# IMPROVING MOBILITY & MOBILITY EQUITY:

**A Study on Public Transportation Mode Choice in Response to Fare Changes in Metro Vancouver**

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**April 20, 2016**

In October of 2015, TransLink – the statutory authority responsible for Metro Vancouver's regional transportation network, including public transport, major roads, and bridges – made changes to the region's fare structure. According to the old fare structure, all modes of mass public transportation were priced using a three-zone system; however, with the changes made, trips by bus are charged as one zone, whilst all other modes maintain the traditional three-zone system. This was done as a temporary solution to frequent issues with overcharging customers on buses during the trial phase of its new Compass Card technology, which is an electronic payment and smart card system. This report then, examines the impact of the change in fare structure on transportation mode choice and routes, and discusses possibilities for fare structure changes once the interim transitional system of one-zone bus fares ends.

The results from this study show that public transportation users largely have not changed their transportation routes as a result of such changes in fare structure, with 84% of survey participants indicating that they have not changed their routes. The main reason suggested for not changing transportation routes was the inadequacies of bus services. Recommendations from this study then, include further research into the possibilities for:

- introducing flat or distance-based fare pricing
- expanding the bus network, particularly in zones two and three, so as to increase mobility and connectivity

In order to collect data on public transportation mode choice and passenger routes, a survey was created and distributed online via social media platforms, as well as in-person at two major transit stations. A sample size of 150 participants was used, with participants ranging from the age of under 18 to 64 years of age. Additionally, the survey created and the recommendations outlined were informed by research compiled from a literature review.

## INTRODUCTION

Mobility can be easily overlooked and taken for granted, however, it has profound effects on one's quality of life and ability to fully participate in society (Clarke & Gallagher, 2013; Jones, Graham, & Shier, 2008). Given the importance of mobility then, there has been increasing interest on the issue of mobility equity – that is, the access to transportation and the fair distribution of costs and benefits associated with these modes of transport (Golub & Martens, 2014). In the following, I will argue that, in regards to recent changes in fare structure in the Metro Vancouver region, there are opportunities for improving mobility and mobility equity. These include improving bus services, particularly in zones two and three, as well as the possibility of introducing flat or distance-based fare pricing.

A discussion of mobility equity inevitably leads to debates over how to best plan for transportation for a region. In the past, urban transportation planners often sought to achieve this by planning for the car. More recently however, given that public transport can service more people, as well as awareness and concerns surrounding climate change, improving public transportation networks seems to have increased in priority.

Faced with multiple transportation options then, which mode of transport do people choose and why? Research on the topic of transportation mode choice has broadly adopted two approaches. An economic-based approach views transportation mode choice as driven by costs and benefits, whereas a psychological approach focuses on how traveller attitudes ultimately affect mode choice. While there is ample research from both sides, there is one notable gap in knowledge. Research has focused on the choice between travelling by private automobile or taking public transit, but little to no research exists comparing two different modes of public transport.

Thus, public transportation in the Metro Vancouver region offers an excellent case for study. It is unique in that it has recently adopted a dual transit-fare structure in which light rail (known as SkyTrain), passenger ferry (SeaBus), and commuter rail (West Coast Express) are priced according to a multi-zone system, while buses are priced according to a single zone system. The intent of this research then, is to examine the effects of such a change to a dual transit-fare structure on transportation mode choice. The results of the study suggest that

individuals are largely not changing their transportation mode choice or behaviours. The reason for which is due to attitudes regarding convenience and time costs of buses.

## RESEARCH ON TRANSPORTATION MODE CHOICE

The existing literature on transportation mode choice has dominantly been concerned with examining the choice between travelling by private car or public transit. To explain individuals' choices regarding transportation mode, research has largely taken two approaches. The first takes an economic approach by considering costs to the individual, including financial costs and costs on time. The other is a psychological approach, considering the attitudes which might influence transportation behaviour. While I have divided the following findings according to the two aforementioned approaches, it is important to understand that these approaches are not mutually exclusive. For example, while weighing financial costs against costs on time may seem like a simple endeavor, built into such a calculation are attitudes regarding money and time.

### The Economics of Transportation mode Choice

As one might intuit, evidence suggests that as financial costs associated with a particular mode of transportation increases, individuals will often alter their transportation behaviours to avoid such costs. One such study by Hess (2001) found that parking price was positively associated with public transit use and negatively associated with private vehicle commutes. More specifically, when parking was free, sixty-two percent of participants in the study drove alone, and twenty-two percent commuted using public transit. By contrast, when parking increased to six dollars, the percentage of private vehicle commuters dropped to forty-six percent, while the percentage of public transit users doubled.

However, depending on trip-related factors and individual demographics, the relationship between costs and transportation behaviour is not as straight forward as it seems. Economist Becker's (1965) theory of time allocation demonstrated that all goods and activities (or the time associated with these activities) have a monetary value calculated in wages. Not all

time is valuated the same however. For example, when income increases, value of time also increases. In this case, travel time is seen as having a higher cost per unit of time, because time spent in travel equates to time taken away from productivity and a potential loss in wages. A study by Kuppam et al. (1998) supports this, finding that those in higher income groups were more likely to not change their travel behaviour when parking fees increased, but instead, continue to make solo commutes by car, perhaps because the costs associated with time outweighed the additional financial costs.

Some other patterns concerning transportation and value of time include: a higher value of time for work trips versus leisure trips; lower costs for activities associated with positive attitudes or outcomes; and a lower value of time associated with children, the elderly, and other groups which are disadvantaged in regards to employment (Victoria Policy Transport Institute, 2013).

### The Psychology of Transportation Mode Choice

More recently, research on transportation behaviour has shifted away from the traditional economic perspective, towards approaches which consider the psychology of transportation behaviours (Popuri et al., 2011). One of the factors which influences our judgement of whether a mode of transportation is worth our time or money is our attitude regarding that mode of transportation. Thus, in a meta-analysis by Wardman (2001), he reports that the value of time is lower for bus riders than for rail riders. In other words, taking the bus has a greater cost per unit of travel time than taking rail. This perception of rail being a better worth of time was largely due the positive attitudes towards rail being more frequent and reliable. A caution on some of the findings from Wardman's study however, is that it is a meta-analysis on British research. As such, there may be cultural differences in regards to attitudes on transportation.

To explain this finding more thoroughly, it may be useful to turn to Li's (2003) analysis of the subjective experience of time. Li explains that commute characteristics, journey episodes, and travel environment impact one's perception of the passage of time (as opposed to objective clock time). For example, wait time is often unoccupied time, which causes the

passage of time to appear slower as passengers attend more to the passage of time itself. Thus, this agrees with Wardman's (2001) finding, where the relative infrequency of bus services compounds with the perception of time, resulting in higher costs per unit of actual travel time.

Other research on attitudes and transportation behaviour has focused on finding key attitudinal variables which predict transportation mode choice. Indeed, there have been numerous studies suggesting different sets of attitudes which may explain individuals' choices regarding mode of transportation (Kuppam et al., 1999; Paulssen et al., 2014; Outwater et al., 2003).

I would argue that the attitudinal variables identified by Outwater et al. (2003) are the most useful for the purposes of this study. This is because, firstly, the variables offer a wide range of explanations for transportation mode choice; secondly, the terminology is easy to understand; and thirdly, there is no obvious overlaps between variables. These six attitudinal variables are: 1) the desire to help the environment; 2) travellers' need for time savings; 3) travellers' need for flexibility; 4) sensitivity to travel stress; 5) sensitivity to transportation cost; and 6) sensitivity to personal travel experience.

Apart from the finding in Wardman's (2001) meta-analysis, little research exists on how economics or psychology impacts the choice between two different modes of public transportation. One study which takes a step in this direction is by Dell'Olio et al. (2012), in which they posed two scenarios to focus groups – bus vs. car and light rail vs. car – and participants were asked which mode they would prefer to use. For each scenario, there were sub-scenarios in which variables, such as fare and frequency of service, were altered. By doing this, they were able to pinpoint which variables led to favourable outcomes for both buses and light rail. One of the conclusions was that for light rail to be favourable over buses, it had to offer greater frequency of service and competitive fare rates.

## METHODS

In order to address the question of how changes in fare structure have affected public transportation mode choice, surveys were conducted with residents of the Metro Vancouver

region. The survey was administered in one of two ways. The first method was online via social media platforms. This was done to capture a wide audience and their responses. The second method was in-person at Joyce-Collingwood Station and Lougheed Town Centre Station. These stations were chosen because they sit adjacent to zone boundaries (zones 1/2 and zones 2/3 respectively), are served by both SkyTrain and several bus routes (see *Figure 1*), and represent the areas where the choice to save money by choosing to cross zone boundaries by bus travel rather than SkyTrain is the most relevant. In-person recruitment took place at 8:00 a.m. on March 22 and March 29, 2016. The dates and time selected were chosen because they fell in the middle of the work week during hours of high ridership. No differences in results were expected based on the method the survey was administered to participants.

One hundred fifty survey responses were submitted and used for analysis in this study. Survey participants skewed towards a younger demographic. Nonetheless, I was able to capture responses from participants ranging from under 18 to 64 years of age, with a fairly balanced number of female (46%) and male (53%) participants.

Figure 1: Fare Zone Map showing SkyTrain Lines



Source: TransLink, April 2013

The survey consisted of three main parts (see *Appendix 1*). In the first section, participants were asked demographic questions, including age, gender, and income. Section two asked questions pertaining to commute characteristics (i.e. recent mode of public transportation, trip distance, and purpose of trip). The third section asked respondents to explain their choice of transportation, as well as asked questions concerning participants' attitudes towards SkyTrain and bus. More specifically, the attitudinal variables included in this study were adapted from those identified by Outwater et al. (2003), including: 1) travellers' need for time savings, operationalized as convenience; 2) sensitivity to travel stress, operationalized as reliability; 3) sensitivity to transportation cost, operationalized as cost/affordability; and 4) sensitivity to personal travel experience, operationalized as comfort. The remaining two attitudinal variables (desire to help the environment and travellers' need for flexibility) originally identified by Outwater et al. were not included in the survey, as they are less applicable in a scenario between two different modes of public transportation.

## RESULTS

The primary goal of this study was to conduct research on potential impacts of TransLink's one-zone bus fare system on public transportation users' routes. The results of the study show that the majority of public transit users have not changed their transportation routes as a result of such changes (see *Figure 2*). Out of 150 responses, twenty-nine respondents failed to respond or had unclear responses, and thus were not included in the following statistic. Of



Figure 2: Change in Transportation Routes by Public Transit Users

16%

84%

■ Change in Route    ■ No Change in Route
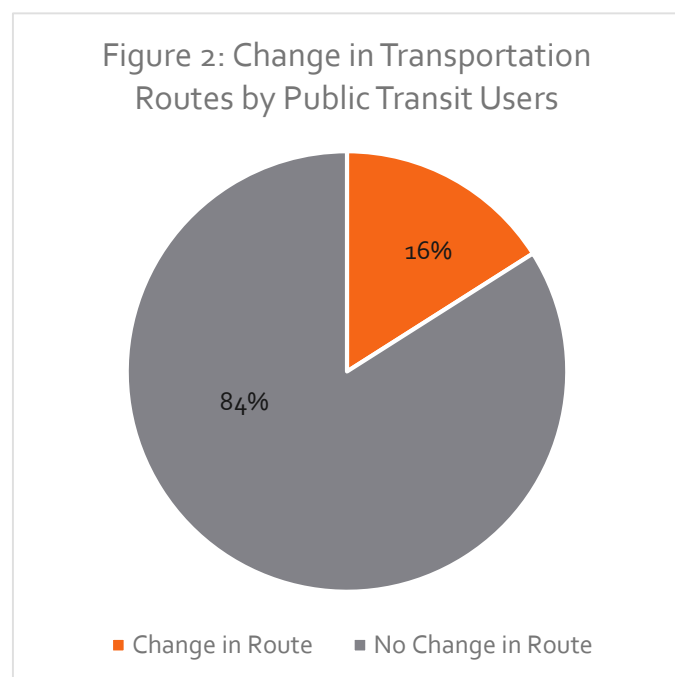
the remaining 121 responses, only 16% of participants (or 19 individuals) responded that they have changed their routes as a result of the changes in fare structure, while the remaining 84%

responded that they have not changed their routes. These numbers are similar to those found in a survey conducted by TransLink, where the results showed that only 12% of public transportation users have changed the way they use transit and 88% have not (TransLink, 2016a).

The reason provided by those participants in this study who replied in the affirmative for a change in behaviour was simply because of the incentive of cheaper fares and monetary savings. It may be important to note however, that several participants stated that a change in their routes was tied to the idea of value of time, where one participant said, "*Yes, if I am not in a rush, I will use bus only to cross zone[s].*"

At 84% however, the overwhelming majority of participants responded in the negative. The most common theme in the responses of those individuals was the inconvenience and inadequacies of bus services, both spatially and temporally. In regards to the spatial inadequacies of buses, one participant stated, "*…there isn't an efficient bus route that duplicates my SkyTrain ride,*" while another explained, "*I have not altered any of my transportation routes due to the single-zone bus fare system. I take whatever mode of transportation is most convenient in terms of the closest Skytrain station or bus stop is to me and where I'm going.*" On the topic of cost on time, one survey participant described how changing routes to cross zone boundaries would take them out of their way, saying, "*Although I live close to a zone boundary (and am thus penalized for short trips across it), it doesn't make sense to hop the boundary by bus. [It] would take much longer.*"
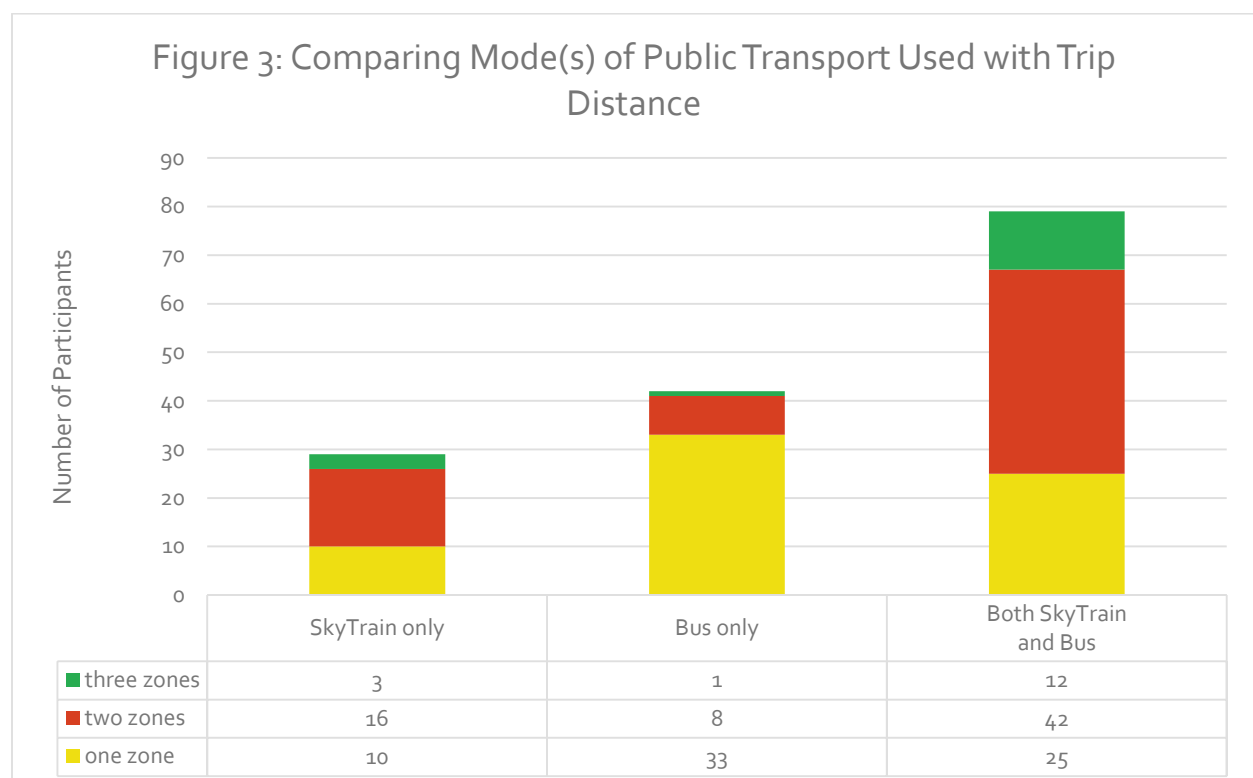
Indeed, convenience was the factor most often listed by participants when asked which factors played a role in deciding their transportation route, ranking ahead of cost/affordability, reliability, and comfort in importance (in descending order). When asked which mode they would rate higher in terms of convenience (i.e. frequency of service and location), eighty-one percent picked SkyTrain.

Additionally, another group of participants consisted of youths and seniors with concession monthly passes, which allows for unlimited trips across transit zones no matter the mode. Thus, this group was not affected by the transition to a dual transit-fare structure, and consequently have not changed their transportation routes by taking the bus more often.

Seeing as this study aimed to examine the overall impact of the fare structure changes, this group was included in the results of the study. Additional research however, may wish to primarily target groups which have been impacted by fare structure changes.

The survey also aimed to see whether there was any relationship between transportation mode choice and individual demographics or trip characteristics. From the results of the survey, the relationships between transportation mode choice and age, gender, income were inconclusive. This may be because the age and incomes brackets provided were too wide, thus hiding significant findings. Also, no relationship was found between transportation mode choice and trip purpose.

Despite this, interesting findings regarding transportation routes and trip characteristics emerged. *Figure 3* summarizes the modes of public transportation participants used, and compares this with the number of zones travelled according to the traditional multi-fare-zone boundaries. Several patterns that can be seen from this include: a higher number of single zone trips using bus only, a higher likelihood of using either SkyTrain only or both SkyTrain and bus for two zone trips, and a low number of commutes across all three zones.



Figure 3: Comparing Mode(s) of Public Transport Used with Trip Distance

| | SkyTrain only | Bus only | Both SkyTrain and Bus |
|---|---|---|---|
| three zones | 3 | 1 | 12 |
| two zones | 16 | 8 | 42 |
| one zone | 10 | 33 | 25 |

## DISCUSSION

The results of the survey indicate that public transportation users in Metro Vancouver largely have not changed their transportation routes or mode choice as a result of one-zone bus fares. Firstly, a recurring theme from survey respondents as to why they have not changed their transportation routes was that the network of buses does not serve public transit users adequately for buses to be their primary mode of transportation despite potential financial savings. As it is currently structured, the backbone of the public transportation network seems to be SkyTrain, with bus routes feeding into those stations. For example, TransLink operates 210 bus routes, of which only thirty-four travel across two zones and two travel across all three zones (TransLink, 2016b). In order for passengers to get from one location to another then, keeping in mind value of time and people's perception of what a reasonable amount of transfers or travel time is, it is often necessary to make trips using a combination of SkyTrain and bus.

Secondly, looking back at the comparison between modes of public transport used versus distance travelled (see *Figure 3*), the data showed that passengers using bus only tended to make single-zone trips (according to the traditional multi-zone boundaries). Upon further analysis, 25 out of 33 (76%) bus only users travelling within a single zone indicated that their travels were confined to zone 1, which only encompasses the City of Vancouver, Downtown Vancouver, and University Endowment Lands. Furthermore, the number of passengers travelling by bus only for two- or three-zone trips was comparatively less than the number for SkyTrain only or both SkyTrain and bus users travelling two or three zones. Thus, we can conclude that bus services may be lacking temporally (i.e. infrequent) or spatially, particularly in zones 2 and 3.

Clearly, despite potential monetary savings from the one-zone bus system, the majority of public transportation users have not seen an increase in benefits from it. Since TransLink has stated that the one-zone bus fare system is transitory however, this provides an excellent opportunity to review other possible fare structures in line with principles of mobility equity.

Mobility equity can be defined as access to transportation and the fair distribution of costs and benefits of said transportation. A large component of this is arguably fare equitability.

Nuworsoo et al. (2009) outline three criteria for fare equitability to be: 1) the benefit criterion, meaning that people should pay for services in proportion to benefits received (e.g. paying more for faster service); 2) the cost criterion, meaning that people should pay for services in proportion to the cost of providing such services (e.g. time-of-day or location-based pricing); and 3) the ability to pay criterion, meaning that people should be charged for services in proportion to their income (e.g. discounted fares for economically disadvantaged groups).

At first glance, TransLink's fare structure seems quite equitable in terms of fare equitability. On average, users now pay more for faster SkyTrain service than for slower bus service; users pay more during peak hours of use (weekdays before 6:30 p.m.) and for travelling across more zones using SkyTrain; and certain user groups, including youths and seniors, which studies have suggested tend to unequally bear the costs of transportation (Hobson, 2005; Shirmohammadli et al., 2016), are eligible for discounted fares. Zoned-based pricing however, may be a point of contention. Zone boundaries are somewhat arbitrary, and are unfair to those who make short-distanced trips but cross zone boundaries.

I would therefore recommend further research into the possibility of flat or distance-based fare pricing, in conjunction with the current quality of service-, time of day-, and needs-based pricing. The decision between a flat or distance-based fare structure will require balancing the need to maintain revenues, with the need to provide affordable fares to public transportation users. For example, in a case study comparing the fare structures in two different cities, the authors found that for Salt Lake City, USA, distance-based fares were more equitable because lower-income populations tended to make shorter trips, but for Bogota, Columbia, flat fares were more equitable because lower-income populations tended to live in city peripheries and thus travel longer distances to work (Kramer & Goldstein, 2015).

We must also remember that fare equity does not equate to mobility equity. While fare equitability is a large component, another major component is network design and mobility. Given the results of survey discussed above, I have argued that access to frequent bus service needs improvement and recommend further research into areas (particularly in zones 2 and 3) which might benefit from an expansion of the bus network. After all, introducing a fare

structure which is equitable, but where the network serves few or is inadequate, is ultimately pointless.

The major barriers to moving forward with these recommendations are the costs associated, particularly with expanding bus services. However, given the importance of mobility in people's lives, improving mobility and mobility equity should be a priority. As for research into introducing flat or distance-based fare pricing, the Compass Card technology readily collects this information as users "tap in and out." As public transportation becomes more accessible and equitable, side benefits would be an increase in ridership, thereby boosting revenues, as well as cutting down on private vehicle commutes and the production of greenhouse gases.


## SUMMARY & FUTURE RESEARCH

The recent change to a one-zone bus fare system by TransLink fails to make a significant impact on the transportation mode choice of many public transportation users in Metro Vancouver. From a survey of 150 participants, eighty-four percent of participants said that they have not changed their transportation routes by taking the bus more often, despite it being the more affordable mode of transport in comparison to SkyTrain. The main reason for this is the inadequacies in bus services outside of zone one.

Therefore, I have suggested that further research be conducted to assess where areas of improvement are needed within the bus network, specifically in zones 2 and 3. Furthermore, I also recommend further research into the possibility for introducing a fare structure which incorporates flat or distance-based pricing, and which upholds the principles of mobility equity.

Due to limits and restrictions based on study design, I was unable to find significant relationships between transportation mode choice and income. Additional research then, may wish to conduct focus groups with lower income groups for a more in-depth study of how the one-zone bus fare system has affected these groups (if at all), and examine the price thresholds at which users are willing to switch from SkyTrain to bus.

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**Appendix 1**. Public Transportation Mode Choice Survey

## What is your age?
○ under 18

○ 18-24

○ 25-34

○ 35-44

○ 45-54

○ 55-64

○ 65 and above

## What is your gender?
○ Male

○ Female

○ Other, please specify... _____

○ I prefer not to answer

## What is your approximate household income?
○ under $20,000

○ $20,000 - $40,000

○ $40,000 - $60,000

○ $60,000 - $80,000

○ $80,000 - $100,000

○ $100,000 - $150,000

○ over $150,000

○ I prefer not to answer

## On your most recent trip involving SkyTrain or bus, which mode of transportation did you use?
○ SkyTrain

○ Bus

○ Both SkyTrain and bus

## In which zone did this trip start?

○ zone 1

○ zone 2

○ zone 3

## In which zone did this trip end?

○ zone 1

○ zone 2

○ zone 3

## What was the main purpose of this trip?

○ work

○ school

○ leisure (e.g. meeting with friends)

○ personal errands (e.g. doctor's appointment)

○ Other, please specify... _____

**For the same trip, which of the following played a role in your choice between SkyTrain and bus? (check all that apply)**

☐ Convenience

☐ Reliability

☐ Cost/Affordability

☐ Comfort

☐ Other, please specify... _____

**Overall, which would you rate higher in terms of convenience?**

○ SkyTrain

○ bus

**Overall, which would you rate higher in terms of reliability?**

○ SkyTrain

○ bus

**Overall, which would you rate higher in terms of affordability?**

○ SkyTrain

○ bus

**Overall, which would you rate higher in terms of comfort?**

○ SkyTrain

○ bus

**Since the implementation of a single-zone bus fare system, have you altered any of your transportation routes using SkyTrain or bus? Why or why not?**

_____

_____

_____

_____

_____

_____