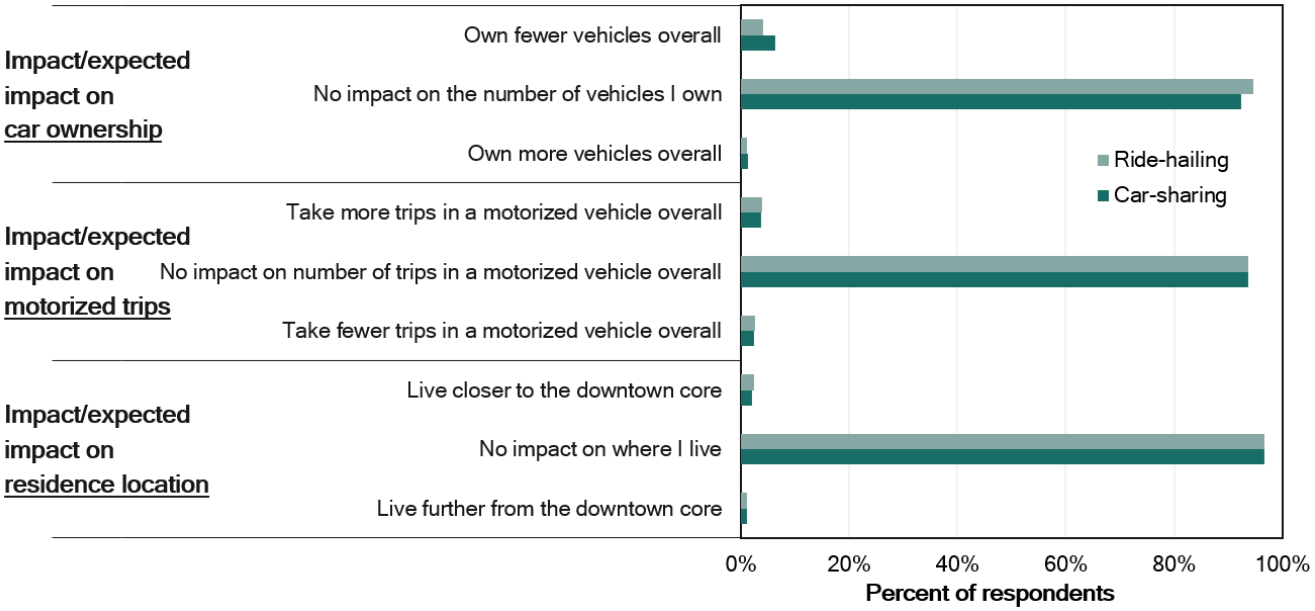


Figure 18: Impacts and expected impacts of the availability of car-sharing on respondents' use of cars, transit, and active travel (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples). Note that responses to questions about impacts (if respondents perceive car-sharing as being available) and expected impacts (if respondents do not perceive ride-hailing as being available) are combined, as both versions of the question had the same response options.



Next, respondents answered if the availability of ride-hailing and car-sharing *has caused* them or *would cause* them to change their car-ownership patterns (to own more, the same, or fewer vehicles), trips in a motorized vehicle (to take more, the same, or fewer trips), and residence choices (to live closer, the same distance, or further from their nearest downtown core). Respondents overwhelmingly answered that the availability of both ride-hailing and car-sharing has not or would not impact their car ownership, motorized trips, or residence choices Figure 19). 92%-95% report that they would not change the number of vehicles they own, 94% would not change the number of trips they take in a motorized vehicle, and 97% would not change the distance they live from their nearest downtown core. We note that results were largely similar across neighbourhood types, so we show results for the overall Metro Vancouver sample only.

Figure 19: Impacts and expected impacts of ride-hailing and car-sharing on car ownership, motorized trip frequency, and residence location (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



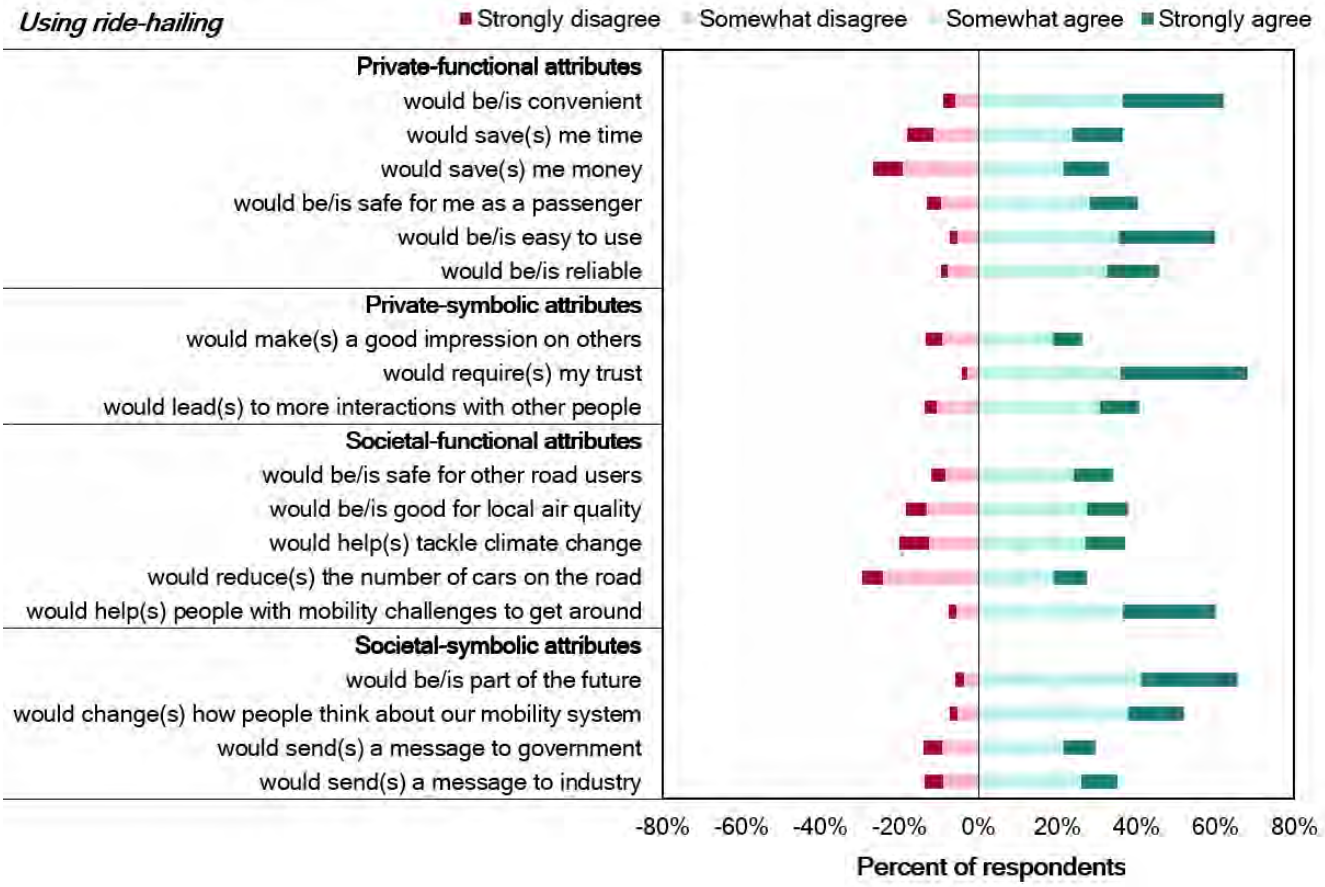
5.5 Perceptions of shared mobility

The survey asked respondents the extent to which they agreed or disagreed with a variety of statements regarding private-functional, private-symbolic, societal-functional, and societal-symbolic attributes of each innovation, following our conceptual framework. The statements were phrased based on if a respondent had adopted each innovation or not. Respondents were then asked the degree to which they associated a variety of images with a person that uses each innovation.

For ride-hailing, respondents generally agreed more than they disagreed about its private vs. societal and functional vs. symbolic attributes (Figure 20). Disagreement is higher around ride-hailing's ability to save money (27% disagree) and reduce the number of cars on the road (29%

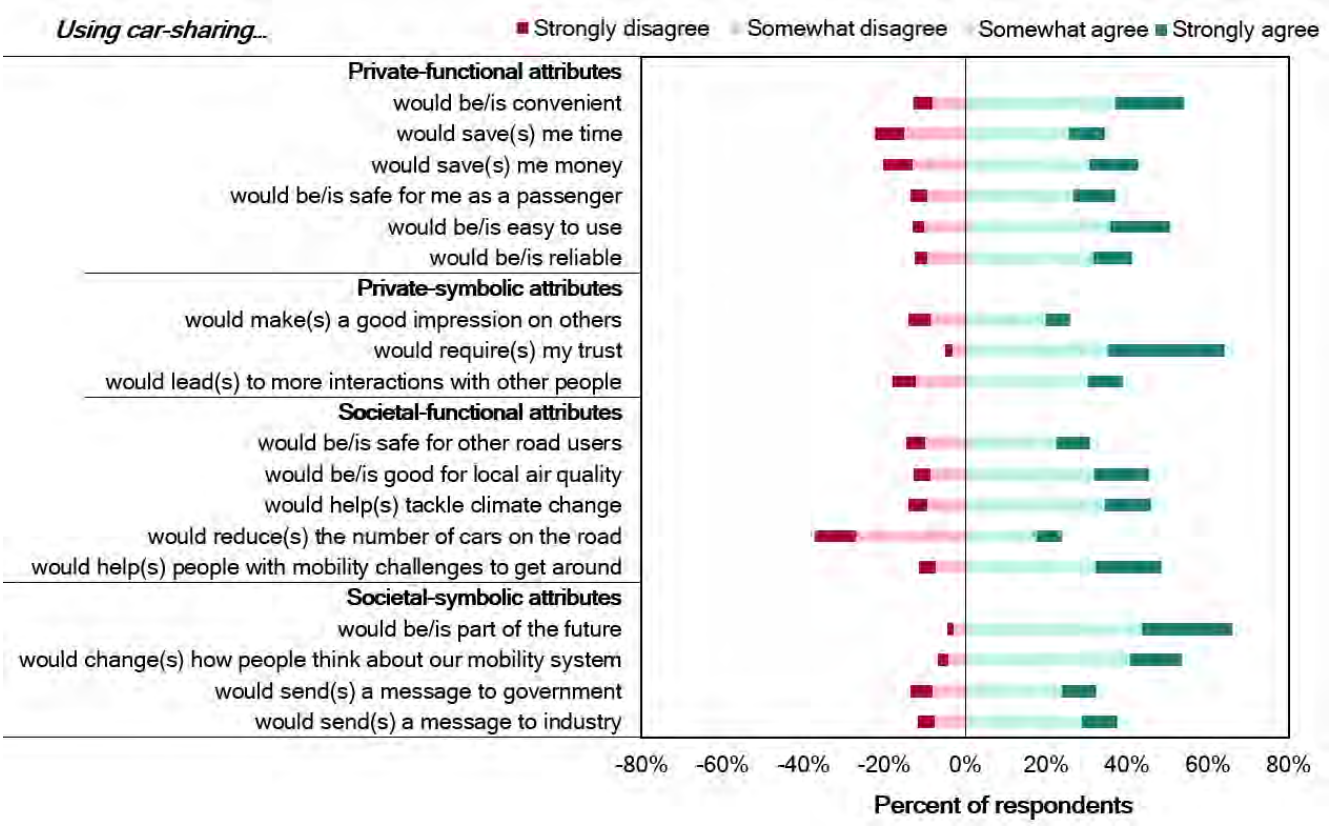
disagree) – though similar proportions agree that ride-hailing can save money and reduce the number of cars on the road. Over 40% of respondents agree that ride-hailing is convenient, safe for passengers, easy to use, reliable (private-functional attributes), requires trust (private-symbolic attribute), leads to more social interactions, can help people with mobility challenges get around (societal-functional attributes), is part of the future, and changes how people think about the mobility system (societal-symbolic attributes).

Figure 20: Agreement and disagreement with statements about the private-functional, private-symbolic, societal-functional, and societal-symbolic attributes of ride-hailing (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



In general, most respondents agree more than disagree about car-sharing's attributes (Figure 21). In particular, over 40% agree that car-sharing is (or would be) convenient, save money, easy to use, reliable (private-functional attributes), requires trust (private-symbolic attribute), is good for local air quality, helps tackle climate change, helps people with mobility challenges to get around (societal-functional attributes), is part of the future, and changes how people think of the mobility system (societal-symbolic attributes). Less than 20% of respondents disagree with each of these statements. The strongest disagreement is with the societal attribute that car sharing would reduce the number of cars on the road (37% disagree).

Figure 21: Agreement and disagreement with statements about the private-functional, private-symbolic, societal-functional, and societal-symbolic attributes of car-sharing *(full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).*



In terms of image associations with ride-hailing users (Figure 22), over 40% of respondents associate ride-hailing ("somewhat", "mostly", or "very much") with being reliable and independent. Over 30% of respondents associate ride-hailing users with images of being adventurous, successful, and intelligent. 40% or more of respondents also associate a ride-hailing user with images of being innovative and pro-environmental.

Figure 22: Percent of respondents that "somewhat", "mostly", or "very much" associate ride-hailing users with images (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).

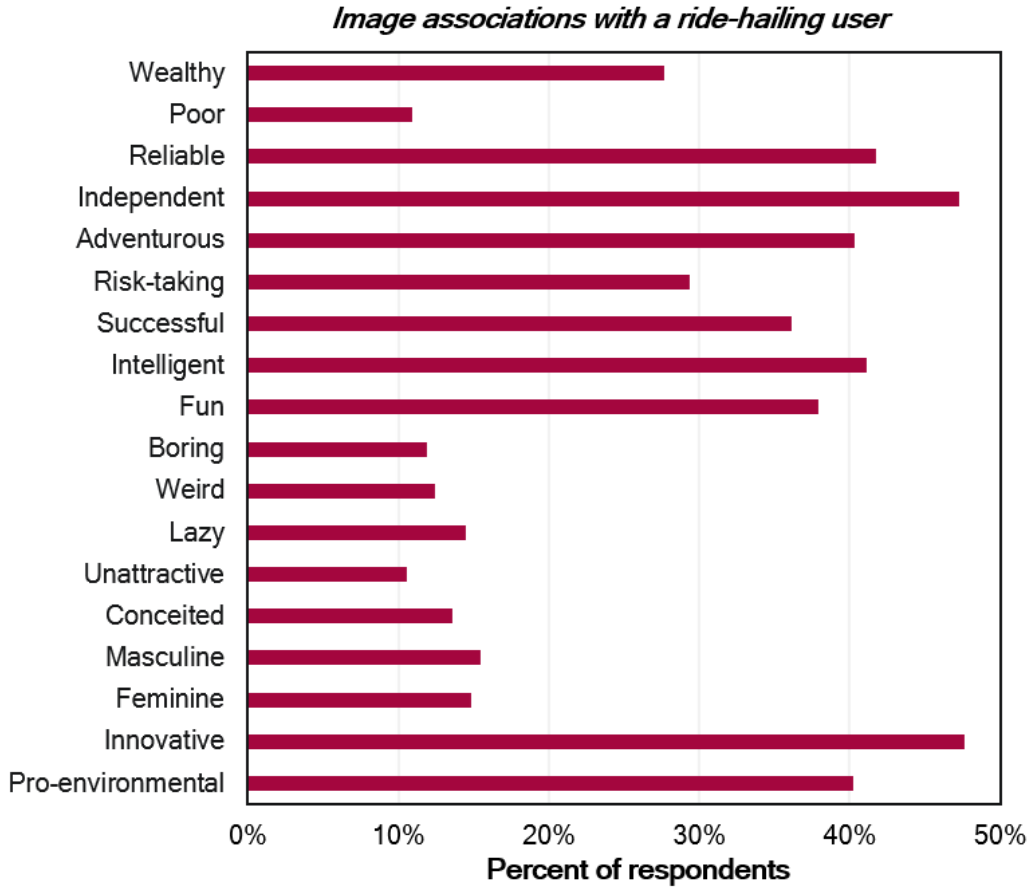
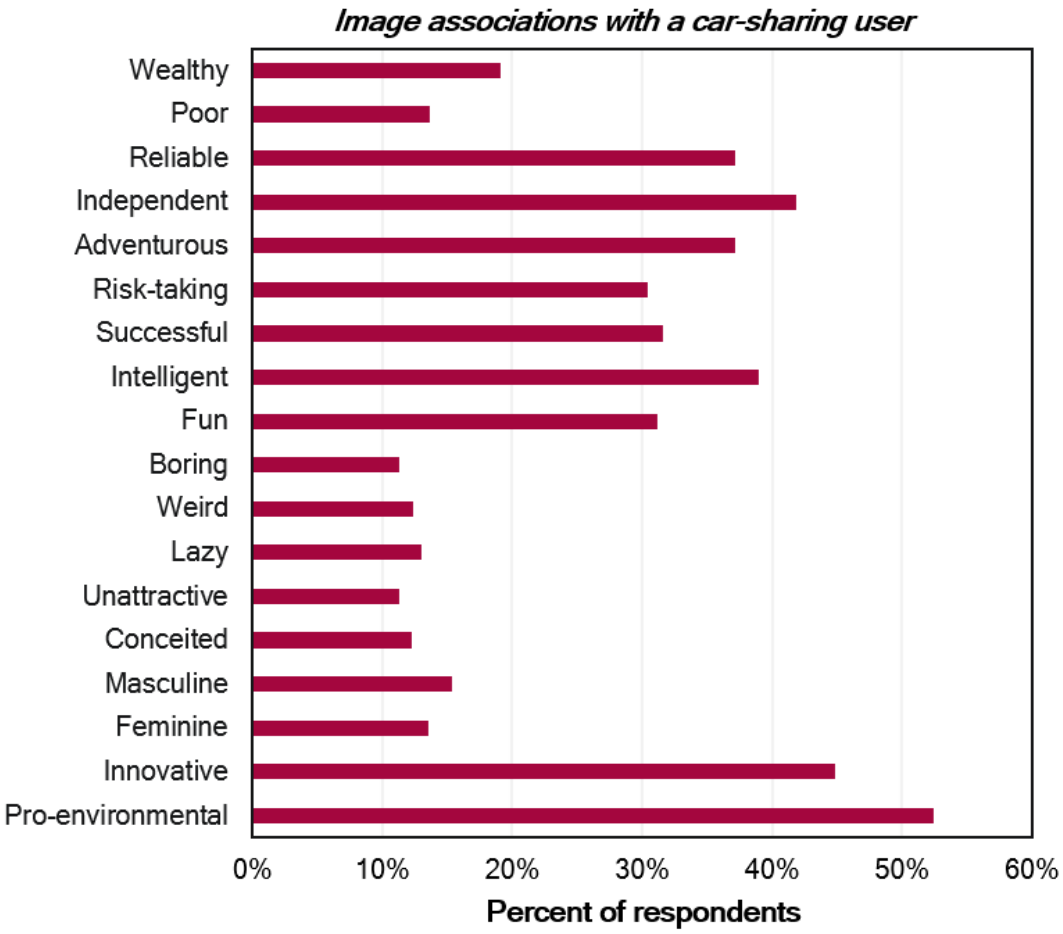


Image associations with a car-sharing user are seemingly stronger, compared to ride-hailing (Figure 23). Over 30% of respondents associate someone who uses car-sharing with the images of being reliable and independent, adventurous, risk-taking, successful, intelligent, fun, as well as innovative and pro-environmental.

Figure 23: Percent of respondents that "somewhat", "mostly", or "very much" associate car-sharing users with images full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



6. Automated vehicle technologies

This section presents results for automated vehicle technologies: self-parking, automated cruise control, lane centering steering, Tesla Autopilot, and fully-automated vehicles (FAVs). We assess respondent *adoption* of these innovations, *interest* in adopting them individually and in combination with other new mobility innovations, *expected impacts* of FAVs on travel and living preferences, and *perceptions* of automated mobility.

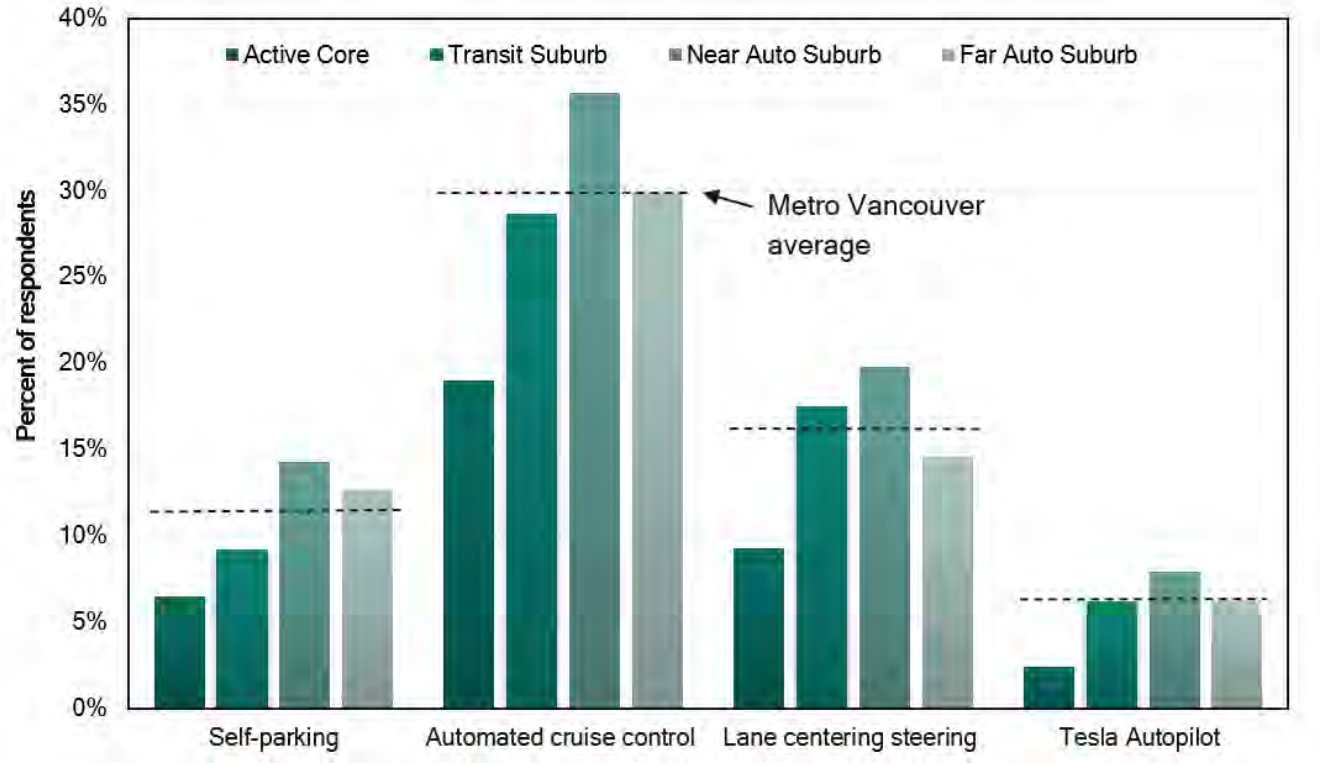
Key takeaways include:

- Current or past ownership of automated cruise control is the highest of the technologies considered, and generally current or past ownership of all automated features is highest among those in near and far auto suburbs and lowest among those in active cores.
- Around one-fifth to one-third of respondents or fewer are interested in purchasing some type of fully-automated vehicle in the future.
- Around 20% of respondents reported that having a fully-automated vehicle as an option for a ride-hailing or car-sharing trip would increase their likelihood of using the service – though over one-third of respondents would be less likely to use ride-hailing or car-sharing if a fully-automated vehicle was an option for their ride.
- The majority of respondents (83% or more) do not expect that the future availability of fully-automated vehicles will impact their use of cars, transit, active travel, and living proximity to downtown cores.
- There are strong perceptions about fully-automated vehicles requiring trust, being part of the future, helping people with mobility challenges to get around, and changing how people think about the mobility system.

6.1 Adoption of automated vehicle features

Adoption of automated vehicle mobility innovations is operationalized as if respondents own (or have owned in the past) vehicles with any automation features. Of the available automation technologies on the market, adoption of automated cruise control is highest among respondents (30% of the Metro Vancouver sample, dashed line in Figure 24), followed by lane centering steering (16%), self-parking (12%), and Tesla Autopilot (6%) (Figure 24). Adoption tends to be higher among respondents in near auto suburbs, far auto suburbs, and transit suburbs compared to those in active cores.

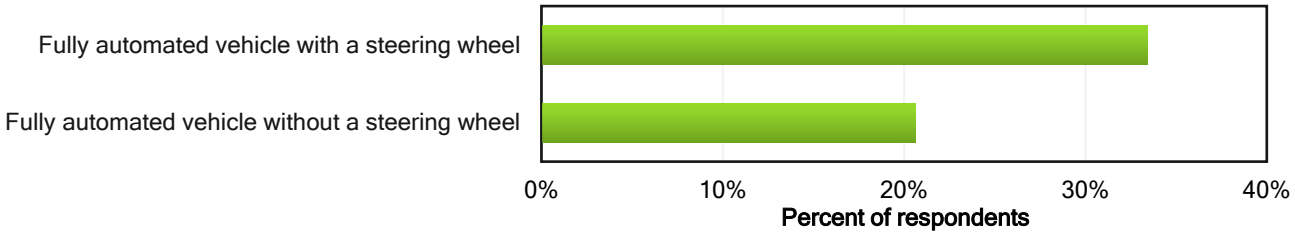
Figure 24: Percent of respondents that are current or past owners of automation technologies by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



6.2 Interest in adopting automated mobility

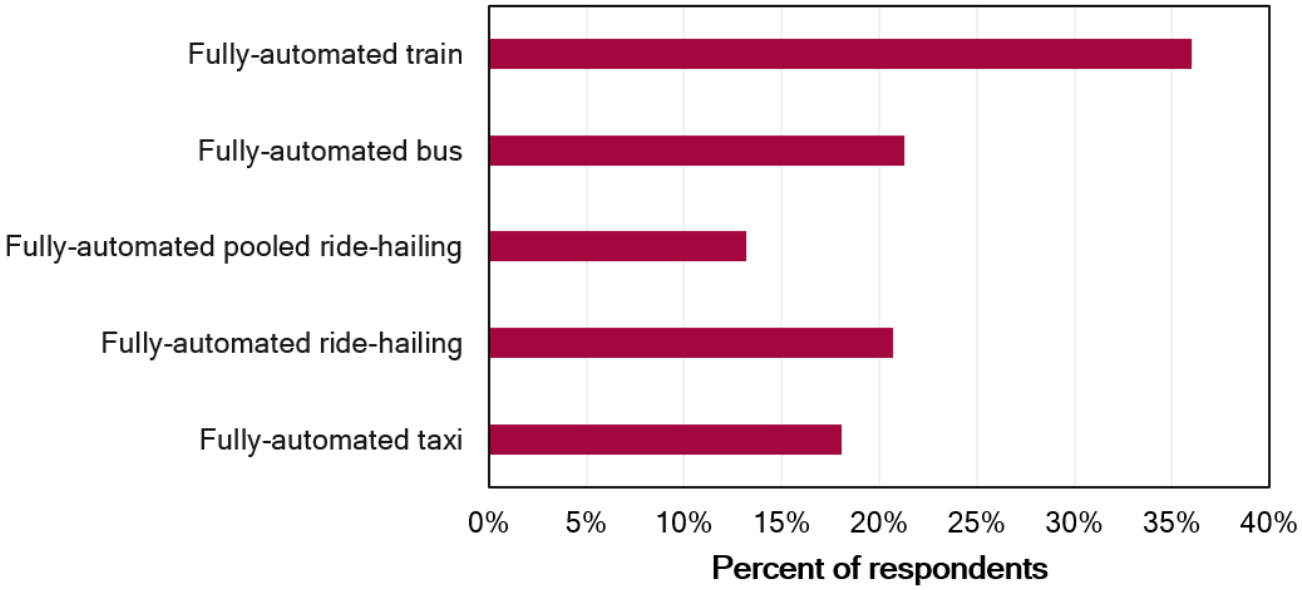
Respondents were asked how interested they are in adopting two types of FAVs: one which has a steering wheel so that automation can be switched off and the vehicle can be driven normally, and one in which the vehicle can only be operated in a fully automated mode (i.e., the vehicle doesn't have a steering wheel). Overall, 33% of total Metro Vancouver respondents are "moderately interested" or "very interested" in purchasing a FAV with a steering wheel, while only 21% are interested in purchasing a FAV without a steering wheel (Figure 25).

Figure 25: Percent of respondents that are "moderately interested" or "very interested" in purchasing a fully-automated vehicle in the future (n=993, weighted).



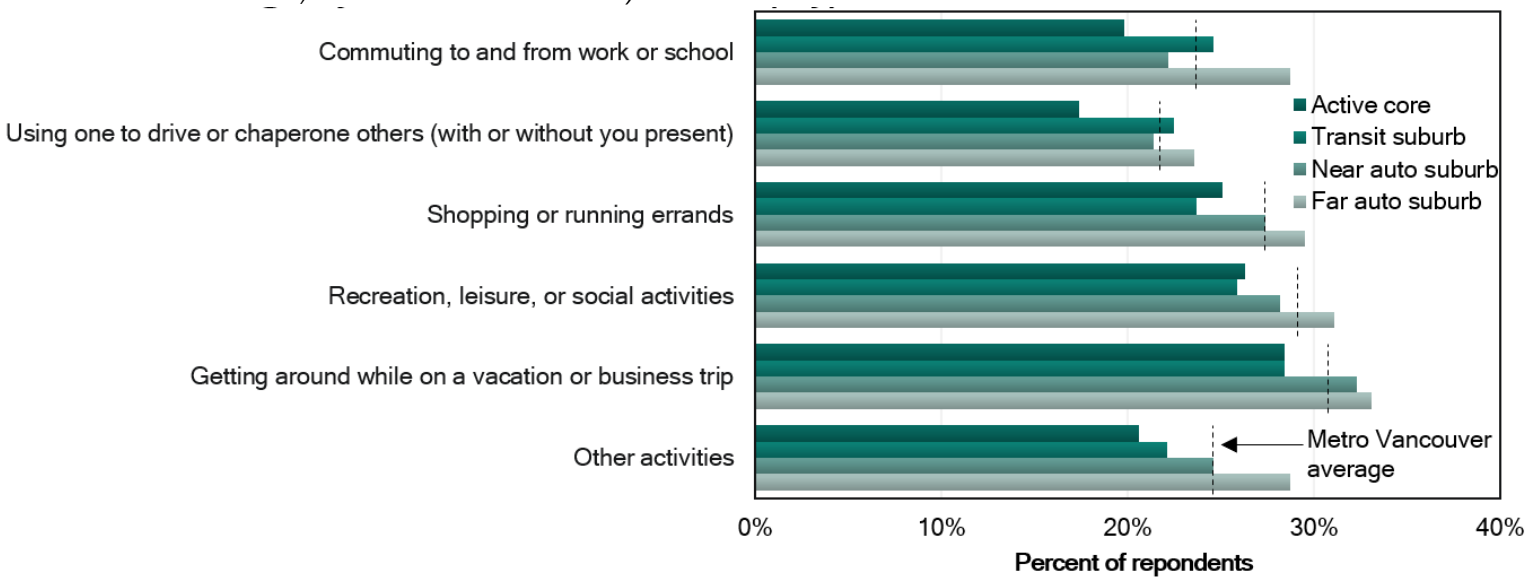
The survey also asked respondents how interested they would be in using several fully-automated transport types (where no driver would be present) (Figure 26). Interest in riding on a fully-automated train is highest (36% are interested), followed by a fully-automated bus (21%), fully-automated ride-hailing vehicle (21%), fully-automated taxi (18%), and a fully-automated pooled ride-hailing vehicle (13%).

Figure 26: Percent of respondents that are "moderately interested" or "very interested" in using a fully-automated transport types in the future (n=993, weighted).



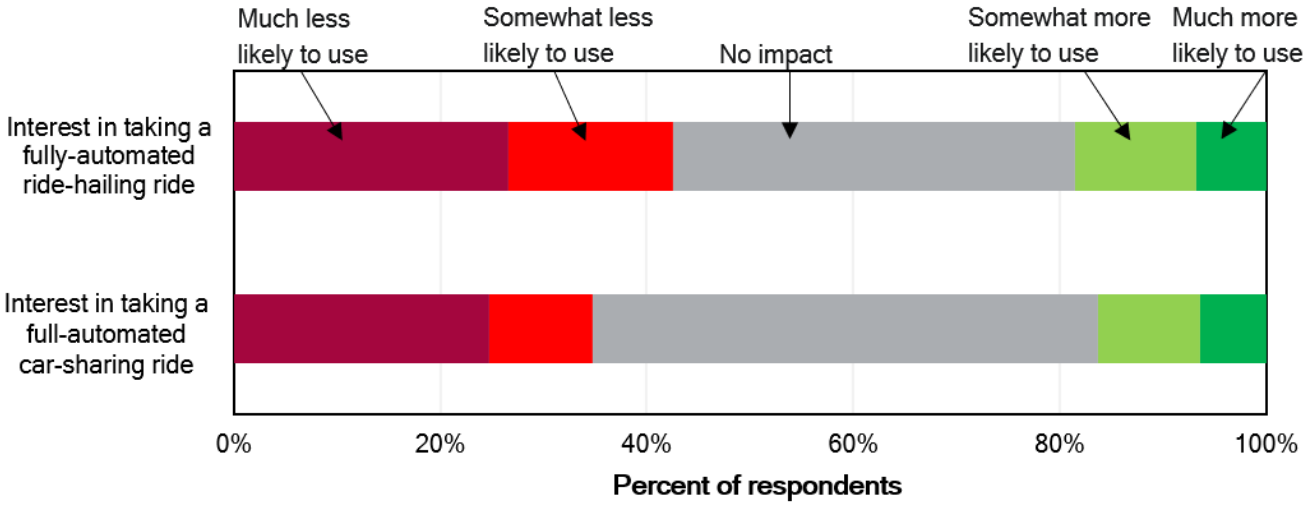
When asked what kind of trips respondents would like to use a FAV for, responses were fairly even across trip types (Figure 27). Interest in using a FAV for all trip types is consistently highest among respondents in far auto suburbs and lowest among respondents in active cores.

Figure 27: Percent of respondents "moderately interested" and "very interested" in using a fully-automated vehicle for different trip types (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



Respondents also reported how having the option of a FAV for their ride would impact their likelihood of using ride-hailing and car-sharing (Figure 28). For ride-hailing, 43% of respondents would be less likely to use it if a FAV was an option for their ride, though 39% reported that this option would have no impact on their likelihood of using ride-hailing and 19% would be more likely to use it. On the other hand, 35% of respondents would be less likely to use car-sharing if a FAV was an option for their ride, while 49% indicated that it would have no impact on their likelihood of using car-sharing, and 16% would be more likely to use it.

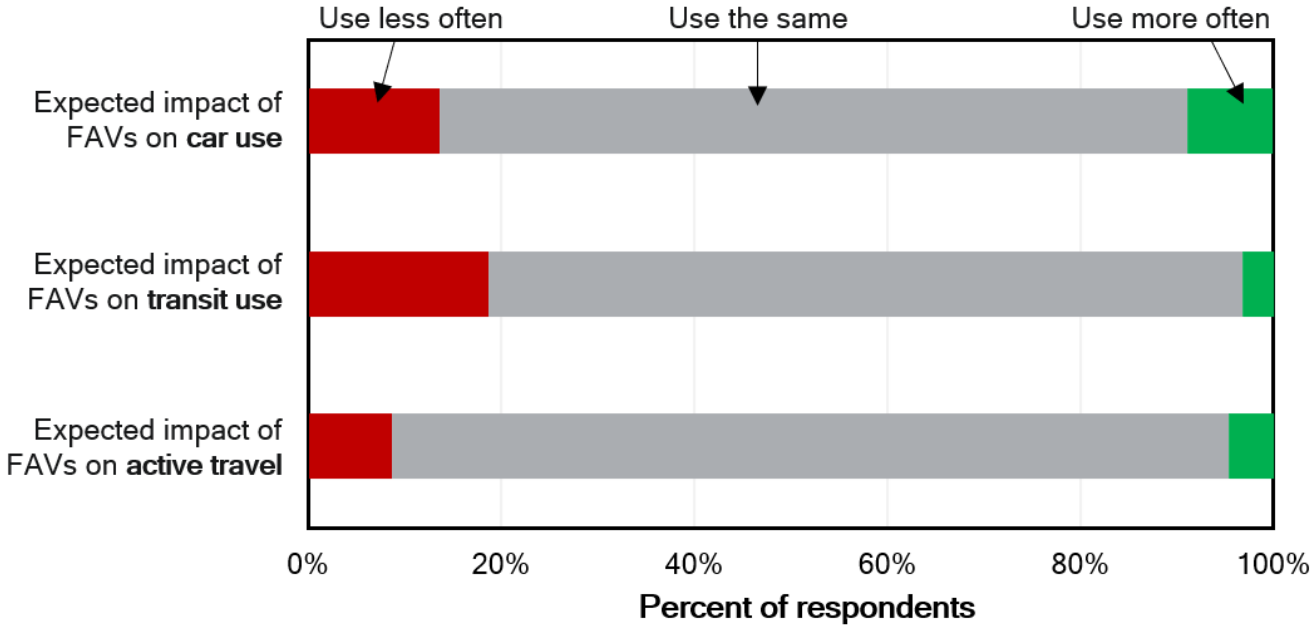
Figure 28: Percent of respondents interested in combining fully-automated vehicles with ride-hailing and car-sharing. Respondents reported the impact on their likelihood of using of ride-hailing and car-sharing if a fully-automated vehicle were an option for their trips (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



6.3 Anticipated impacts of fully-automated vehicles on travel and living patterns

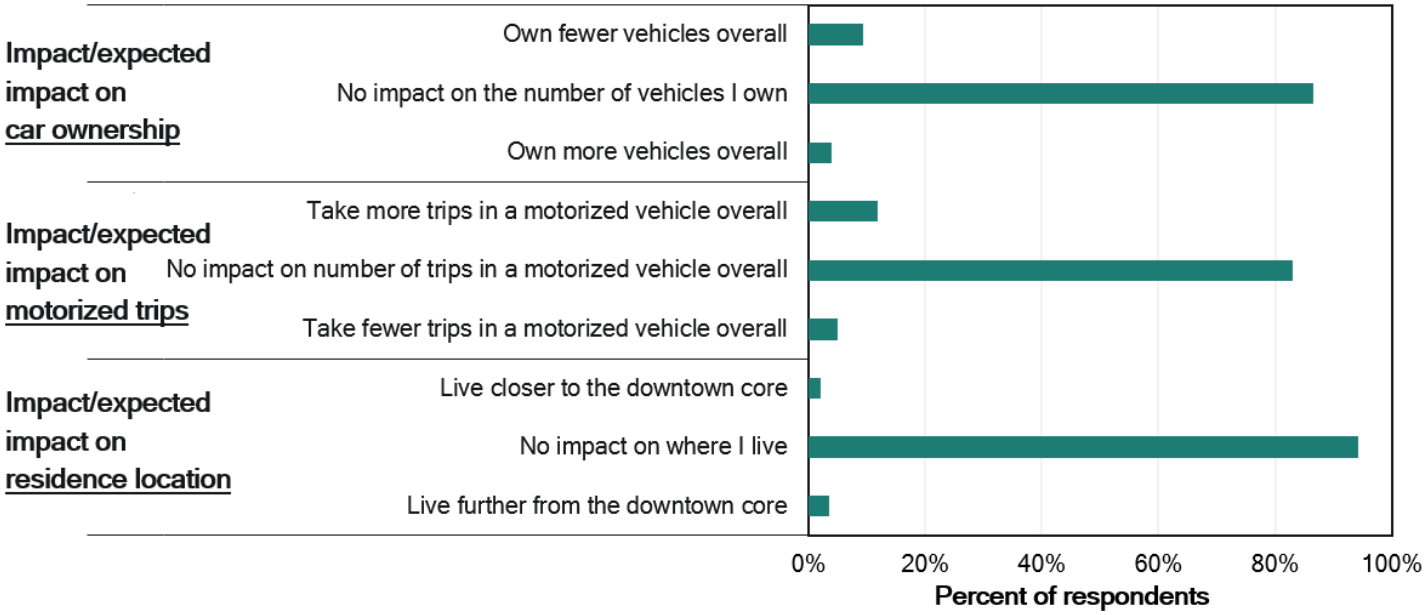
As FAVs are not yet available on the market, the survey asked respondents how they expect the future availability of these technologies might impact their travel and residence choices. First, respondents evaluated how the availability of FAVs might impact their usage of conventional vehicles, transit, and active travel (Figure 29). 77%-87% of respondents expect that they will use the modes the same as they currently do when FAVs are available, and 9% or less expect to use the modes more often. However, 19% expect to use transit less often and 14% expect to use conventional vehicles less often than currently.

Figure 29: Expected impacts of fully-automated vehicles on respondents' use of conventional vehicles, transit, and active travel (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



Respondents next reported how they expect the availability of FAVs would cause them to change their vehicle ownership, number of trips in a motorized vehicle, and proximity of living to a downtown core (Figure 30). As with shared mobility, respondents largely reported the future availability of FAVs is not likely to have an impact on the number of vehicles they own (87%), the number of motorized vehicle trips (83%), and their proximity to a downtown core (94%). The most apparent expected impact of FAVs is that 12% of respondents expect to take more trips in a motorized vehicle overall when FAVs are available.

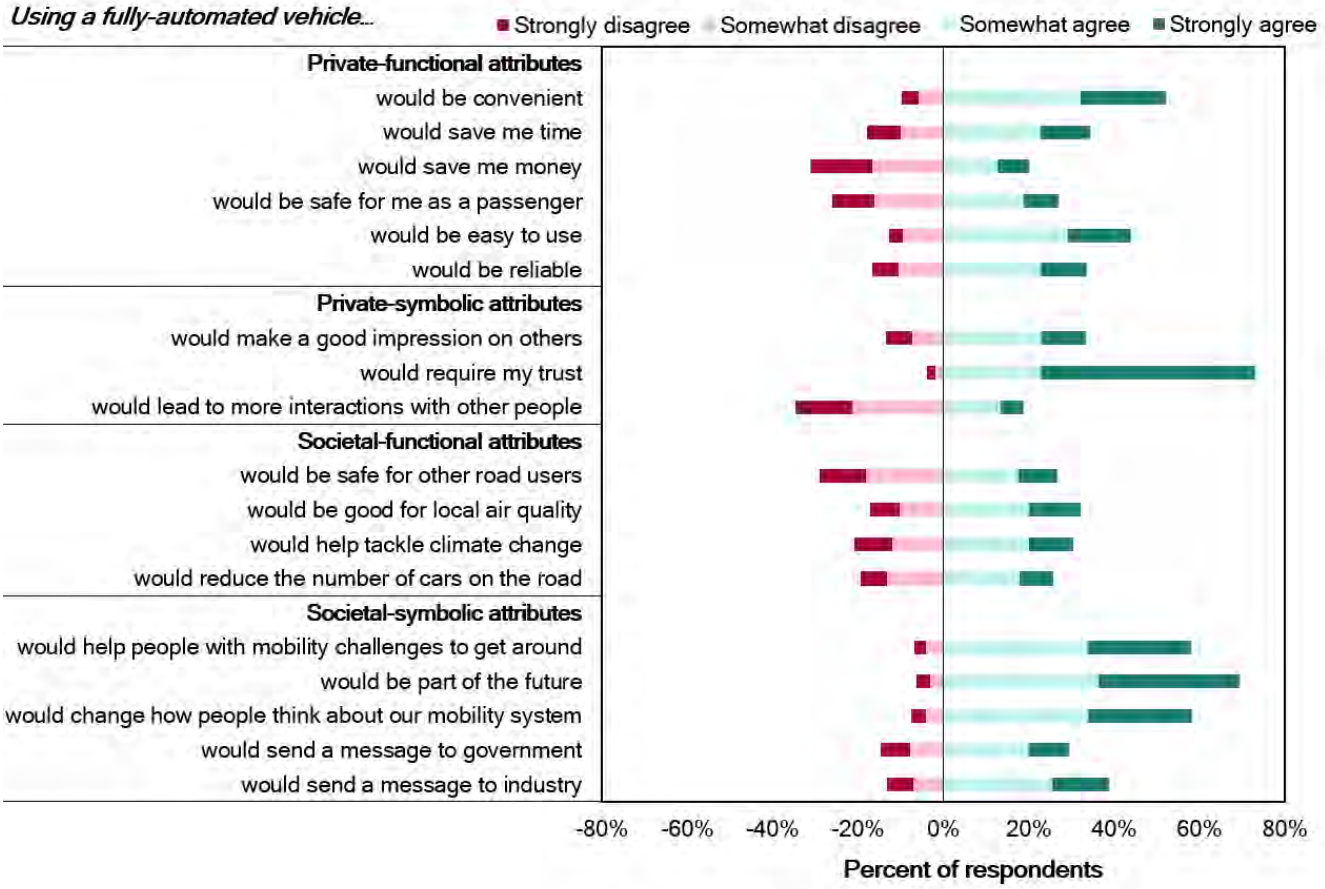
Figure 30: Impacts and expected impacts of the availability of fully-automated vehicles on car ownership, motorized trip frequency, and residence location (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



6.4 Perceptions of automated mobility

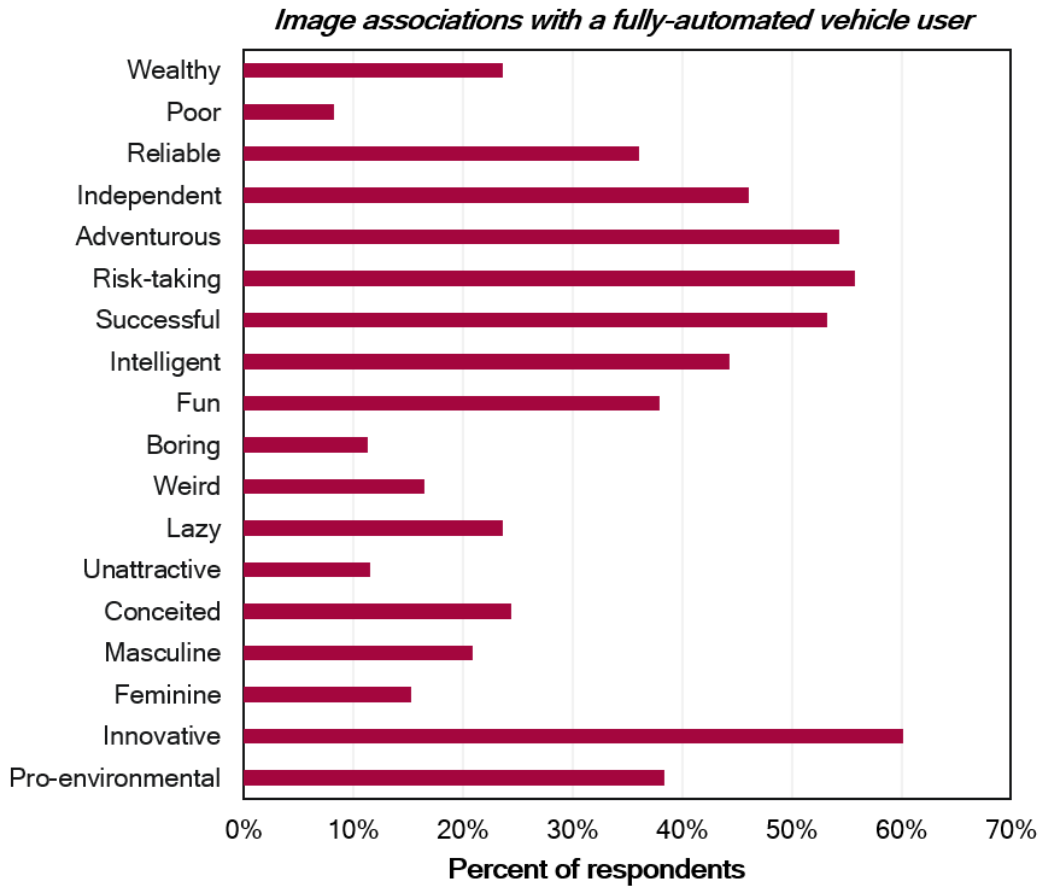
Perceptions about using a FAV are varied (Figure 31). Over 50% of respondents agree that using a FAV would be convenient (private-functional attribute), require trust (private-symbolic attribute), help people with mobility challenges to get around (societal-functional attribute), be part of the future, and change the way people think about the mobility system (societal-symbolic attributes). However, over 20% disagree that using a FAV would save money, be safe for passengers, be safe for other road users, and lead to more interactions with other people – which is a higher disagreement than agreement.

Figure 31: Agreement and disagreement with statements about the private-functional, private-symbolic, societal-functional, and societal-symbolic attributes of using a fully-automated vehicle (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



Respondents show fairly strong image associations with a FAV user (Figure 32). Over 30% of respondents associate someone who uses a FAV with the images of being reliable, independent, adventurous, risk-taking, successful, intelligent, fun, as well as innovative and pro-environmental.

Figure 32: Percent of respondents that "somewhat", "mostly", or "very much" associate a potential fully-automated vehicle user with images (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



7. Electric mobility innovations

This section presents results for electric mobility innovations: battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). We assess respondent *adoption* of these innovations, *interest* in adopting them individually and in combination with other new mobility innovations, and *perceptions* of electric mobility.

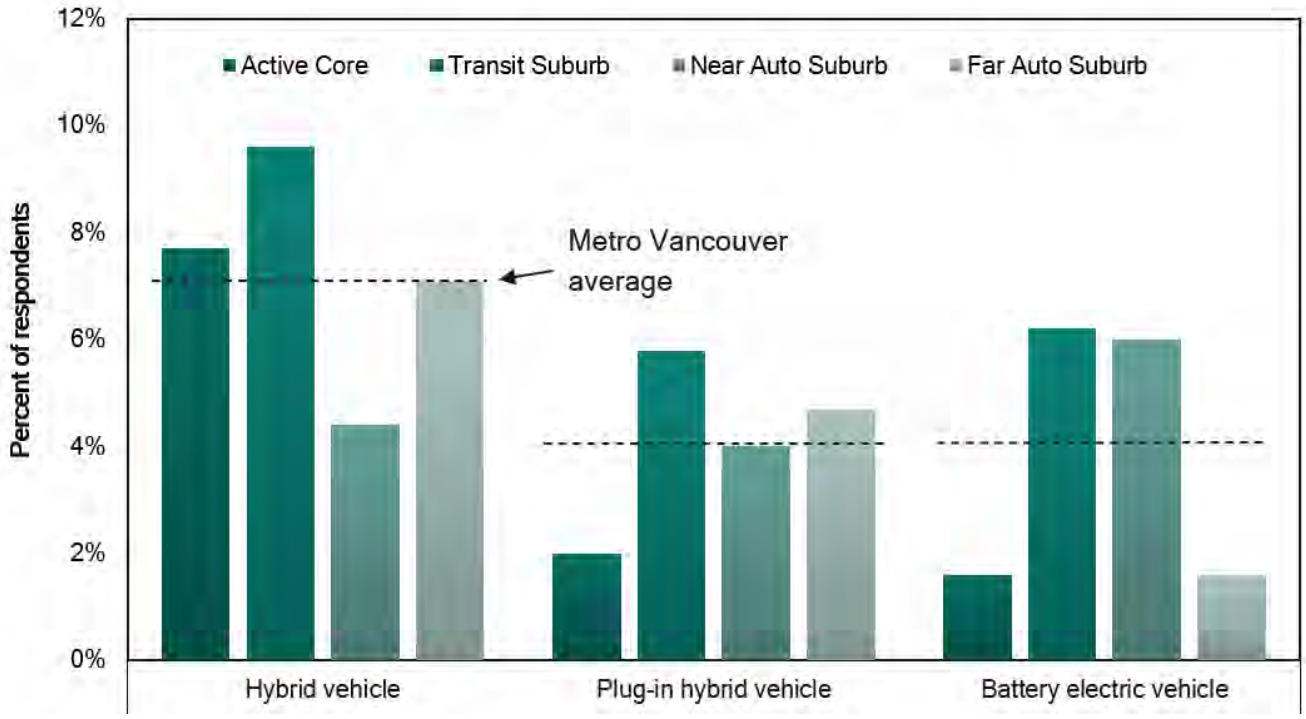
Key takeaways include:

- Among neighbourhood types, 6% of respondents or less have adopted (current or past ownership) a BEV or PHEV, and adoption tends to be slightly lower among those in active cores.
- Over one-third of respondents are interested in purchasing a BEV or PHEV in the future.
- Around one-third of respondents would be more likely to use ride-hailing or car-sharing if an electric vehicle were available as an option for their ride.
- Perceptions are strong regarding BEVs being good for local air quality and helping climate change, as well as being part of the future.

7.1 Adoption of electric mobility

Adoption of electric mobility is operationalized as whether respondents owned (or have owned in the past) a BEV or PHEV. In total, 4% of Metro Vancouver respondents have adopted a BEV or PHEV (Figure 33). By comparison, 7% have adopted a hybrid vehicle. Adoption of BEVs is higher among those in transit suburbs and near auto suburbs compared to respondents in active cores and far auto suburbs.

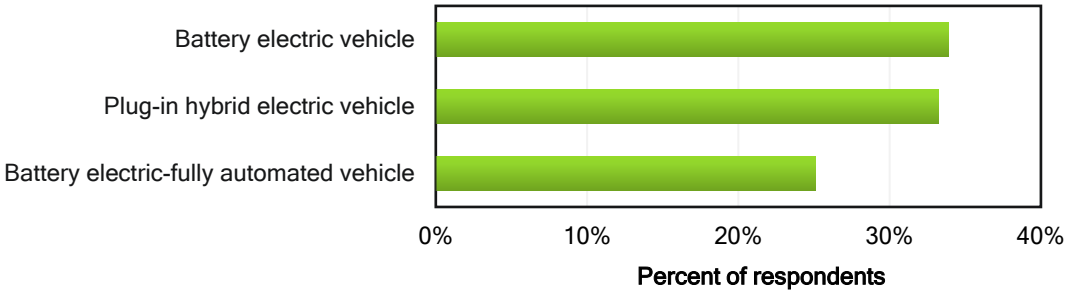
Figure 33: Percent of respondents who are current or past owners of hybrid, PHEV and BEV technologies by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



7.2 Interest in adopting electric mobility innovations

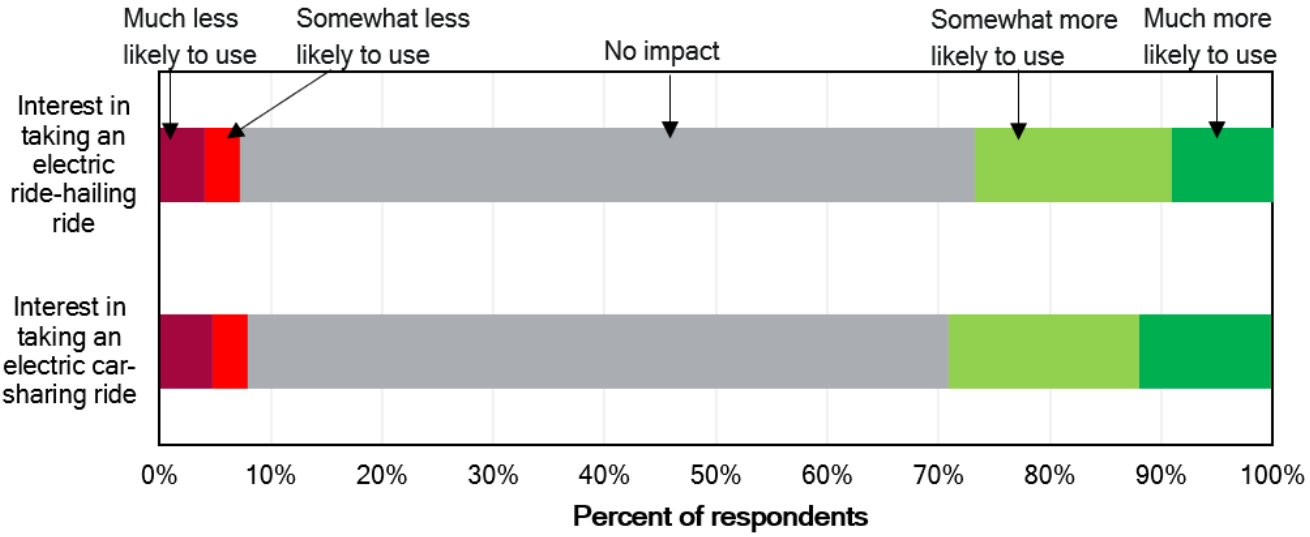
Over one-third of respondents are “moderately interested” or “very interested” in purchasing some type of electric vehicle in the future (Figure 34). Interest in purchasing a BEV that is also fully-automated is lower, with only 25% of respondents expressing interest in purchasing one.

Figure 34: Percent of respondents that are "moderately interested" or "very interested" in purchasing a fully-automated vehicle in the future (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



The survey asked respondents how having an electric vehicle as an option for their trip would impact their likelihood of using ride-hailing or car-sharing (Figure 35). Interestingly, 28% of respondents would be more likely to use ride-hailing and 29% of respondents would be more likely to use car-sharing if they had the option of using an electric vehicle for the trip. However, 59% of respondents report that an electric vehicle option would have no impact on their likelihood of using ride-hailing or car-sharing.

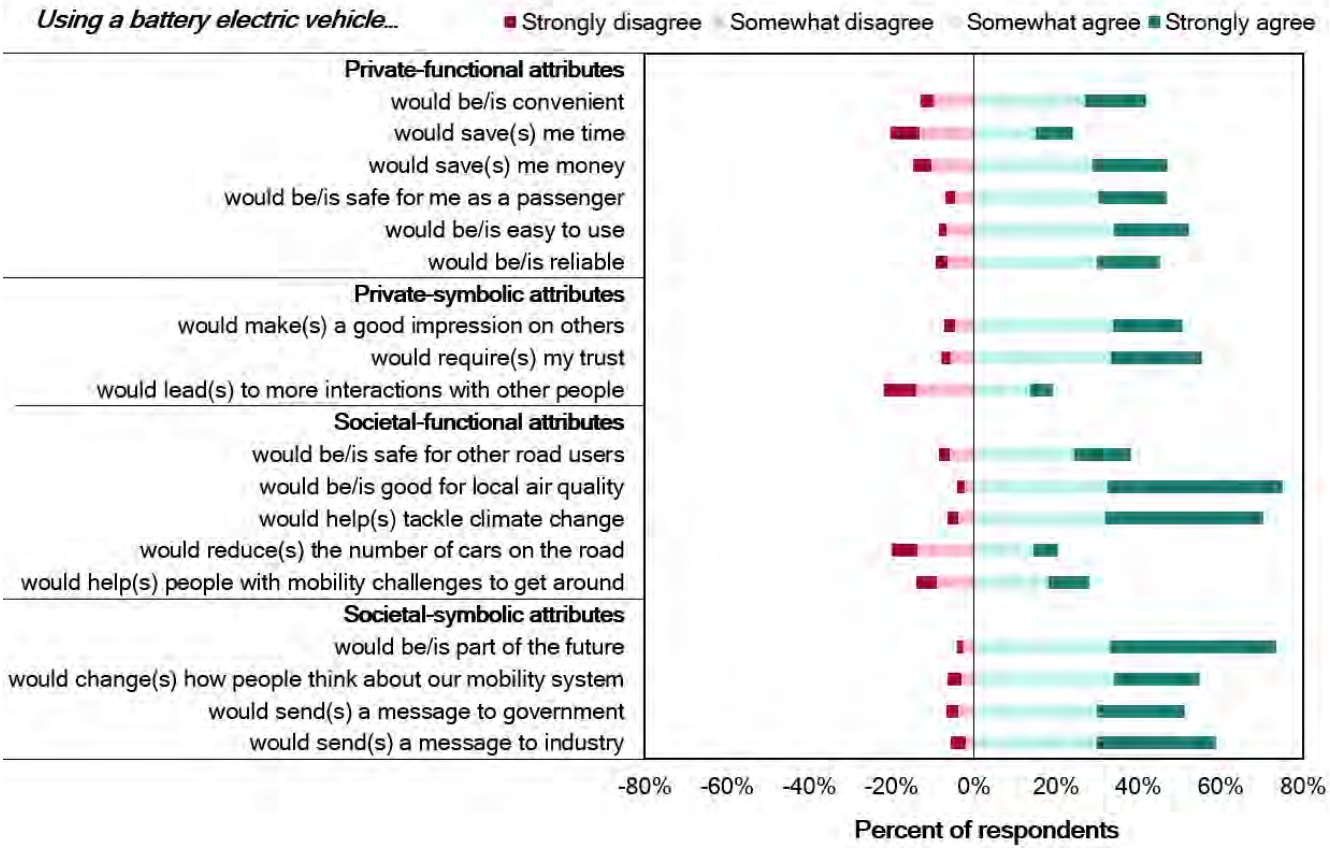
Figure 35: Interest in combining battery electric vehicles with ride-hailing and car-sharing. Respondents reported the impact on their likelihood of using of ride-hailing and car-sharing if a battery electric vehicle were an option for their trips (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



7.3 Perceptions of electric mobility

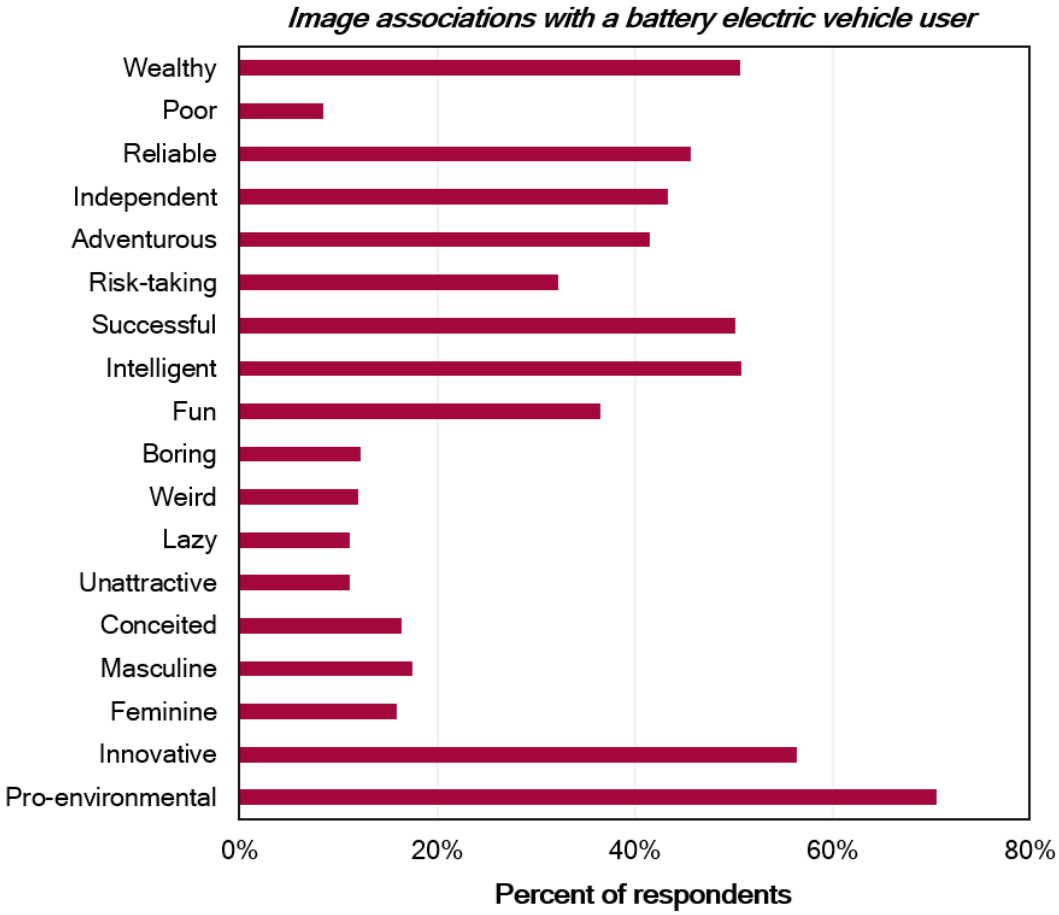
As with the other new mobility innovations, the survey asked respondents about their perceptions of using a BEV and image associations with BEV user. In general there is stronger agreement with the statements about using a BEV than disagreement (Figure 36). Over 40% of respondents agree that using a BEV would be convenient, save money, be safe for passengers, be easy to use, be reliable (private-functional attributes), be good for local air quality and help tackle climate change (societal-functional attributes). In addition, over 50% of respondents agree with all the statements regarding societal-symbolic attributes of BEVs, with 5% or fewer disagreeing. 22% or fewer of respondents disagree with any of the statements about BEVs.

Figure 36: Agreement and disagreement with statements about the private-functional, private-symbolic, societal-functional, and societal-symbolic attributes of battery electric vehicles (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



Regarding image associations with a BEV user, respondents have fairly strong associations (Figure 37). Over 30% of respondents associate someone who uses a BEV with the images of being wealthy, reliable, independent, adventurous, risk-taking, successful, intelligent, fun, innovative, and pro-environmental.

Figure 37: Percent of respondents that "somewhat", "mostly", or "very much" associate battery electric vehicle users with images (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



8. Comparing metro areas

We show key comparisons regarding respondents' *familiarity*, *adoption* of, and *interest* in new mobility innovations between the metro areas considered in this study: Metro Vancouver, the Greater Toronto Area, and the Metropolitan Montreal Area. Overall we find that there are more similarities than differences between the metro areas considered, and note key trends for each comparison.

8.1 Familiarity with new mobility innovations

We compare familiarity with a variety of new mobility innovations across the metro areas (Figure 38). Observations for the shared mobility innovations include:

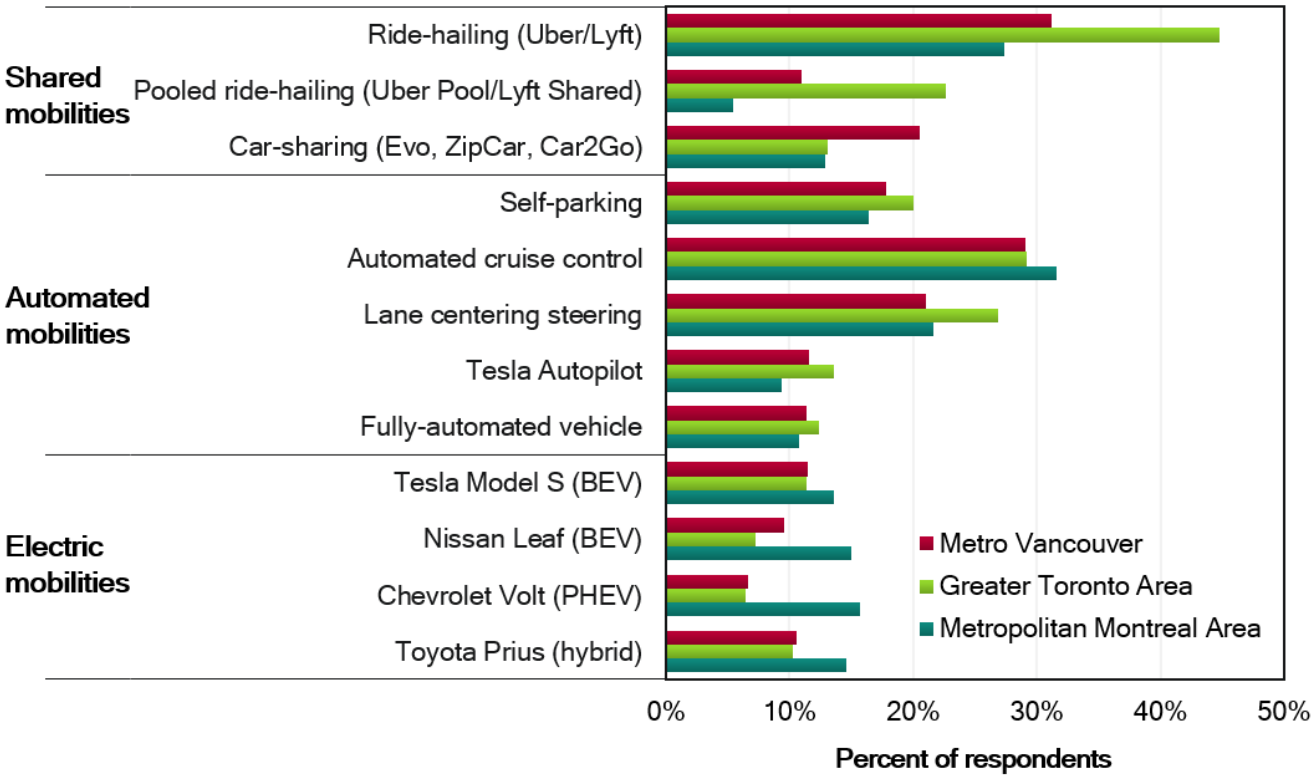
- Familiarity with ride-hailing is highest among Toronto respondents (45% are familiar), and similar between Metro Vancouver (31%) and Montreal respondents (27%).
- Similarly, familiarity with pooled ride-hailing is highest among Toronto respondents (23% are familiar), followed by Metro Vancouver respondents (11%), and then Montreal respondents (5%).
- Metro Vancouver respondents display the highest familiarity with car-sharing (21%), with Toronto and Montreal respondents reporting similar familiarity levels (13% for both).

For the automated vehicle technologies, familiarity levels with the various automated vehicle features tend to be similar between the metro areas, with no clear patterns of differences.

For the electric vehicle technologies:

- Familiarity with the Tesla Model S is similar among the metro areas (11%-14% of respondents consider themselves familiar).
- For the Nissan Leaf and Chevrolet Volt, familiarity levels are higher among Metro Montreal respondents (15% and 16% of respondents, respectively) compared to Greater Toronto (7% and 6% are familiar with the Leaf and Volt) and Metro Vancouver respondents (10% and 7% are familiar with the Leaf and Volt).

Figure 38: Respondent familiarity (percent who are "moderately familiar" and "very familiar") with shared, automated, and electric mobility innovations in Metro Vancouver (n=993, weighted), Greater Toronto Area (n=794, weighted), and Metropolitan Montreal Area (n=819, weighted) samples.

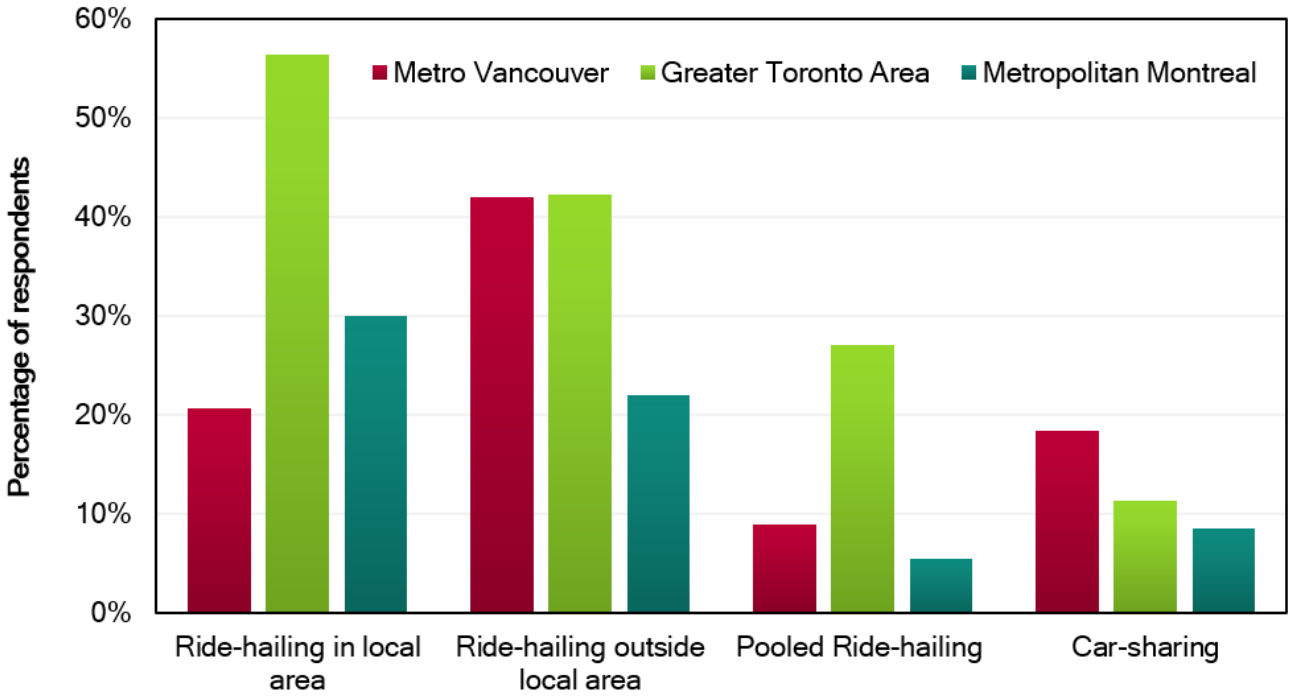


8.2 Adoption of new mobility innovations

First, regarding respondents' adoption of shared mobility types (Figure 39):

- Adoption of ride-hailing in respondents' local areas is highest among Greater Toronto respondents (56% of respondents), followed by Metro Montreal (30% of respondents), and then Metro Vancouver (21% of respondents). This trend is logical given that ride-hailing has been available for the longest in Toronto (beginning in 2012), the second longest in Montreal (beginning in 2014), and the shortest in Metro Vancouver (beginning in early 2020).
- Interestingly, adoption of ride-hailing outside of respondents' local area is similar among Metro Vancouver and Greater Toronto respondents (42% of respondents in both regions), and much higher than Metro Montreal respondents (22%).
- Pooled ride-hailing adoption is highest among Greater Toronto respondents (27% have used it), and similarly low among Metro Vancouver (9%) and Metro Montreal respondents (6%).
- Car-sharing adoption is highest among Metro Vancouver respondents (18% have used it), followed by Greater Toronto (11%) and Metro Montreal (9%) respondents.

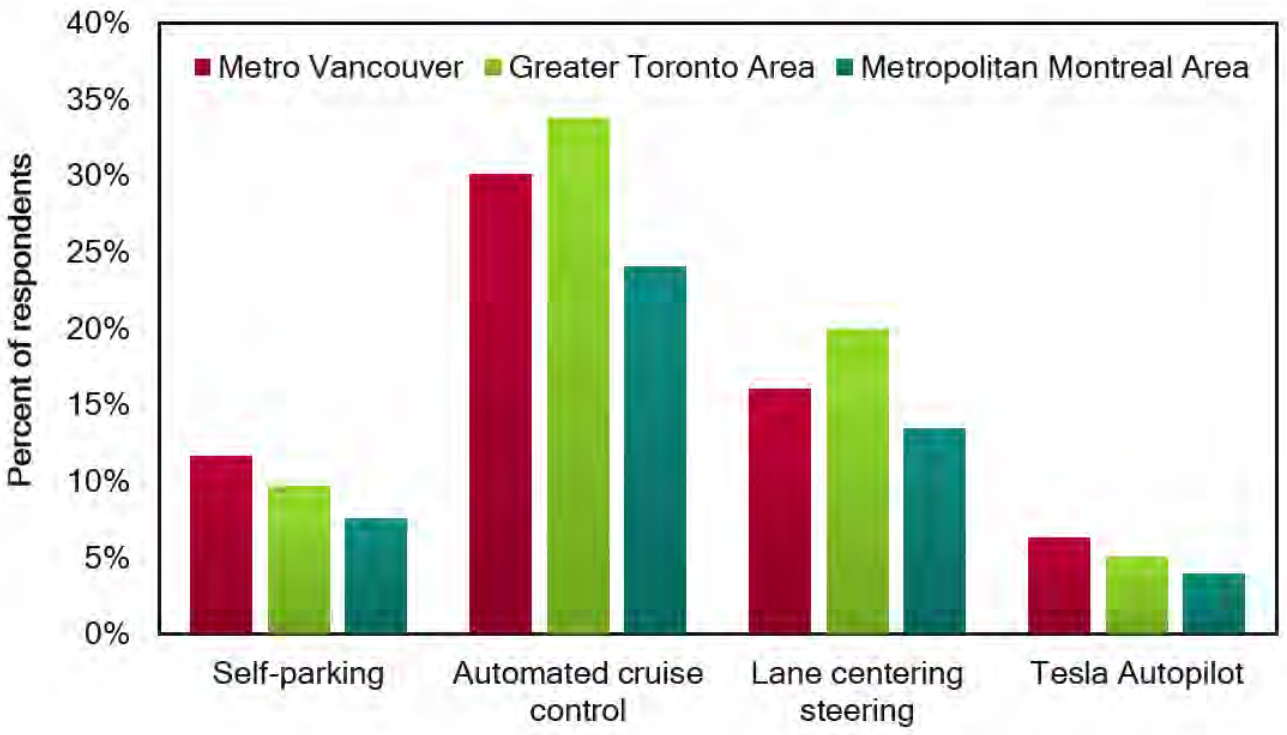
Figure 39: Percentage of respondents that have adopted each shared mobility (i.e., having used a ride-hailing app or car-sharing vehicle at least once) in each metro area (Metro Vancouver n=993, weighted, Greater Toronto Area n=794, weighted, and Metropolitan Montreal Area n=819, weighted). Note that "local area" refers to use in respondents' approximate residential area whereas "outside local area" refers to use when away (e.g., on a vacation or business trip).



For adoption of the automated mobility features, no clear patterns emerge between the metro areas (Figure 40):

- Current or past ownership of self-parking technology is similar between the three metro areas (ranging from 8%-12%).
- Current or past ownership of a vehicle with automated cruise control is also largely similar, though perhaps slightly higher in Metro Vancouver (30% of respondents) and Greater Toronto (34%), compared to Metro Montreal (24%).
- A similar pattern is observed for adoption of lane-centering steering (16% of Metro Vancouver respondents, 20% of Greater Toronto respondents, 14% of Metro Montreal respondents currently own or in the past owned a vehicle with it).
- Adoption of Tesla Autopilot is similarly low in all regions (ranging from 4%-6% having currently or in the past owned a vehicle with it).

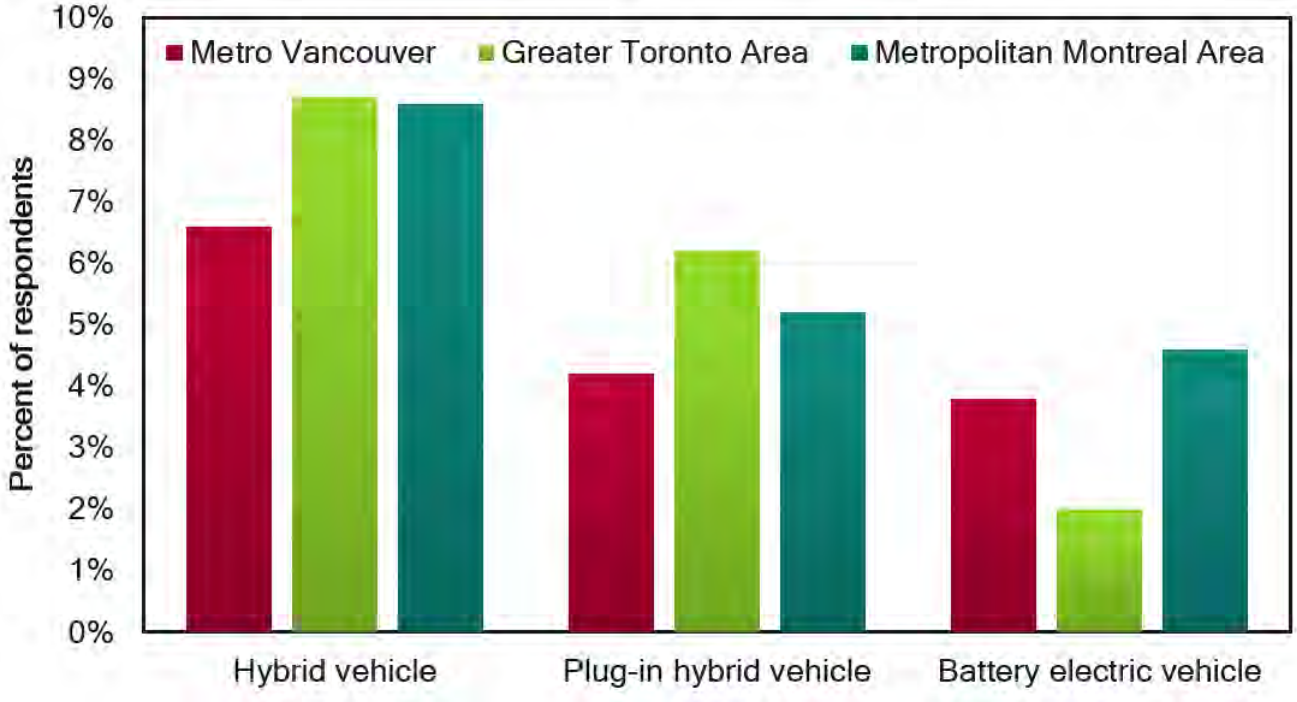
Figure 40: Current or past ownership of automation technologies in Metro Vancouver (n=993, weighted), Greater Toronto Area (n=794, weighted), and Metropolitan Montreal Area (n=819, weighted).



Again, no clear regional patterns emerge regarding adoption of electric mobility innovations (Figure 41):

- Adoption of PHEVs and BEVs is similarly low in all three metro areas (4%-6% own or have owned a PHEV and 2%-5% own or have owned a BEV).
- Adoption of hybrid vehicles is comparatively higher, as 7%-9% own or have owned one.

Figure 41: Percent of respondents that are current or past owners of hybrid, PHEV, and BEV technologies in Metro Vancouver (n=993, weighted), Greater Toronto Area (n=794, weighted), and Metropolitan Montreal Area (n=819, weighted).

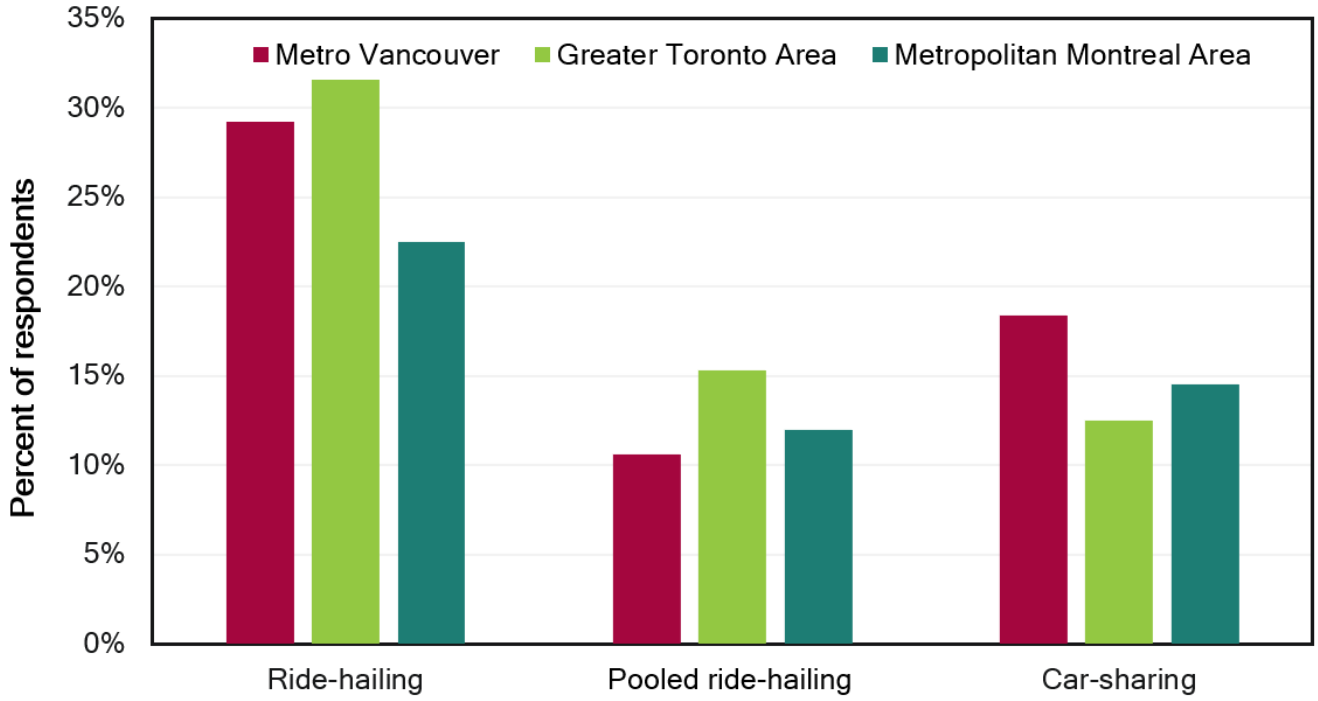


8.3 Interest in adopting new mobility innovations

Regarding interest in adopting shared mobility innovations, no obvious patterns are visible when comparing the three metro areas (Figure 42):

- Interest in using or continuing to use ride-hailing is slightly higher among respondents in Greater Toronto (32%) and Metro Vancouver (29%), compared to respondents in Metro Montreal (23%).
- Interest in using pooled ride-hailing is similar between the metro areas, ranging from 12%-15% being interested in using or continuing to use it.
- Car-sharing interest is slightly higher among Metro Vancouver respondents (18%) and similar among Greater Toronto (13%) and Metro Montreal respondents (15%).

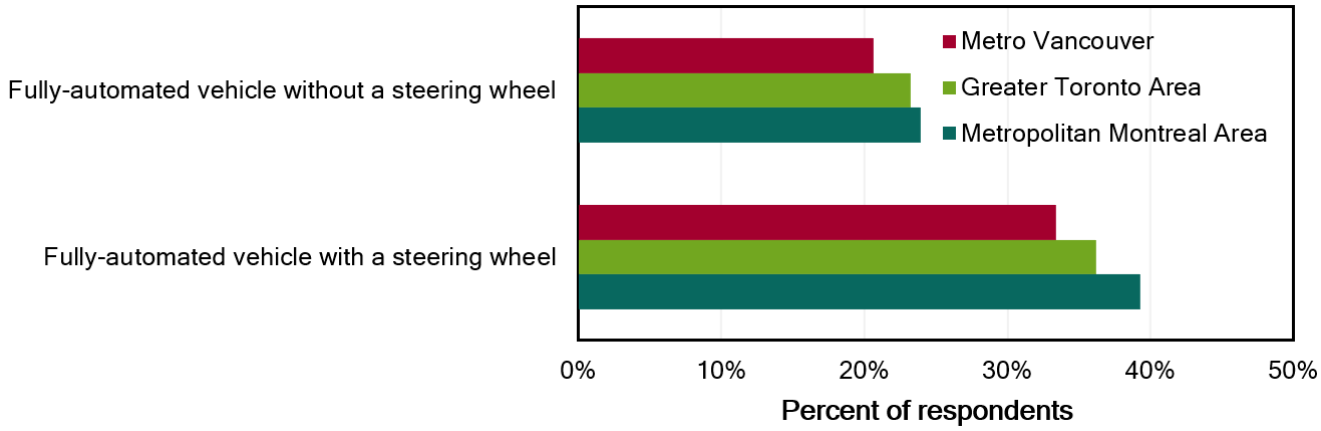
Figure 42: Percent of respondents "moderately interested" or "very interested" in using shared mobility innovations in the future in Metro Vancouver (n=993, weighted), Greater Toronto Area (n=794, weighted), and Metropolitan Montreal Area (n=819, weighted).



Regarding automated vehicles, interest in purchasing some type of FAV is similar in the three metro regions (Figure 43):

- Interest in purchasing a FAV without a steering wheel (i.e., can only be operated in a fully-automated mode) ranges from 21%-24%, while interest in purchasing a FAV with a steering wheel (i.e., automation can be switched off) ranges from 33%-39%.
- Interest is slightly higher among Metro Montreal respondents, followed by Greater Toronto respondents, and then Metro Vancouver respondents.

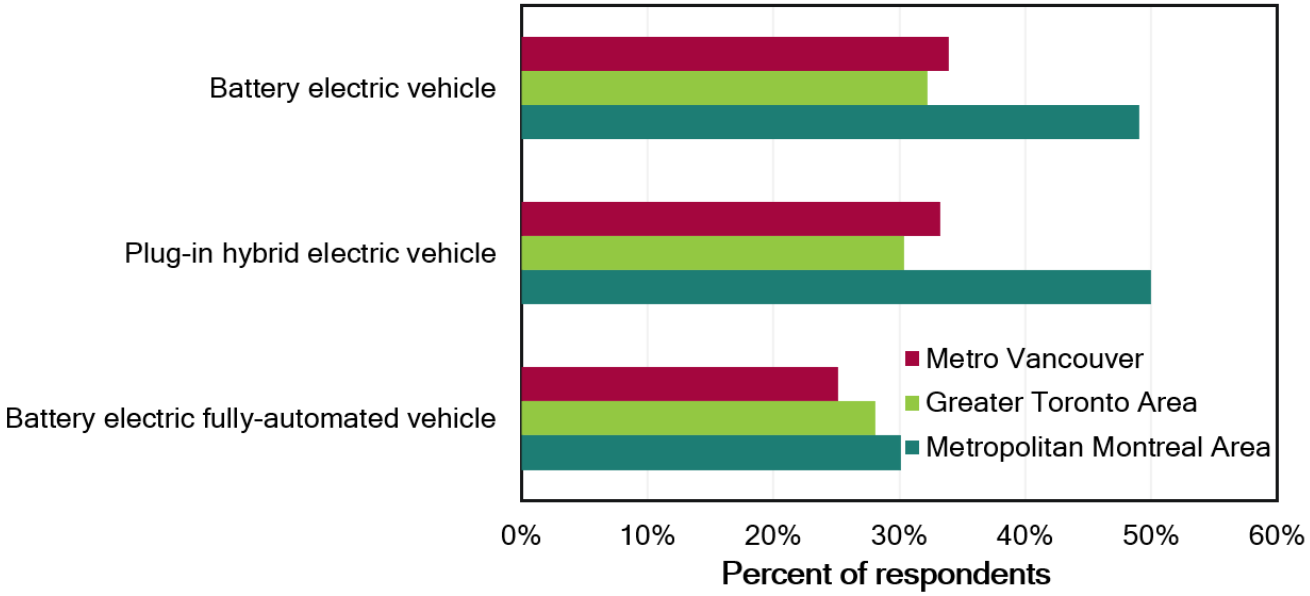
Figure 43: Percent of respondents that are "moderately interested" or "very interested" in purchasing a fully-automated vehicle in the future in Metro Vancouver (n=993, weighted), Greater Toronto Area (n=794, weighted), and Metropolitan Montreal Area (n=819, weighted).



Lastly, interest in purchasing a BEV and PHEV is consistently highest among respondents in Metro Montreal, and similar among respondents in Metro Vancouver and Greater Toronto (Figure 44):

- 49% of Metro Montreal respondents are interested in purchasing a BEV in the future, compared to 32%-34% of Metro Vancouver and Greater Toronto respondents.
- 50% of Metro Montreal respondents are interested in purchasing a PHEV in the future, compared to 30%-33% of Metro Vancouver and Greater Toronto respondents.
- Interest in purchasing a battery electric, fully-automated vehicle is similar among the regions, ranging from 25%-30% of respondents reporting interest.

Figure 44: Percent of respondents that are "moderately interested" or "very interested" in purchasing electric vehicles vehicle in the future in Metro Vancouver (n=993, weighted), Greater Toronto Area (n=794, weighted), and Metropolitan Montreal Area (n=819, weighted).



9. Consumer characteristics associated with new mobility innovation adoption

We estimate several multiple linear regression models to explore characteristics associated with adoption of ride-hailing and car-sharing, as well as interest in adopting ride-hailing, car-sharing, FAVs (one which can have the automated feature switched off), and BEVs (Table 2). As a reminder, adoption is defined as if respondents have ever used a ride-hailing app to take a ride and if respondents have ever used a car-sharing service to take a trip. Interest is assessed by asking respondents how interested they are in using a given innovation on a scale ranging from 1 ("not at all interested") to 4 ("very interested"). The regression models explore how a variety of independent variables (organized by psychological constructs, contextual forces, neighbourhood type, travel patterns, and demographic characteristics) are associated with the dependent variables of interest in adopting each innovation.

Broadly, we observe more similarities in associated variables than differences. We summarize trends in each category of variable. Beginning with psychological constructs:

- Traditional values are negatively associated with interest in and adoption of the innovations.
- Engagement in technology- and environment-oriented lifestyles also are consistently positively associated with adoption and interest in the new mobility innovations.
- There are mixed results for environmental concern, where stronger concern is associated with interest in adopting a FAV and BEV, though less concern is associated with interest in both ride-hailing and car-sharing.

Regarding contextual forces:

- Owning more household vehicles is associated with interest in purchasing a FAV and a BEV, while owning fewer vehicles is associated with ride-hailing and car-sharing interest.
- Intention to purchase a new or used vehicle in the future is positively associated with adoption of and interest in all innovations.

In terms of neighbourhood types:

- Compared to the baseline of living in a far auto suburb, living in active cores and transit suburbs is positively associated with ride-hailing and car-sharing adoption and interest.
- Living in near auto suburbs is positively associated with car-sharing adoption and interest, as well as interest in purchasing a BEV (compared to living in far auto suburbs).

Travel patterns seem to have less of an influence on adoption of and interest in the innovations, compared to the other categories. Specific observations include:

- More frequent trips made for driving and chaperoning others is associated with car-sharing adoption and BEV interest, though negatively associated with ride-hailing interest.

- More frequent trips made for recreation and leisure is associated with ride-hailing and car-sharing adoption, as well as ride-hailing interest.
- Making more trips for recreation and leisure is also associated with less interest in BEVs.

We observe the most consistent patterns across the innovations in demographic characteristics:

- Younger ages and higher education levels are associated with interest in and adoption of all new mobility types.
- Higher incomes are also generally associated with new mobility interest and adoption (except car-sharing).
- Identifying as male tends to be associated with new mobility interest and adoption (except ride-hailing).

*Table 2: Results of multiple linear regressions, unstandardized coefficients (b), and significance level (***p <0.01, **p<0.05, *p<0.1). Each column heading signifies the dependent variable.*

	Ride-hailing adoption		**Ride-hailing interest**		**Car-sharing adoption**		**Car-sharing interest**		**FAV with steering wheel interest**		**BEV interest**	
Psychological constructs	*b*	Sig.	*b*	Sig.	*b*	Sig.	*b*	Sig.	*b*	Sig.	*b*	Sig.
Traditional Values	-0.033	*	-0.067	*	-0.066	***	-0.187	***	0.047		-0.068	*
Biospheric Values	-0.035	*	-0.041		0.016		0.008		-0.023		0.055	
Altruistic Values	0.037	**	0.101	**	0.003		0.045		0.025		0.07	*
Egoist Values	0.016		0.113	***	-0.009		0.018		0.011		-0.048	*
Openness Values	0.041	***	0.06	**	-0.01		0.058	**	0.054	*	0.04	
Technology-oriented Lifestyle	0.057	***	0.177	***	0.044	***	0.102	***	0.305	***	0.191	***
Environmental-oriented Lifestyle	0.014		0.051	*	0.017	*	0.211	***	0.038		0.188	***
Environmental concern (NEP)	-0.008		-0.034	*	0.001		-0.031	**	0.103	***	0.127	***
Contextual forces												
Household vehicle ownership	0.008		-0.042	*	0.003		-0.084	***	0.063	**	0.112	***
Vehicle purchase intention	0.039	**	0.197	***	0.000		0.062	*	0.228	***	0.253	***
Neighbourhood type (base = far auto suburb)												
Active Core	0.137	***	0.251	***	0.219	***	0.442	***	0.055		-0.005	
Transit Suburb	0.064	***	0.091	*	0.085	***	0.192	***	0.018		0.095	*
Near Auto Suburb	0.019		0.046		0.027	*	0.118	***	0.078		0.14	***
Travel patterns												
Commuting frequency (days per week)	0		0		0.0000787		0.012		-0.001		0.011	
Driving-chaperoning frequency (days per week)	-0.006		-0.018	*	0.01	***	0.005		0.009		0.035	***
Shopping frequency (days per week)	0.002		0.004		0.000		0.002		-0.017		-0.014	
Recreation frequency (days per week)	0.03	***	0.051	***	0.01	**	0.006		-0.006		-0.035	***
Demographic characteristics												
Age	-0.103	***	-0.161	***	-0.033	***	-0.087	***	-0.138	***	-0.148	***
Education	0.064	***	0.047	**	0.027	***	0.077	***	0.055	**	0.057	**
Income	0.034	***	0.056	***	0.006		-0.013		0.052	***	0.03	**
Gender (base = female)	-0.01		0.062	*	-0.039	***	-0.092	***	-0.142	***	-0.273	***
Household size	-0.003		-0.019		-0.013	**	0.013		0.013		0.013	
Pseudo R^2	0.224		0.182		0.137		0.189		0.206		0.249	

10. Policy support and opposition

Respondents were asked to express how much they support or oppose several types of policies related to new mobility regulation and sustainable transport more generally.

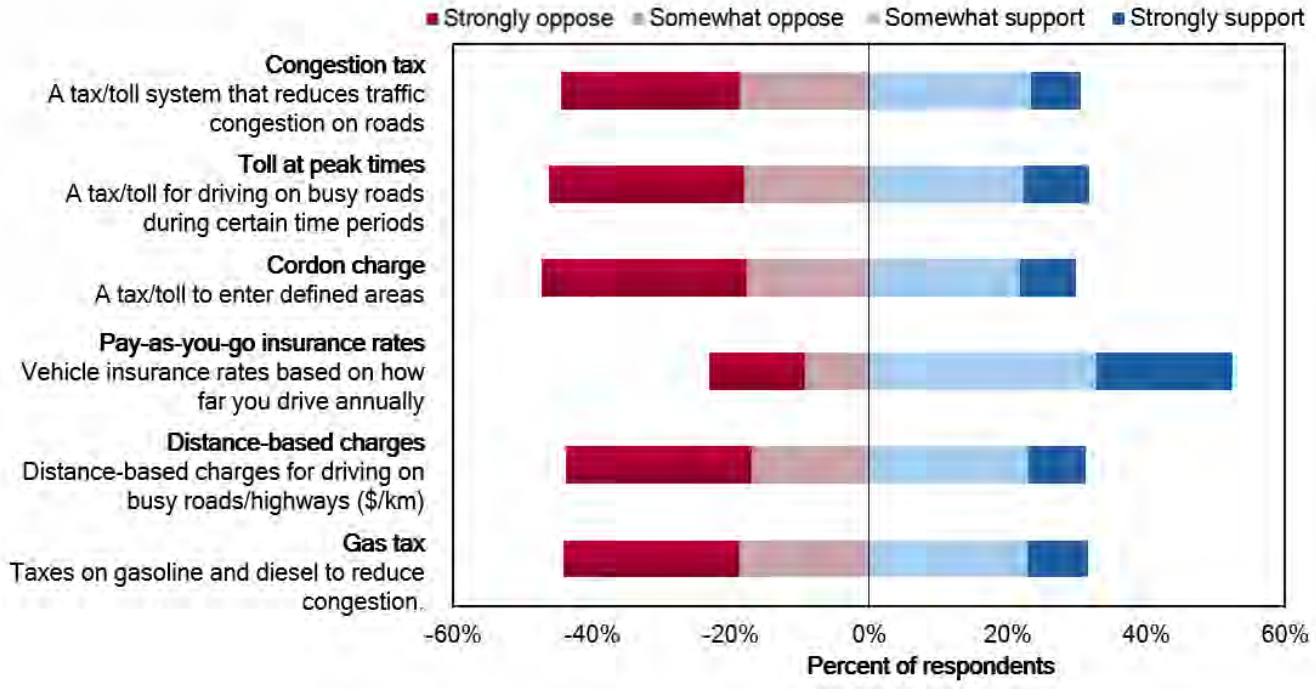
Key takeaways include:

- Support tends to be low and opposition high for road pricing policies.
- Support is high and opposition is low for policies related to regulation and implementation of new mobility innovations.
- Support is high and opposition is low for other transport-focused climate policies (low carbon fuel standard, vehicle emissions standard, electric vehicle subsidy, and electric vehicle sales mandate)
- Support is low and opposition is high for a carbon tax.

10.3 Road pricing policies

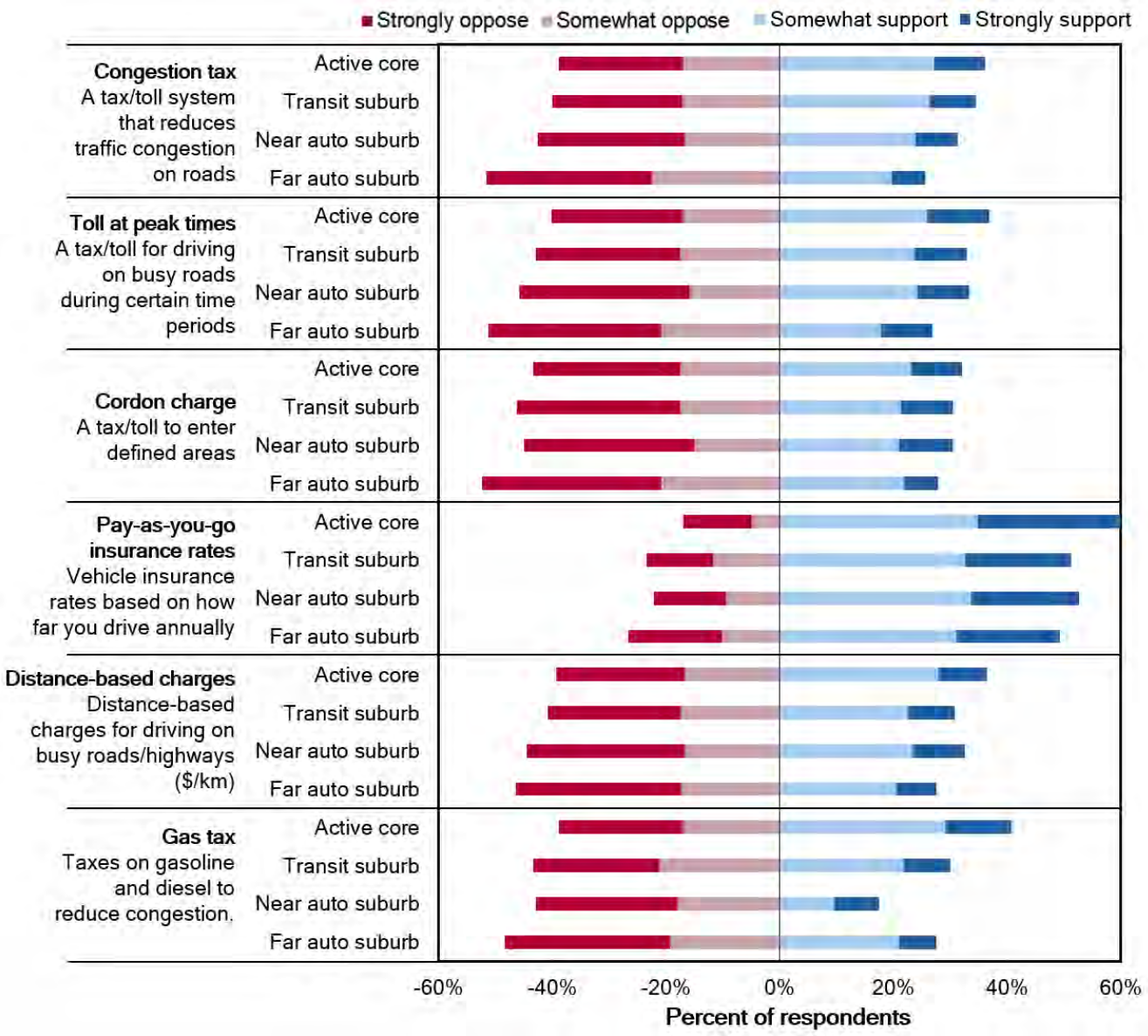
The survey asked respondents about six road pricing policies (defined in Figure 45). For each policy, respondents were asked to assume that all revenues would go to improving public transportation. Overall, respondents tend to express more opposition than support for most road pricing schemes (Figure 45). 44%-47% of respondents oppose congestion taxes, tolls at peak times, cordon charges, distance-based charges, and gas taxes – with 30% or fewer respondents expressing support for the policies. In contrast, 53% support pay-as-you-go insurance rates (insurance rates based on annual distances driven), and 23% oppose.

Figure 45: Support and opposition for road pricing policies (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



We also show how support for these road pricing policies varies by neighbourhood type (Figure 46). Overall, we observe that respondents in active cores express the highest support for road pricing policies (and the lowest opposition), and the lowest support (and highest opposition) to the policies is displayed by respondents in far auto suburbs. Respondents in transit suburbs and near auto suburbs display similar levels of support and opposition.

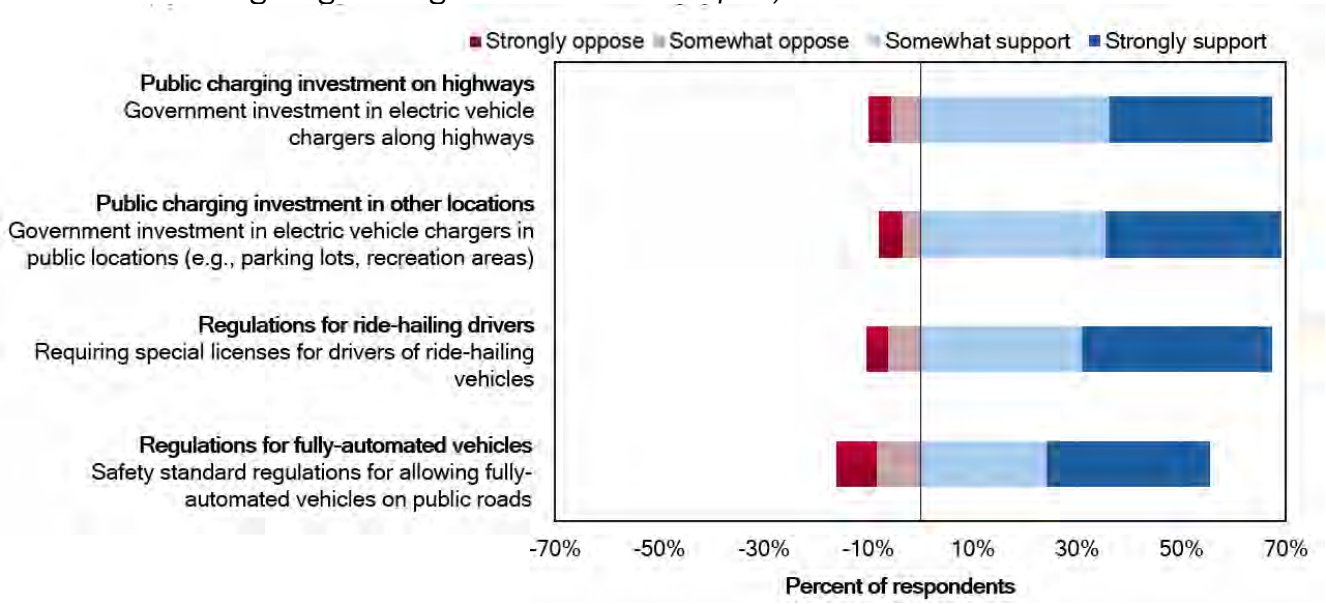
Figure 46: Support and opposition for road pricing policies by neighbourhood type (active core n=247, transit suburb n=240, near auto suburb n=252, far auto suburb n=254).



10.4 New mobility policies

The survey then asked respondents how much they support and oppose several policies related to the new mobility innovations specifically (defined in Figure 47). Support for these policies is much higher – 67%-69% support government investment in electric vehicle chargers, 67% support regulations requiring special licenses for ride-hailing drivers, and 56% support safety standards for regulating FAVs on roads. Less than 16% of respondents oppose any of these policies.

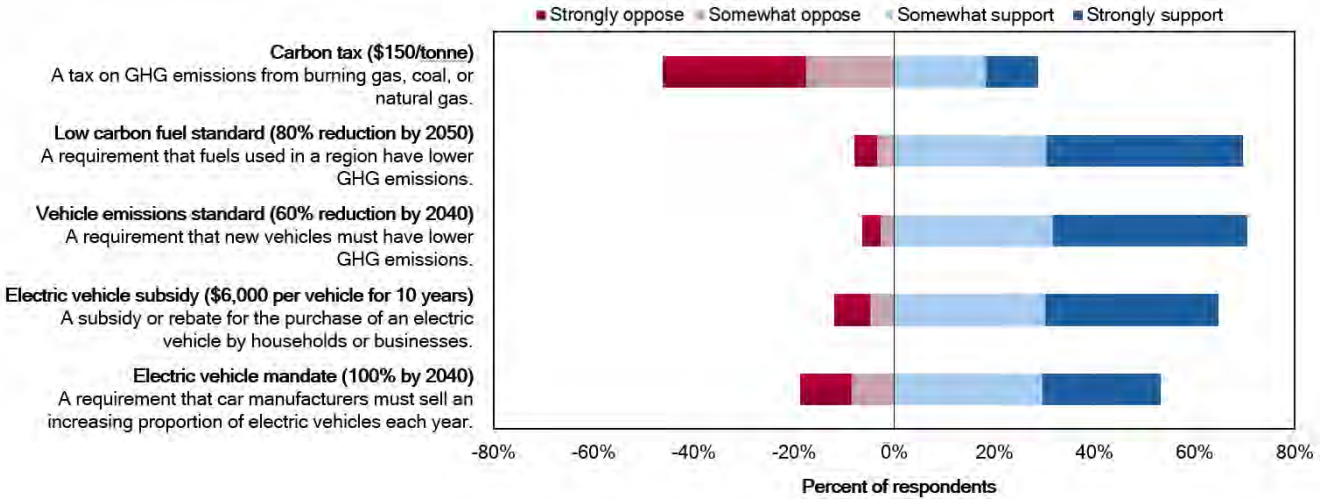
Figure 47: Support and opposition for new mobility policies (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



Other transport policies

Lastly, the survey asked respondents about their support or opposition for five climate policies that target the transport sector: a carbon tax, low carbon fuel standard, vehicle emissions standard, electric vehicle purchase subsidy, and electric vehicle sales mandate (also known as a zero-emissions vehicle mandate). The policies are defined in Figure 48. The policies were evaluated at stringencies that experts say are needed to achieve deep cuts in GHG emissions consistent with meeting 2050 climate goals. Respondents are generally supportive of a low carbon fuel standard (69% support), vehicle emissions standards (71% support), and electric vehicle purchase subsidies (65% support), with minimal opposition (12% or fewer respondents oppose). Support is slightly lower for an electric vehicle sales mandate (54% support) and opposition is also slightly higher (18% oppose). Support for a carbon tax is low, with only 28% expressing support and 46% opposing one.

Figure 48: Support and opposition for transport-focused climate policies (full Metro Vancouver sample, n=993, with corrective weighting for neighbourhood oversamples).



11. Conclusions

This study evaluates broad trends in awareness, adoption of, interest in, and perceptions towards emerging new mobility innovations among residents of Canada's largest urban regions. We explore characteristics associated with adoption of and interest in adopting ride-hailing, car-sharing, BEVs, and FAVs. Lastly, we assess support and opposition for various new mobility, transport, and climate policies. We distill key takeaways and observations related to each of these objectives.

Regarding **awareness** of new mobility innovations:

- Of the shared innovations, familiarity is highest with ride-hailing (31% of respondents are "moderately" or "very familiar"), while 21% are familiar with car-sharing, and 11% are familiar with pooled ride-hailing.
- Awareness (having heard of ride-hailing and car-sharing companies and perceiving that these services are available in local areas) is generally highest among respondents in active cores and lowest among respondents in far auto suburbs.
- Regarding automated technologies, familiarity is highest for automated cruise control (29% are familiar), followed by self-parking (18%), Tesla Autopilot (12%), fully-automated vehicles (11%), and then lane centering steering (8%).
- Familiarity with the most common BEVs (the Tesla Model S and Nissan Leaf) are similar, with 12% considering themselves familiar with the Tesla Model S and 10% with the Nissan Leaf. Familiarity with the Chevrolet Volt (PHEV) is lower, with only 7% of respondents considering themselves familiar with it.

Regarding **adoption** of the new mobility innovations:

- Adoption of ride-hailing and car-sharing is highest among those in active cores (30% and 53% have used it at least once in their local areas and outside their local areas) and lowest among those in far auto suburbs (14%-33%).
- Current or past ownership of automated cruise control is highest of the automated technologies considered (30% have adopted it), and generally current/past ownership of all automated features is highest among those in near and far auto suburbs and lowest among those in active cores.
- 6% of respondents or currently or in the past have owned a BEV or PHEV, and rates of ownership tend to be slightly lower among those in active cores.

Regarding **interest** in adopting the new mobility innovations:

- We observe moderate interest in using ride-hailing (29% of respondents) and car-sharing (18% of respondents).
- Around one-third of respondents or fewer are interested in purchasing some type of fully-automated vehicle in the future.

- Over one-third of respondents are interested in purchasing a BEV or PHEV in the future, with fewer respondents reporting interest in purchasing BEV that is fully-automated (25%).
- Respondents are more interested in combining ride-hailing and car-sharing with electric vehicles than they are with combining shared mobility innovations with fully-automated vehicles.

Regarding **perceptions** of the new mobility innovations:

- Perceptions vary by new mobility type, though we observe that each new mobility innovation tends to evoke stronger perceptions around the innovations requiring trust, being part of the future, and changing how people think of the mobility system.
- Image associations also vary by the innovation type, however all new mobility innovations tend to be strongly associated with images of a user being innovative and pro-environmental.

When **comparing** Metro Vancouver, Greater Toronto, and Metro Montreal:

- There are more similarities than differences between the metro areas.
- Familiarity with ride-hailing and pooled ride-hailing is higher among Greater Toronto respondents, though familiarity with electric vehicle models is higher among Metro Montreal respondents.
- Ride-hailing adoption tends to be higher among Greater Toronto respondents.
- Interest in purchasing PHEVs and BEVs is higher among Metro Montreal respondents.

Regarding **consumer characteristics** associated with new mobility adoption and interest in adoption:

- Engagement in technology- and environment-oriented lifestyles are consistently, positively associated with adoption and interest in the new mobility innovations.
- There are mixed results for environmental concern, where stronger concern is associated with interest in adopting a FAV and BEV, though less concern is associated with interest in both ride-hailing and car-sharing.
- Owning more household vehicles is associated with interest in purchasing a FAV and a BEV, while owning fewer vehicles is associated with ride-hailing and car-sharing interest.
- Intention to purchase a new or used vehicle in the future is positively associated with adoption of and interest in all innovations.
- Living in active cores and transit suburbs is positively associated with ride-hailing and car-sharing adoption and interest (compared to living in far auto suburbs).
- Younger ages, higher education levels, higher incomes, and being male tend to be associated with interest and adoption of the new mobility innovations.

Last, regarding **policies** for new mobility innovations, climate, and transport:

- Respondents report low support and fairly high opposition to most types of road pricing (up to 30% support most and up to 47% oppose most), as well as a carbon tax (28% support and 46% oppose).
- On the other hand, support is high and opposition is quite low for new mobility regulations (56%-69% support), a low carbon fuel standard (69% support), vehicle emissions standard, (71% support), electric vehicle subsidies (65% support), and electric vehicle sales requirement (54% support).

12. Recommendations and future research

The findings from this research lead to several recommendations, insights, and future research directions for TransLink:

- **Post-pandemic, consider opportunities for interest in ride-hailing and car-sharing**. We observe some reservations around using shared mobility forms, which may be due to perceptions of safety and public health guidelines surrounding the COVID-19 pandemic. That said, there is substantial interest in ride-hailing and car-sharing: 29% of Metro Vancouver respondents are interested in using ride-hailing and 18% are interested in using car-sharing. Future research can explore how consumers use and are interested in using shared modes after pandemic restrictions end, and how to encourage the use of pooled ride-hailing.
- **Consider opportunities for electrification of shared mobility.** Around one-third of respondents would be more likely to use ride-hailing and car-sharing if an electric vehicle option was available for their ride. This suggests that for a segment of consumers, having electric vehicles available in ride-hailing and car-sharing fleets would make these modes more attractive.
- **Consider opportunities for shared mobility to address first and last mile issues with public transit.** Shared modes such as ride-hailing, pooled ride-hailing, and car-sharing hold promise for first and last mile trips to access transit. Respondents in active cores and transit suburbs have higher levels of interest in using shared modes already, which may make these populations more suitable for encouraging shared mobility in combination with transit. Future research should explore how this potential further.
- **Build trust among consumers.** For all new mobility innovations, respondents had fairly strong perceptions around the innovations requiring their trust. Messaging, promotions, and trials could help build trust among potential users, though future research could better explore and understand these perceptions.
- **Consider opportunities to improve consumer awareness.** Consumer awareness remains low for several new mobility innovations, including pooled ride-hailing, car-sharing, and electric vehicles. Less than one-third of Metro Vancouver respondents are familiar with any of these innovations. One hypothesis is that promoting these innovations could help consumers to become aware these as alternatives to their usual modes that could be leveraged with transit use. That said, any information campaigns would likely to have to be carefully planned to be effective.

Findings from this study lead to many more questions that should be explored in further research, for example:

  - Will shifts in transport patterns brought on by the COVID-19 pandemic be temporary or permanent?
  - Will the increasing trend of walking affect or increase transit usage?
  - How can regional policies encourage usage of more sustainable modes?

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