ENGL 301 FORMAL REPORT

Increasing the use of Environmentally Friendly Transportations in Vancouver

To: Mayor's Office of City of Vancouver

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Contents

Abstract

The first objective of the report is to discuss the effects of air pollutants produced by gas powered vehicles such as Nitrogen Oxide (NO) and Carbon Monoxide (CO) to humans and the second objective of the report aims to find solutions that can influence commuter's behaviour into switching into more sustainable transportation methods.

As population continues to increase and the rate of urbanization grows, it is highly plausible that there will be a greater demand for transportation. The City of Vancouver and TransLink have to find different ways of adapting to the challenges as a result of rapid urbanization. The City and TransLink decision makers should create a plan that both supports the citizens with increased demand for transportation and encourages them to use sustainable and eco-friendly transportation options.

Personal automobiles still remain the most preferred method of transportation as per the Mode Share 2017 report and unfortunately, the greenhouse gases produced from vehicles is the main contributor to air pollution (*Health Impacts of Air Pollution in Canada)*. The report will investigate how we can achieve that by asking questions listed below and hopefully achieving the goal of reducing Vancouver's emission of harmful pollutants into the atmosphere.

- What is the current air quality in Vancouver, BC.
- Discover why personal vehicles are the main contributor to the air pollution in Vancouver
- What are the choices for Vancouverites to choose from when it comes to transportation
- Why are some people reluctant to change their transporting behaviour
- How can the provincial government and TransLink encourage people to choose transportation that produces less air pollution.
- Choose the options that are financially feasible, legally permissible and physically possible in Vancouver.

Introduction

Passenger gasoline cars and commercial trucks are one of the major sources of air pollutants and greenhouse gases (Air Pollutant Emissions*)*. Sometimes the impact of poor air quality is minuscule and unknown but in other cases, the consequence of poor air quality contributes to an incident of death (Causes of Poor Indoor Air Quality). According to Canadian Environmental Sustainability Indicators, transportation is the main source of nitrogen oxide and carbon dioxide. These two pollutants are one of the six pollutants that the environmental department keeps track of and they pose adverse effects on human health and the environment. Globally, around 7 million premature deaths annually are linked to air pollution (Seven Million Premature Death*s*) and the total economic cost of all the health impacts attributable to air pollution is $114B per year (2015 currency) (Health impacts of air pollution in Canada). This report will aim to investigate the possible solutions to the vehicle air pollution crisis that Vancouver officials can consider adopting.

The purpose of this report is to propose ways to encourage citizens in Vancouver to consider using a more environmentally sustainable method of transportation to reduce air pollution. In addition to that, the report will attempt to discover how people in Vancouver commute on a daily basis and how most people decide the kind of transportation. Is there a particular reason that prevents Vancouverites from choosing a more sustainable way of transport? In order to change commuters behaviour, the City of Vancouver and TransLink have to contribute together to build the infrastructure, technology and establish legislations that encourage environmentally friendly behaviours that will keep the air pollution level low in Canada. To obtain information regarding how people are transporting, a survey was sent to the online community, friends and family. Questions about their current primary method of transportation and reasons they would not choose the more sustainable way of transportation. For example, the survey asked why respondents are not planning to switch from driving a gasoline engine car to an electric vehicle (EV). Secondary data such as pollution reports, demographics and other statistics will be collected from government databases.

There are a few limitations to the collection of the primary data as the sample size of the survey will not be sufficient for us to make a definite conclusion that will represent the whole city but may provide us great insights into Vancouverites opinion and habits. This information may guide the process of change that will make Vancouver a greener place to live. However, in order to see a significant positive change to the air quality and have long lasting effects to the environment, requires a large amount of resources such as capital, human and land resources from both the public and the private sector. Due to the vast geography of Canada, most Canadian cities and neighbourhoods were built to support the usage of personal vehicles. In 2017, 55.3%, 4.4 million of Metro Vancouver trips were private vehicles and only 923,000 trips were by transit (*Mode Share*). This shows that the majority of people still consider driving as their primary choice when planning for a trip. With more effort from the private and the public sector, the City of Vancouver can decrease the air pollution emission from vehicles by asking questions that may lead us to more solutions.

- What is preventing people from using eco-friendly transportation methods?
- What is the reason people do not use environmentally friendly transportation methods?
- How can we encourage people to change their behaviours to adopt greener transportation methods?
- What can be done to lower the reliance of personal vehicles?

Data Section

Key chemicals and its effect

Transportation is the main source of NOx (Nitrogen oxides) (*Air pollutant emissions*). Nitrogen oxides include emissions of nitric oxide and nitrogen dioxide (NO_2). NOx is formed primarily from the release of nitrogen contained in fuel and combustion air during combustion processes. The NO released during combustion will oxidizes to NO_2 and both NO_2 and the untransformed state (NO) can have adverse effects to the environment and our health. The major issue with NO is that it damages the respiratory systems when inhaled and it can also be dissolved by water vapour transforming rain

into acid rain and causing damage to humans and animals. The adverse effect will magnify if NO infiltrates into the aquatic and terrestrial ecosystems and further causes damage to our society (*Common air pollutants: nitrogen oxides*).

Another kind of chemical that is worth mentioning is Carbon Monoxide (CO). This chemical is colourless, odourless, tasteless and poisonous gas and is emitted directly from automobiles tailpipes (Common Air Pollutants: Carbon Monoxide). CO can affect everyone but especially persons with heart disease because when it enters the bloodstream through the lungs, it will form a compound that inhibits the blood's ability to transport oxygen to organs. CO is lethal if the concentration is high.

Why should we care?

The composition of Traffic-related air pollution (TRAP) can vary vastly, depending on its source of generation; however, pollutants generated from automobile sources are of high health risk (Edwards et al. 127003). Substances such as NO_2 and CO contribute to many premature deaths in Canada and people living close to major roads had mortality rate advancements of 2.5 years and a significant increase in all-cause mortality of 18%. People who have underlying health issues such as chronic pulmonary disease, chronic ischemic heart disease, and diabetes will have higher mortality advancements of 3.4 years, 3.1 years, and 4.4 years, respectively.(Murray et al. 173). As we can see, the effects of air pollution is crucial to the health of humans and should be addressed carefully by encouraging citizens to switch to a transportation method that is less harmful to the environment.

TABLE 1. Characteristics of subjects exposed to traffic air pollution and control subjects in relation to distance of residence from major roads and highways, Hamilton, Ontario, Canada, 1992–2001

Variable	Control subjects (>100 m from a highway *and* >50 m from a major road) (n = 4,280)				Exposed subjects (within a road/highway buffer (<50 m from a major road or <100 m from a highway)) (n = 948)			
	No.	%	Median	IQR*	No.	%	Median	IQR
Male gender	1,905	45			401	42		
Age (years)			60.4	49.8–70.0			63.6	51.7–72.4
Annual household income (thousands of Canadian dollars)			48.3	36.5–61.1			39.1	30.7–52.2
Forced vital capacity (% predicted)			84	70–97			81	67–94
Forced expiratory volume in 1 second (% predicted)			79	55–96			73	52–91
Body mass index†			27.8	24.4–31.6			27.6	24.4–31.6
Diagnosed with asthma	471	11			85	9		
Diagnosed with chronic pulmonary disease (except asthma)	1,753	41			432	46		
Diagnosed with chronic ischemic heart disease	1,372	32			318	34		
Diagnosed with diabetes mellitus	695	16			145	15		
Nonaccidental death	706				217			

* IQR, interquartile range (25th–75th percentile).
† Weight (kg)/height $(m)^2$.

Fig. 1. Murray et al.; Characteristics of subjects exposed to traffic air pollution and control subjects in relation to distance of residence from major roads and highways, 2004.

This graph contains data comparing the control group (people living 100m away from a highway and 50m away from a major road) and the subject group (people living less than 100m away from the highway and 50m from a major road). The results show that the exposed group has a lower lung capacity and lower forced expiratory volume in 1 second. As the city continues to expand, more people will be forced to live near major roads and lower income households will be affected the most because they usually have less options for housing.

Current air quality and trend

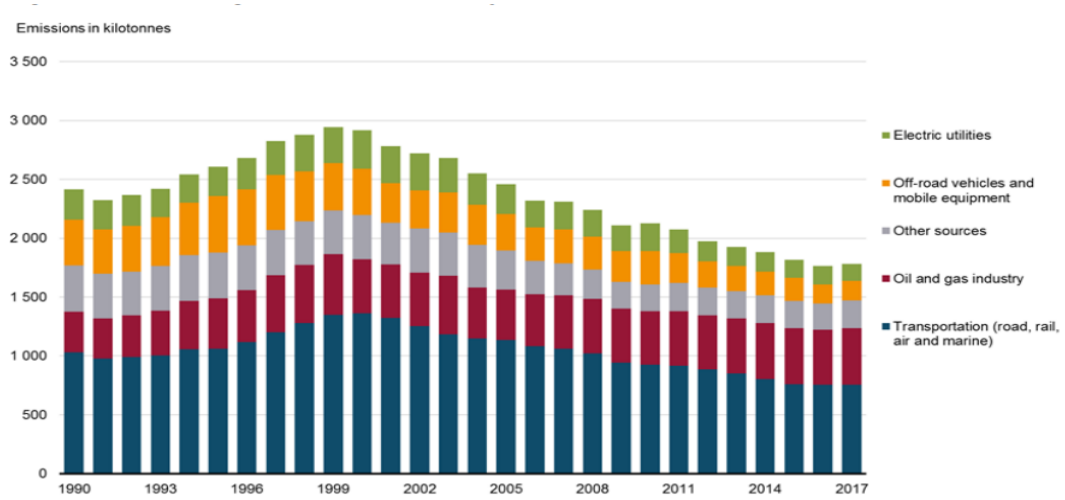


Fig. 2. Government of Canada; Total Nitrogen Oxide emissions by source in Canada, 1990-2017

Measuring in kilotonnes, this bar graph shows the total NO emissions by different sources in Canada. As the graph shows, transportation is the main source of NO in 2017. A promising trend is the decrease of NO emission since Canada hit the peak in 1999.

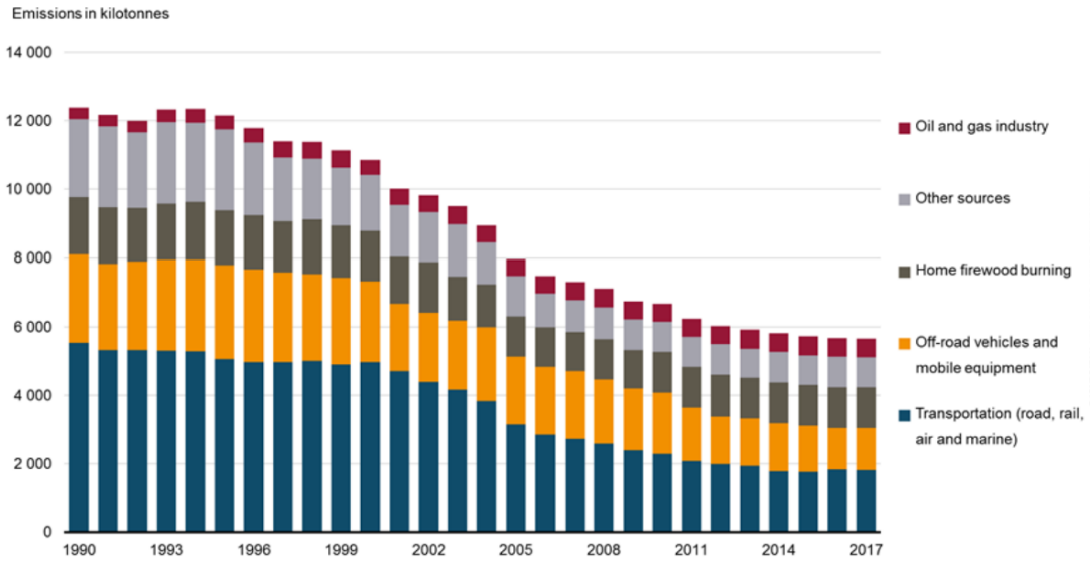


Fig. 3. Government of Canada; Total Carbon Monoxide emissions by source in Canada, 1990-2017

Similar to the first graph, this bar graph indicates the total emission of other main sources of air pollution, CO. The trend is promising as Canada has reduced the CO emission by almost half since the 1990s but the progress seemed to be hitting a plateau

in 2013. Decision makers have to keep up with the effort to further improve the transportation system to reduce the amount of CO in the air.

Table A.3. Data for Figure 3. Distribution of air pollutant emissions by province and territory, Canada, 2017

Province or territory	Sulphur oxides (percentage of national emissions)	Nitrogen oxides (percentage of national emissions)	Volatile organic compounds (percentage of national emissions)	Ammonia (percentage of national emissions)	Carbon monoxide (percentage of national emissions)	Fine particulate matter (percentage of national emissions)
Newfoundland and Labrador	1.7	2.7	1.6	0.2	1.8	1.2
Prince Edward Island	<0.1	0.2	0.4	0.6	0.5	0.3
Nova Scotia	7.1	3.6	2.2	0.7	2.9	1.6
New Brunswick	2.2	1.7	1.9	0.7	2.7	1.5
Quebec	11.4	11.0	16.1	13.4	27.5	12.6
Ontario	18.9	16.8	19.9	18.4	24.6	16.2
Manitoba	12.5	2.5	3.4	12.8	3.0	5.3
Saskatchewan	12.6	7.9	14.3	21.7	5.7	20.8
Alberta	25.2	35.7	31.3	27.4	17.9	35.3
British Columbia	8.2	16.5	8.7	4.1	13.0	5.0
Yukon	<0.1	0.1	0.1	<0.1	0.1	<0.1
Northwest Territories and Nunavut	0.2	1.2	0.1	<0.1	0.3	0.2

Note: The indicator reports air pollutant emissions from human activities only. It does not include emissions from natural sources such as forest fires and from vegetation. The percentages have been rounded off and their sum may not add up to 100.
Source: Environment and Climate Change Canada (2019) Air Pollutant Emissions Inventory.

Fig. 4. Environment and Climate CHange Canada; Distribution of air pollutant emissions by province. 2017

Factors to consider when choosing a transportation method

As was previously stated at the introduction, this report aims to address the obstacles. According to the results I have gathered from the survey, there are few major factors that will influence the types of transportation methods they may choose.

A. Accessibility
- This refers to the ease of getting to and from a bus stop/ skytrain station. Accessibility affects people's willingness to take public transport and a person will be more likely to drive a car if the distance between home and the public transit.

B. Cost
- This refers to the cost of taking public transportation versus the cost of owning a personal car. If the marginal benefit of driving a car exceeds the marginal benefit of taking the public transit, then a person will decide to drive instead of taking transportation.
- Other costs include the cost of maintenance, fuel and insurance required to own a car.
- Few survey responses reflected that the cost of parking at UBC has made them choose to take public transit instead of driving to school.

C. Speed and time
- The time required to get to their destination is one of the biggest factors that influences how commuters pick their transportation method.

D. Integration
For longer trips that require change of mode(e.g., Taking the bus to a skytrain station), this factor is significant for completion of the trip.

E. Reliability
- All factors will be deemed useless if that particular transportation method ceased to provide service. In general, personal vehicles have the highest reliability and public transits have lower reliability due to the nature of uncertainty.

F. Comfort
- This factor refers to the comfortableness of using that particular transportation method.

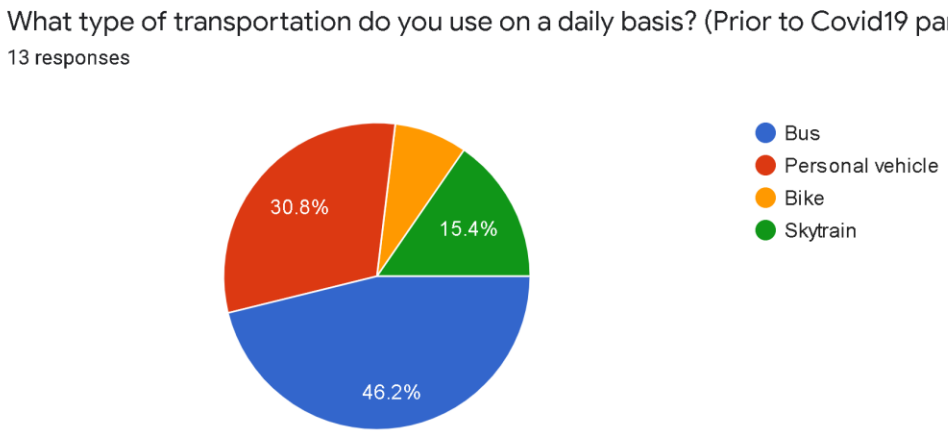
G. Safety
- Safety includes free from accidents, illegal activities and diseases.

General Findings

Most people who have responded to the survey are students so this mostly reflects the opinions of UBC students.

Public transportation takes time

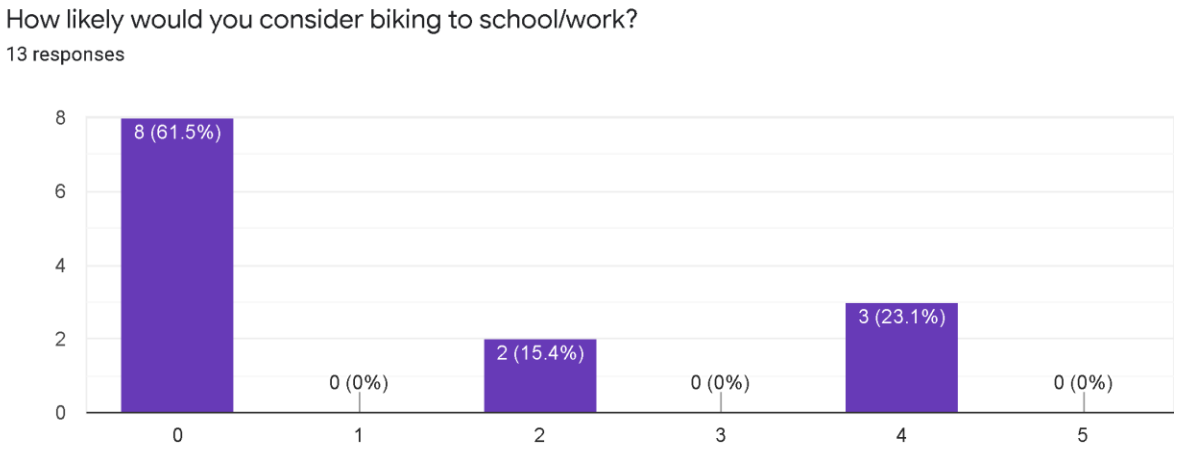
According to the survey results, most people take the bus to school (46.2%) and 30% of the students drive to school. Most students drive to school because they are concerned about the travel time. Taking the bus will require additional time for them to get to their destination. One response even claimed that driving a car saves as much as half of the traveling time during peak hours when compared to taking the bus. If we consider the value of time, it is much more convenient to drive a car. Hence, driving a car provides comfortness that no other transportation can offer. This creates a problem to the air quality when more people prefer cars because when factoring in engine size to emission and passenger capacity ratio, gasoline and diesel passenger cars emit 10 times more NOx per litre of fuel than large vehicles such as buses and trucks (Muncrief).



Biking is a feasible option only if the distance is short and the weather is appropriate

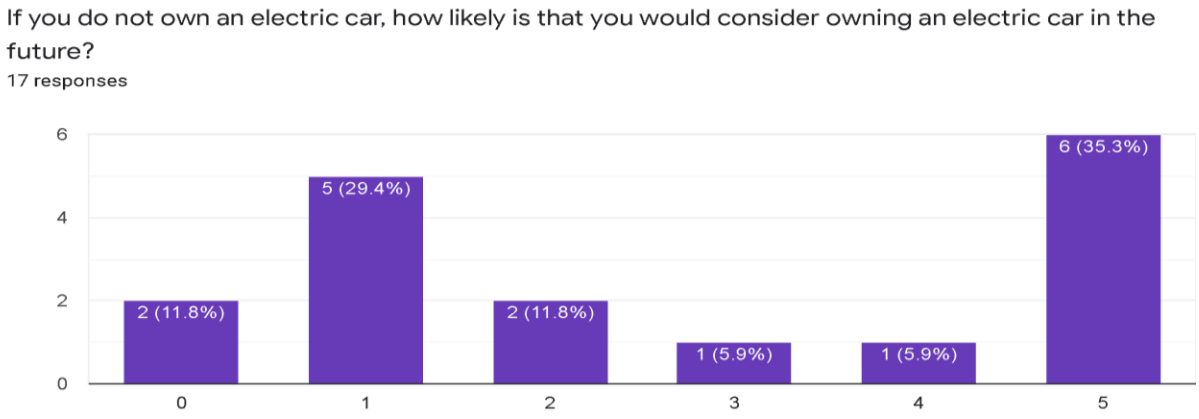
Biking is the most reliable transportation method when the distance to travel is short. However, during the winter and summer times when the temperature is very cold or hot, survey participants prefer driving to school/work because it is much more comfortable being in a personal vehicle. Especially during winter times when Vancouver

experiences plenty of rainfalls and they will not consider biking to school. In conclusion, this demographic group (18-24 years old) emphasizes speed, time and comfortness when they choose a transportation method.



The cost of EV is still relatively higher than normal gas cars and switching to an EV requires significant lifestyle change

Even though some respondents believe that it is cheaper to maintain and drive an EV, the initial cost of owning an EV is still relatively higher than normal cars.



The bar graph shows that most people are open to the idea of using an EV in the future but a portion of people will not consider switching to owning an EV. Responses collected through the survey shows that they are not ready for the switch because they don’t think there are enough charging stations in good locations for them to use in

Vancouver or they don’t think there is enough supplementary facility for electric car users.

Recommendations

Recommendation 1

One problem commuters are concerned about is where to store their bikes safely. Consider building an underground bike storage. In Japan where 78% of households own a bike, there is a major problem with storage space and theft. However, these two problems can potentially be solved when building an underground bike storage system. According to a CNN news report, underground bike storages have greatly reduced the amount of massive congestion near major stations in Japan (Springer and Han). If the storage area is not sufficient, cyclists are less likely to bike to school and work because there is not enough space to keep their bike safe from theft. In Japan, Giken Ltd built underground storage for the city and below are some photos of the actual project.

Fig. 5. GIKEN LTD; Automated Parking Facility ECO Cycle. 2019

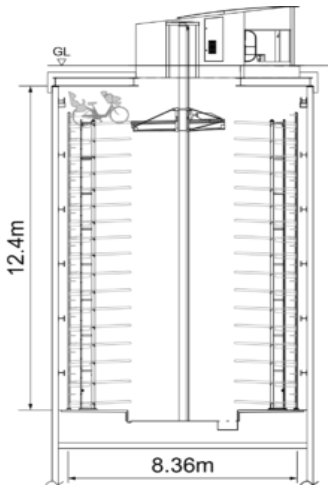


Fig. 6. GIKEN LTD; Automated Parking Facility ECO Cycle. 2019

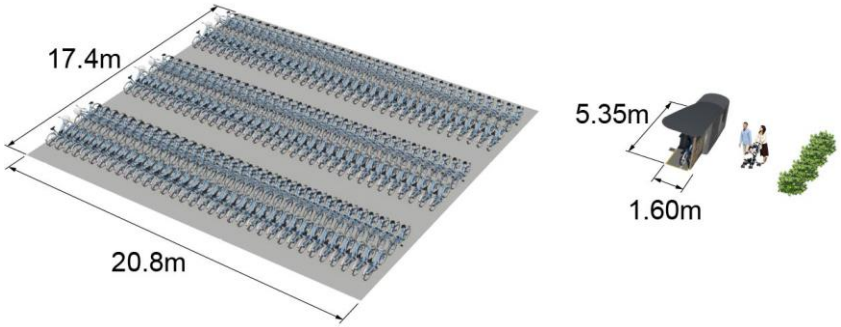


Fig. 7. GIKEN LTD; Automated Parking Facility ECO Cycle. 2019

According to the company, the operation is very easy. First, an electronic tag mounted on the front wheel corresponds to the user's membership card. Next, load the bike onto the bay and press start. Inside the system, a carrier lift that holds the bicycle rotates downwards, placing the vehicle into an open rack. To retrieve the bike, one swipes their electronic card, and the automated system retrieves the bike and places it above-ground in about 8 seconds. This is especially ideal for peak, and rush hour times. Since bikes are securely stored underground away from eternal elements such as weather and theft, this in my opinion will incentivize more people to consider biking to school or work and lower the emission of greenhouse gases that could cause harm to people.

Recommendation 2

Increasing the comfortableness of cycling in major routes. Since most survey respondents responded that because they don't think biking is enjoyable, they will not consider biking to school. The City should consider increasing the comfortableness of biking on certain roads to encourage bicycle usage. For example, point out quieter route options available options like backstreets, parks, cycle paths and canal towpaths.

Currently, bike sharing stations operated by Mobi Share are only concentrated in Downtown Vancouver and Broadway street between Arbutus street and Commercial Drive. There are buses available in that area already so the demand for the bikes will not be very high. Consider installing near skytrain stations where people can consider biking to a skytrain station and then switch to taking the skytrain. Skytrain stations that can be considered are all stations on Canada Line. This will improve the integration of the transit system and improve public transit ridership rate.

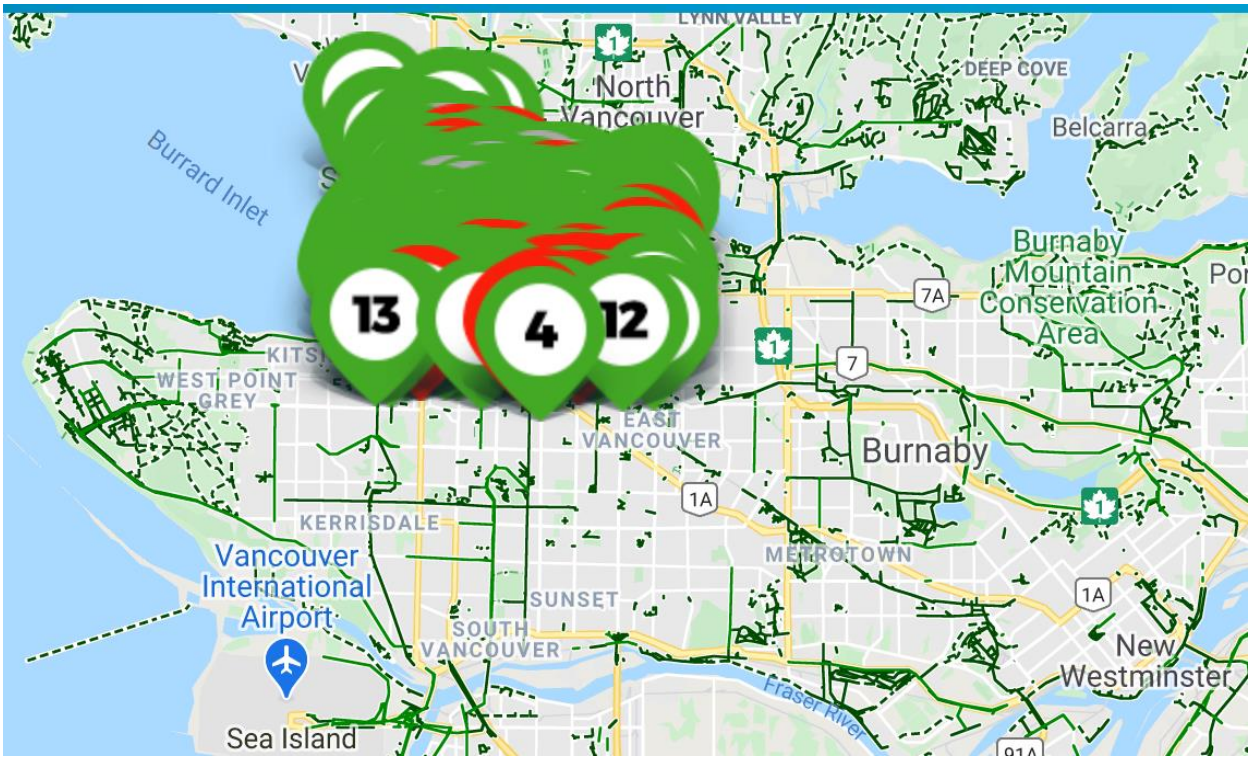


Fig. Mobi by Shaw Go, Vancouver Bike Share Inc, 2019

Recommendation 3

Commuters will be more likely to consider switching to taking public transit if the commute time is shorter. Consider upgrading the service provided by the bus route 49 Metrotown/ UBC to accommodate peak hours ridership. Prior to the pandemic, it is not uncommon to be denied boarding three times because buses are too full during the morning rush hours. 49 Metrotown/UBC being the second busiest bus route in Metro Vancouver with 10.06 million annual boarding and 31,350 average weekday boarding, should have a B-Line route to increase efficiency. Understanding that 49th avenue is much narrower than other RapidBus routes such as R1 King George Blvd, R2 Marine Dr and R4 41st Ave, employing the double decker buses to service the commuters living along the 49th avenue during peak hours can hugely decrease time required to commute. This will make using the public transit a much more favourable option to consider when commuting to work or school.

Conclusion

Summary of Findings

- People dislike taking public transit because of the additional time required to travel.
- Most people are willing to switch to driving an EV or consider possibly switching to driving an EV in the future but a reasonable number of respondents say they will not consider giving up their gas vehicle just yet.
- Biking is environmentally friendly but this method of transportation is largely influenced by external factors such as the environment and geography of its surroundings.

Interpretation of Findings

- TransLink may have to find better ways to improve speed and reliability of the public transportation system.

- A considerable lifestyle change is required to switch to using an EV and most people are not quite ready for it yet. Humans are very susceptible to habits and it will take some effort to encourage positive action. Another issue is the higher initial cost for owning an EV, most people do not feel like the additional cost is justified yet.
- Travel time during peak rush hour is somewhat unreliable. Therefore, some people chose not to use the public transit system.

Recommendations

1. Providing cyclists more benefits to incentivize people to use the bike as their primary form of transportation. Decision makers and government officials can promote the benefits of sustained physical exercise involved in cycling, easier parking, increased maneuverability, and access to roads, bike paths and rural trails. Installing underground bike storages in major locations can also encourage people to bike to major rapid transit stations because storages will protect their personal property from environmental factors and theft.
2. Expanding bike sharing service to outside of Downtown area and W.Broadway to cover other skytrain stations and its neighbourhoods along the Canada Line.
3. Consider adding RapidBus lane on 49th avenue or using double deck buses during rush hour peak time to service more commuters. Upgrade buses and skytrain so that it is more comfortable for passengers. Implement stricter rules to keep the cabin clean and safe.

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