Encouraging sustainable transportation through behavioural insights

A study to assess the impacts of fare capping on transit ridership

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Disclaimer

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Executive summary

Affordable and accessible public transportation promotes thriving communities, well-being and health by ensuring access to services and opportunities for the wider community. Fare products, the ways in which customers pay for transit, are an important policy instrument for transit agencies. As the main contact point for customers they can be used to shape ridership patterns. Pre-paid passes, such as monthly passes, have long been offered as a convenient way to pay for transit while encouraging customer loyalty and additional ridership.

TransLink's recent Transit Fare Review recommended consideration of fare capping as a potential fare product, but also noted substantial uncertainties regarding the impact of fare capping on transit ridership and revenue. The goal of this project is to use behavioural insights to examine how fare products influence transit ridership and assess customer preferences for various fare products to help inform whether to pursue the implementation of fare capping.

The report builds on the initial fare capping investigations with two distinct sections. The first part consists of a review of scholarly and grey literature from behavioural science and transportation studies to further explore the influence of fare capping on transit ridership. The second part incorporates these findings into a proposed study methodology to experimentally examine the impacts of fare capping on transit ridership and revenue.

The literature review of human behavioural biases related to transportation revealed numerous heuristics and biases- mental shortcuts that humans use to understand the world- that influence transit decision making. It suggested that fare capping may cause ridership to decrease due to behavioural biases that favour flat rates. In general, people prefer flat rate pricing schemes in purchasing decisions. This bias is driven by four effects: the insurance effect (the desire to guard against possible unexpected additional costs), the convenience effect (simplicity of a one-off payment), the overestimation effect (people are bad at forecasting their own consumption), and the taximeter effect (the preference for avoiding the 'pain' of observing accumulating costs). Other relevant behavioural biases included the pre-commitment effect (making short term investments with the expectation of better decisions in the long term) and loss aversion (people generally value what they have and avoid losses). Although the wide range of biases suggested that transit riders will favour the predictability and convenience of flat rates, they also demonstrated the powerful influence of context on behaviour. As such, how options are presented and message framing can have a major impact on how discount schemes are perceived, and how they influence ridership.

A behavioural approach to examine appropriate fare systems revealed major uncertainties surrounding the effect of fare capping on transit ridership. The literature also highlighted fare capping as a tool for increased equity. Academic studies and public engagement activities have identified that the upfront cost of monthly passes present a barrier for some low-income customers who are therefore unable to take advantage of frequent rider discounts available to more affluent customers. Fare capping could make the fare system more equitable by removing the high up-front costs associated with prepaid options such as monthly passes. Case studies from the cities of Melbourne, London and Portland illustrated that it is important to collect data to evaluate whether and how fare capping influences ridership, and to conduct community consultations in order to develop fare products and fare caps that are publicly accepted.

These findings emphasised the need to understand how fare capping influences ridership. They informed the study design described in this report, which aims to assess the impact of fare capping on transit ridership, revenue and customer perceptions in Metro Vancouver. The study will inform whether implementing fare capping as a new fare scheme is a practical, feasible and beneficial option for TransLink and its goals of promoting sustainable transportation and social welfare.

In addition to assessing the impact of fare capping on ridership, the study will inform whether feedback on transit usage influences ridership, and what perceptions customers hold regarding pre-paid monthly passes and fare capping. Study participants will be recruited from the transit community and randomly allocated into one of three possible conditions:

1) Experimental condition, in which participants will use fare capping, receive information about their usage and complete pre-intervention and post-intervention surveys;
2) Survey + usage information condition, in which participants will use their normal fare product (i.e. no intervention), be provided with transit usage information, and receive pre-intervention and post-intervention surveys; or
3) Control condition: participants will not receive a different fare product nor surveys.

The pre-intervention survey will be administered after participants have agreed to participate in the study and provided their consent, and before the experimental period starts. The post-intervention survey will be administered immediately following the experimental period. The proposed survey questions are intended to probe what features of fare products are most important to customers, explore participants' perceptions of fare capping and monthly passes, understand preferences for the fare products, and assess how these might have changed

following the experimental treatment. The differences in number of trips and survey results will then be compared in statistical analysis to determine how fare capping impacts ridership.

Based on insights from the literature review and case studies the anticipated result is less ridership from all conditions. The potential revenue impact of fare capping is highly significant, and experimental evidence will improve decision-making related to the implementation of this fare product. Any decision to go forward with a new fare product should be evidence-based and part of a comprehensive policy to improve transit opportunities.

The recommendations made in this report include:

- to develop convenient, intuitive and equitable fare products;
- to carefully frame messaging about fare products according to human biases and the context;
- to base fare products on the various needs and concerns of community members;
- to use behavioural insights in combination with other strategies such as fare products to increase ridership and improve equity in the transit system;
- to experimentally examine the impacts of fare capping on transit ridership and customers' perceptions; and
- to experimentally examine how feedback on transit usage can influence ridership.

Introduction

Introduction

An integral part of healthy and thriving communities is affordable and accessible public transportation, and TransLink is continually looking for ways to increase the use of sustainable transportation modes. Recently, attention has been paid to the role of human behaviour and decision making in transportation. As the transit environment is defined by choices, transit behaviour is often best described by behavioural approaches. It is therefore important to consider human behaviour and decision making for transit agencies seeking to increase ridership.

Fare products, or how customers pay for transit, are an important policy instrument for transit agencies. They are the main contact point for customers and can be used to shape ridership patterns. Pre-paid passes, such as monthly passes, have long been offered as a convenient way to pay for transit while encouraging customer loyalty and additional ridership. TransLink's recent Transit Fare Review examined a range of fare products and highlighted fare capping as a potential future fare product. The Review also emphasized substantial uncertainties regarding how customers would react to fare capping and the impact of fare capping on transit ridership and revenue.

Despite the large body of literature on transportation behavioural modification, research on impacts of fare capping on ridership is very scarce. Given this lack of research, this project aims to inform TransLink's policy development regarding fare capping. It consists of two distinct sections which examine how fare capping and feedback on transit usage impact ridership and revenue. The first part consists of a review of scholarly and grey literature from the fields of behavioural science and transportation studies to further explore how fare capping influences transit ridership. The second part incorporates these findings into a study methodology to experimentally examine the impacts of fare capping on transit ridership and revenue. The report concludes with fare product recommendations for TransLink.

Part 1: Literature review

Part 1: Literature review

Affordable and accessible public transportation promotes thriving communities, well-being and health by ensuring access to services and opportunities for community participation (Stevenson et al., 2016). However, the largest transportation segment in Vancouver consists of auto drivers, causing congestion and associated health implications such as elevated stress and cholesterol levels (Savage, 2019; Schrank, Lomax, & Eisele, 2012; Wener & Evans, 2011). There has been a strong move towards analyzing travel behaviour in order for governments, policy makers and travel companies to develop appropriate transport structures to increase public transit ridership (e.g., City of Vancouver, 2018; Savage, 2019). To develop effective transit options for Vancouver residents it is necessary to gather travel characteristics, understand barriers for transit use and assess fare options.

TransLink conducted a comprehensive four-phase review of the transit price structure in Metro Vancouver, and included a recommendation to continue investigations into fare capping. This report builds on the fare capping investigations by exploring the influence of fare capping on transit ridership. It summarizes TransLink's fare review and the current transit fare structure in Vancouver, reviews literature on human behavioural biases that influence how fares are perceived, and presents three case studies from Portland, London and Melbourne. The goal is to understand how to leverage behavioural insights to influence transit ridership, with particular consideration of fare capping as a tool to increase ridership in Vancouver. Based on findings, an experimental study that examines the impacts of fare capping on transit ridership will be developed.

Current fare structure in Vancouver

Transit authorities seek to increase accessibility while maintaining affordability, and increasing transit ridership generally aligns with these goals (Chalabianlou et al., 2015; Wang et al., 2015). TransLink's recent fare review considered how to improve outcomes on their long term strategic outcomes, including ridership, customer experience, fairness and affordability (Transit Fare Review, 2018). In the area of fare products, the review recommended continuing with pre-paid passes. Pre-paid passes, such as Daily Passes or Monthly Passes, grant unlimited travel within the specified zone(s) for a flat fee. For instance, the 1-zone $98 Monthly Pass allows the rider to take unlimited 1-zone trips for a calendar month (Transit Fare Review, 2018). However, the report also noted the potential benefits of fare capping, a price scheme which provides the rider with free or discounted trips after a certain threshold of travel is reached within a set period of time. There

are numerous aspects of fare products that can influence transit ridership and travel choices (Metcalfe & Dolan, 2012). Currently there are multiple uncertainties tied to the introduction of fare capping, including the impact on revenue and ridership, the costs for frequent riders and the impact on low-income riders (Transit Fare Review, 2018).

What is fare capping?

Fare capping is built on the concept of a guaranteed lowest fare, and offers the possibility to 'earn' free rides after a certain number of rides are taken within a given time frame. Customers pay a regular stored value for their rides until an absolute dollar threshold is reached, after which trips are free for the rest of the given time period. There are also fare capping schemes which cap the number of trips taken. After a given number of trips are taken within a time period, such as ten in a week, trips are free for the rest of the period. Fare capping offers the same overall savings as pre-paid fare products as well as a best-price guarantee for riders, eliminating the need to predict at the beginning of the time period how much travel will be undertaken (Chalabianlou et al., 2015). Moreover, there is no upfront decision necessary regarding which fare product to purchase.

There are multiple ways to implement fare capping:

- trip-based caps or value-based caps;
- capping universally for all riders or depending on demographics such as age or income;
- graduated caps depending on time/distance/fare zones (for an extensive review, see Chalabianlou et al., 2015).

These various implementation methods open a myriad of possible fare caps, the scope of which lies outside this literature review. For the purposes of this review, human behavioural biases will be considered in regards to the principle of fare capping; paying per trip until a given threshold is reached, after which transit will be free. It should be noted that this limits the complex environment that individuals face when making transport decisions- such as the time of day, distance traveled, frequency of trips and time constraints. Chalabianlou et al. (2015) further note that different ways of capping might result in different outcomes, which is important to consider as a limitation of this report.

Considerations of fare products

Simplicity

A main benefit of fare capping is that riders will not have to estimate how much they will be riding before a given time period (i.e., they do not have to pre-determine whether they will be traveling frequently enough to make a monthly pass worth the cost), and they do not need to worry about renewing their pass. Simple, intuitive solutions often retain a larger customer base (Ferris et al., 2009), and would not discriminate against riders who have difficulties navigating complex fare calculations and systems. As such, fare capping could improve accessibility and increase ridership.

Social equity

Fare capping ensures that riders will never pay more than the cost of a daily, weekly or monthly fare, depending on the cap. This holds important implications from a social justice perspective. Pre-paid passes offer unlimited rides once paid for, but have high upfront costs that may present a challenge for low-income riders. If low-income customers cannot afford the upfront cost, they will not enjoy the benefit of discounted rides, resulting in a regressive fare structure. One study conducted in Montréal revealed that vendors in low-income neighbourhoods sold a greater proportion of more expensive weekly passes compared to neighbourhoods with high household incomes and low rates of unemployment that sold a higher proportion of more heavily discounted monthly passes (Verbich & El-Geneidy, 2017). Moreover, recurring purchases of weekly fares depended on income and unemployment, and riders from socially vulnerable neighbourhoods were likely to purchase three or more weekly fares and thereby spend more money on transit than financially secure neighbourhoods (Verbich & El-Geneidy, 2017). Pre-paid fare products may thereby inflict disproportionate burdens on low-income riders.

Often, low-income citizens who are the most socially vulnerable cannot afford pre-paid fare products that would save them money in the long term (D. Verbich, personal communication, 21. April 2020). Qualitative research conducted in New York revealed a strong case for fare capping. Low-income riders who have unlimited fare cards (e.g., weekly or monthly) spoke about their daily travel differently. They were able to plan ahead; they took more non-work trips including trips that ultimately saved them money; and took trips that enriched their children's lives and their own social capital (A. Perrotta, personal communication, 16. March 2020). Fare capping can enable mobility and open opportunities for low-income riders. Any policy that can relieve the in-the-moment decision between transit and another necessity (often food) will benefit low-income riders (A. Perrotta, personal communication, 16. March 2020). As such, a social justice

perspective highlights that fare capping has procedural justice and can serve as a tool for social equity.

Expanding ridership

Many customers wrongly choose flat rates when it comes to subscriptions (Lambrecht & Skiera, 2006). Transit ridership has been viewed as a function of the utility of the trip and its costs: time (access time, wait time, travel time), money (transit fare) and uncertainty (delays, safety) (Taylor et al., 2009). Moreover, transit riders are not a homogenous entity, but a group consisting of individuals with various needs and wants (Verbich & El-Geneidy, 2016). Fare capping could simplify the fare system and benefit various socioeconomic segments of the population, thereby expanding ridership. Researchers further highlight the power of social norms on individual behaviour, which can also be harnessed in fare designs (Farrow et al., 2017). A review article by Abrahamse and Steg (2013) indicated that using social influence and face-to-face approaches to behaviour change, such as commitments and social modeling, were on average more efficient than using feedback. The implication for fare capping from such findings is that fare capping can be communicated according to social norms, and that information can be framed to leverage such social influences. Gravert and Collentine (2019) suggest that social norms do not induce behaviour change in the short term, but that they establish long term behaviours and assist habit formation. Changes to the fare structure could thus require longer time frames to influence behaviour. These findings highlight the numerous factors that influence human behaviour, that any attempt to modify behaviour and expand ridership must consider.

Need for a behaviourally informed solution

Human behaviour is complex and governed by habits, limitations in mental capacity and contextual factors (Frederiks et al., 2015; Kahneman, 2003). Although people *think* they are making evaluated decisions and behave in rational ways, daily life illustrates that this is often not the case. Instead of following the 'rational choice' model of human behaviour, in which one objectively evaluates and measures up the costs and benefits of all possible actions before choosing one, people rely on habits, heuristics and biases in order to more easily navigate the complex options of choices that surround us (Biel, 2017; Tversky & Kahneman, 1974). The reliance on these mental shortcuts biases human behaviour in systematic ways (Thaler et al., 2013). The field of behavioural science combines insights from economics and psychology to reveal these cognitive and contextual influences that shape behaviour and decision making. Insights from behavioural science are used to influence consumers (Frederiks et al., 2015), by conservation practitioners (Rare, 2019) and governments (Government of Canada, 2017).

Behaviour change theories have a long-standing tradition, however to date results are mixed and their uptake is limited in the transportation sector (Abrahamse & Steg, 2013). Transit ridership is defined by choices and inherently contextual, and is better described in terms of behavioural approaches than by rational agent models (Garcia-Sierra et al., 2015). This gives behavioural insights a large unrealized potential within transportation.

In the context of Vancouver, TransLink's report explored three options for frequent rider discounts: 1) Pre-paid passes, 2) fare capping, or 3) a hybrid of pre-paid passes and fare capping (Transit Fare Review, 2018). The report recommended implementing pre-paid passes based on a range of criteria including survey results, financial considerations and ridership impacts. This review complements the final recommendations report by exploring possible impacts of fare capping on ridership. The remainder of the paper is structured as follows; it will first review the theoretical background for behaviour change; it will briefly review the most common behaviour change methods; it will then review fare capping as a transit fare product; and finally it will present case studies from Portland, London and Melbourne.

Theoretical background

Psychology offers multiple perspectives and theories to predict human behaviour and how it can be changed. Traditionally, the standard neoclassical economic model of human decision making portrays behaviour as the product of rational deliberation and individualistic utility maximization (Welsch & Kühling, 2009). However, this rational-choice approach has been criticized for neglecting limitations to people's cognitive capacity and contextual factors that exert powerful influence over decision making and behaviour (Kahneman, 2003). Recently, the concept of bounded rationality has gained increased attention along with the field of behavioural economics. The transport system is a choice environment associated with uncertainty and a myriad of options, making traditional economic accounts poorly suited to predict behaviour (Ben-Elia et al., 2008).

Behavioural economics and bounded rationality

The field of behavioural economics can be attributed to Tversky and Kahneman (1979) and Simon (1955), whose rationale is based on the observation that people do not always make consistent choices. Humans are surrounded with information that constantly needs to be filtered, processed and responded to. As such, people desire to preserve cognitive effort in their decision making, and adjust their cognitive effort to the importance of a decision, the information available and time constraints (Kahneman, 2003). In general, this field is founded on the notion

that there are two cognitive 'systems' which operate in the brain; System 1, which is fast, unconscious, uncontrolled, effortless and affective; and System 2, which is reflective, controlled, effortful, slow and rational (Kahneman, 2011). This dual processing model has received extensive support, and has recently been applied in the transportation literature (e.g., Ben-Elia & Avineri, 2015; Dolan et al., 2012). It provides a comprehensive method of evaluating human behaviour and how to influence it, and some of the main findings are summarized in the following points (for an extensive review, see Metcalfe & Dolan, 2012):

- People *dislike losses* and react disproportionally to losses compared to gains of equal value. For example, an individual with $100 will react more strongly to losing $10 than to gaining $10- the loss is valued more negatively than the gain is positively valued.
- People are influenced by reference points: the estimation of subjective probabilities is greatly influenced by *anchoring*. Anchoring happens when people rely on irrelevant information to make judgements. When people were asked to estimate the number of African states in the United Nations while being given a number drawn from a spinning roulette, their answers were derived from the arbitrary roulette number (Tversky & Kahneman, 1974).
- People *overestimate small chances*: people assume that rare events are more likely than they actually are and underestimate more likely options (Ben-Elia & Avineri, 2015; Tversky & Kahneman, 1979). For instance, people buy lottery tickets despite slim chances of actually winning, and overestimate the likelihood of a plane crashing (the chances of being in a car crash are statistically much higher).
- People think in discrete bundles: *mental accounting* happens in categories. As an example, money is labelled into different categories such as "savings," "expenses," or "disposable" (Metcalfe & Dolan, 2012). This means that the same incentive has different impacts depending on the context; people are willing to make a trip to save $5 on a $15 lamp, but not to save $5 on a $300 TV (Thaler, 1985). Such mental accounting could be important for understanding people's evaluations of transport expenditure or transit time (Metcalfe & Dolan, 2012).
- People *value the present* highly and inconsistently. People show a preference for smaller, immediate rewards as opposed to distant, larger ones- a phenomenon known as hyperbolic discounting- the future is discounted, in particular when sacrifices are necessary in the present (Garcia-Sierra et al., 2015).
- People care about other people and adhere to *social norms*. Findings from dictator games show that people care about being treated fairly and give to others even when they do

not gain personally from it (Gneezy & List, 2006). Understanding how transport behaviour can be changed by leveraging such personal relationships and social ties is an important avenue for further study.

- People can be influenced by *incentives*. Incentives are often used as a method for behaviour change, but it can also have adverse effects by undermining intrinsic motivation and backfire (Gneezy et al., 2011).

These behavioural effects demonstrate that intentions do not necessarily predict future behaviours (Webb & Sheeran, 2006). Rather than being utility maximisers with perfect decision making and cognitive processing capacity, people are subject to biases and often rely on mental shortcuts (Lehner et al., 2016). The situations in which people evaluate options are often different from the situations where the actual behaviours are performed. Given the major influence of contextual factors on behaviour (Steg et al., 2014), individuals are poor at forecasting their behaviour (Metcalfe & Dolan, 2012). Behavioural interventions, including those addressing transit behaviour, must therefore consider cognitive biases. The following section reviews specific biases that have been tied to transportation.

Behavioural economics and transit ridership

Whereas economic theory asserts that consumers strive for utility-maximization in all instances, such as evaluating price against value for goods or services, numerous empirical studies demonstrate that consumers often deviate from the economic prediction due to cognitive, social and contextual circumstances (Gerpott, 2009; Grubb, 2009; Krämer & Wiewiorra, 2012; Lambrecht & Skiera, 2006). Comprehensive reviews of behavioural mechanisms that are relevant to transit ridership and the limitations of current policies have been conducted by Garcia-Sierra et al. (2015) and Metcalfe and Dolan (2012). Several heuristics and biases are particularly relevant to fare capping.

The flat rate effect

One of the most prominent biases is the flat-rate effect, which has been demonstrated with gym memberships (DellaVigna & Malmendier, 2006), internet plans (Lambrecht & Skiera, 2006) and phone plans (Gerpott, 2009). The flat rate bias stipulates that consumers favour flat rates, despite circumstances where pay-as-you-go rates would be cheaper given their total consumption (Krämer & Wiewiorra, 2012). From a psychological perspective, a key discrepancy between the pay-as-you-go and the flat rate is that costs are sunk in the latter, resulting in the consumer not having to worry about marginal costs associated with present or future use

(Thaler, 1985). With specific reference to fare capping, the act of having to pay for every trip could represent a psychological barrier by making the associated cost salient to the consumer. Four distinct effects are assumed to drive the flat rate bias; the insurance effect, the overestimation effect, the taximeter effect and the convenience effect.

The insurance effect

The insurance effect protects consumers from future costs. It is produced by loss aversion and uncertainty, which stimulate a willingness to pay more up front for insurance against such costs (Lambrecht & Skiera, 2006; Tversky & Kahneman, 1974). The up-front cost thereby protects the consumer from any price increase due to unexpected travel.

The overestimation effect

The overestimation effect implies that the consumers often fail to correctly estimate their own usage, due to factors such as limited foresight, uncertainty and bounded rationality (Dolan et al., 2012; Kahneman, 2003). Consumers often overestimate their future demand for a service, which induces them to select a flat rate (Krämer & Wiewiorra, 2012). Simultaneously, consumers are overly confident that their estimates are correct (Grubb, 2009), which distinguishes the overestimation effect from the insurance effect and causes consistent selection of the economically undesirable plan.

The taximeter effect

The taximeter effect (Prelec & Loewenstein, 1998) is procured from the experience of riding a taxi with an unknown duration: the discomfort associated with a taximeter constantly accumulating costs (Krämer & Wiewiorra, 2012). A flat rate means that all costs are sunk. In the context of fare capping, under a pre-paid scheme the consumer can benefit from the comfort of not having to consider costs associated with every trip, and enjoys the perception of ‘free’ travel after the initial purchase.

The convenience effect

Finally, consumers prefer convenience and are driven by the desire to avoid multiple, often complex rates (Srivastava & Kaul, 2014). Costs which are associated with a flat rate are easily comprehensible and accessible, and liberate any dwellings on which option to choose or how much to spend.

Other relevant biases

In addition to the flat rate effect and associated biases, numerous other behavioural mechanisms can impact how fare products and ridership interact. The following section highlights some of these biases and effects (a summary is provided in Table 1).

Pre-commitment effect

The pre-commitment effect manifests by making a decision to invest with the expectation that this will be beneficial in the future. Evidence suggests that making commitments increases the likelihood of actions being fulfilled, and commitments are particularly powerful when made in public (Abrahamse & Steg, 2013; Cialdini, 2001). Purchasing a pre-paid pass might increase ridership by producing such a pre-commitment effect, for reasons such as budget, reducing car rides, or making more environmentally friendly decisions.

Loss aversion

Loss aversion represents the phenomenon that people are more sensitive to losses relative to their reference point than to gains of the same amount (Tversky & Kahneman, 1979). To illustrate, when being given $200, people are more sensitive to losing $50 than to being given an extra $50. In selling and purchasing decisions, people ask for a higher price when selling an item than they are willing to pay when offered to buy the same item (Kahneman et al., 1990). People perceive items they possess as more valuable than similar items outside their possession, and research suggests that consumers are highly sensitive to loss aversion (Heidhues & Koszegi, 2004). Loss framing refers to semantically reformulating (i.e., framing) an option so that the tendency people have to avoid losses guides their choice to the desirable option (Tversky & Kahneman, 1979). As a behaviour change technique, loss framing could highlight desirable choices. A particular concern from a transport perspective is that the effects of high-carbon transport alternatives such as cars are associated with external costs, whereas communal transportation is associated with internal costs (Waygood & Avineri, 2011). For instance, the emissions from cars are not considered personal costs, but longer travel time or high costs associated with transit are. This has implications for fare capping as a behaviour change tool. Policy makers can highlight the desirability of fare capping for society while being as transparent as possible, so that the public could become aware of its use (Waygood & Avineri, 2011). Rather than focusing on the gains after the fare cap has been reached, the losses associated with pre-paid passes can be highlighted. As such, loss framing can be exploited to improve the design of fare systems.

Distant reward

The distant reward associated with fare capping further favours pre-paid products and flat rates as opposed to fare capping. In general, people devalue future outcomes and favour immediate rewards. The temporal discounting rate represents the rate at which an individual devalues delayed rewards (Story et al., 2014). Understanding the factors that affect discounting is essential for analysis of decisions related to trade-offs between present and future benefits or costs (Hardisty & Weber, 2009). In the context of fares, the marginal cost of each trip under a fare capping scheme only reaches zero when the cap is reached, at which point rides might be perceived as 'free'. Trips under a pre-paid scheme provide zero marginal cost trips as soon as the one-off payment has been made.

Sunk cost bias

The rational decision when evaluating future investments would be to make a choice based on future consequences. However, the sunk cost bias occurs when prior investments that are 'sunk' and therefore not recoverable influence the decisions about future investments (Krämer, 2017; Strough et al., 2014). People have a tendency to be influenced by past costs and unrewarding decisions while ignoring future costs (Hafenbrack et al., 2014). The sunk cost bias suggests that pre-paid products would be more successful in increasing ridership than fare capping, as people will have made a large investment and therefore want to reap good value. To combat the sunk cost fallacy it is important to focus on the temporal horizon of the fare product, where longer time horizons are associated with stronger sunk cost bias (Strough et al., 2014).

Feedback

Some attention has been paid to giving feedback as a way to influence people's travel choices and behaviour, and some studies claim that feedback is a necessary element for riders to learn through experience (Ben-Elia et al., 2008; Selten et al., 2007). Riders largely base their decisions on feedback and experiential information, which reinforces learning and in turn establishes habits (Ben-Elia & Avineri, 2015). These kinds of studies have only assessed feedback of travel time, and it is uncertain how feedback of other information, such as cost or CO2 emissions, could influence decision-making.

Habits

People are creatures of habit, and strong travel habits present barriers to behaviour change. Habits are strongly related to the preference of transport choices (Chen & Chao, 2011). Some authors suggest that habits must be interrupted or for the context to be changed in order to permit conscious deliberation and behaviour change to occur (Garcia-Sierra et al., 2015; Gärling

& Axhausen, 2003; Verplanken et al., 2008). Habits can also be interrupted with financial incentives (Fujii & Kitamura, 2003; Gravert & Collentine, 2019). In addition, normative influences and habits interact to determine transport preferences (Chen & Chao, 2011). This suggests that the power of social norms and message framing can be harnessed to influence transport behaviour. Most studies have concerned habitual travel choices in relation to modal use, in particular cars (e.g., Ben-Elia et al., 2008; Garvill et al., 2003; Verplanken et al., 2008), and more research is needed to understand how a new fare system would influence travel choice. It is possible that the introduction of fare capping would represent a context change that could interrupt established travel habits (Verplanken et al., 2008), thereby activating new thought patterns and induce riders to re-evaluate their transit use.

Summary of behavioural impacts

Taken together, these multiple biases appear to favour a flat rate, despite being the less economically desirable option in the long run. As consumers commit themselves to a set amount for a set period, the potential discrepancy between their actual usage and committed costs can result in negative outcomes if their usage is less than what they paid for. However, there is no empirical evidence to support the notion that flat rates are cognitively favourable, to the best of the author's knowledge. Krämer and Wiewiorra (2012) highlight the flexibility effect as a reason for pay-as-you-go schemes, which allow the consumer to react flexibly to low usage, avoid commitments and prevent excess service usage (e.g., over-using service to prevent post-purchase regret). In their study, consumers were presented with a flat rate tariff scheme or a cost cap tariff scheme which allowed flexibility, but would be capped at the same level as the flat rate tariff scheme. A striking preference for the cost cap tariff was evident, where 83% of respondents chose the cost cap scheme as opposed to the economically equivalent flat rate (Krämer & Wiewiorra, 2012). Under the cap scheme customers would maintain their flexibility while being protected from unexpected high costs (insurance effect) and usage (overestimation effect). The flexibility effect should be highlighted as a strong reason for fare capping, and included in assessments of rate biases and choices.

Table 1. Summary of behavioural biases and their anticipated impacts on fare capping and pre-paid fare schemes.

BEHAVIOURAL BIAS AND DESCRIPTION	REFERENCES AND EVIDENCE RELATED TO PRE-PAID MONTHLY PASSES / PAY-AS-YOU-GO	ANTICIPATED IMPACT ON RIDERSHIP UNDER FARE CAPPING	ANTICIPATED IMPACT ON RIDERSHIP UNDER PRE-PAID MONTHLY PASSES
Flat rate bias - Consumers favour flat rates over pay-as-you-go rates	Gym memberships (DellaVigna & Malmendier, 2006), Internet (Lambrecht & Skiera, 2006), phone plans (Gerpott, 2009)	Likely to lower ridership due to adverse reaction to recurring costs	Likely to increase preference for pre-paid monthly passes and increase ridership
Pre-commitment - Making decision to invest with the expectation that it will be beneficial in the future	Making commitments increase the likelihood of actions being fulfilled, particularly when made in public (Abrahamse & Steg, 2013; Cialdini, 2001)	Fare capping does not require any pre-commitment and could decrease ridership	Likely to increase ridership with pre-paid monthly passes
Loss aversion - People are more sensitive to losses relative to their reference point than to gains of the same amount	People ask for a higher price when selling an item than they are willing to pay when offered to buy the same item (Tversky & Kahneman, 1979)	A preference for fare capping could be produced by framing it as the desirable option- less uncertainty and prevents possible losses associated with monthly passes	Likely to increase preference for pre-paid monthly passes and increase ridership
Distant reward - People devalue future outcomes and favour present rewards	There is a trade-off between present and future benefits or costs; distant rewards are less appealing (Story et al., 2014)	Likely to decrease; a fare cap is perceptually beneficial in the future	Likely to increase, the perceptual benefits of pre-paid monthly passes are immediate
Default bias - Tendency to stay in the default choice	In the face of choice, people are more likely to do nothing- robust finding in field such as health (organ donation) and	Favourable if fare capping is the default scheme- opportunity to 'default' riders into fare capping	Pre-paid passes are opt-in, however could be leveraged by making pre-paid monthly passes the

BEHAVIOURAL BIAS AND DESCRIPTION	REFERENCES AND EVIDENCE RELATED TO PRE-PAID MONTHLY PASSES / PAY-AS-YOU-GO	ANTICIPATED IMPACT ON RIDERSHIP UNDER FARE CAPPING	ANTICIPATED IMPACT ON RIDERSHIP UNDER PRE-PAID MONTHLY PASSES
	finance (insurance) (Dolan et al., 2012)		default options on ticket machines
Anchoring - Decisions are influenced by random reference points	When asked to estimate a number while being given a number drawn from a spinning roulette, answers were derived from the arbitrary roulette number (Tversky & Kahneman, 1974)	Likely to decrease ridership if new cap is higher than pre-paid fare - perception of fare cap is influenced by the price of the monthly pass	Price adjustments (normally increases) of pre-paid monthly passes are likely to decrease ridership
Status quo bias - People are adverse to changes	People are adverse to changes and go with previously made decisions (Garcia-Sierra et al., 2015)	If fare capping is set as default option it could become the status quo and produce favourable attitudes	Introduction of a new fare scheme could produce adverse reactions to the new option and favour the old
Hyperbolic discounting - People show a preference for smaller, immediate rewards as opposed to distant, larger ones	Future rewards are less important than present ones for guiding behaviour (Garcia-Sierra et al., 2015)	Could favour fare capping; instant return on investment	Can decrease ridership; people are unwilling to pay a large up-front amount for benefits that appear distant
Habits - Routine behaviours that occur subconsciously	People tend to stick to their habits- habits are strongly related to transport choices (Chen & Chao, 2011)	Introduction of fare capping can disrupt old habits and represent an opportunity to increase ridership	Pre-paid monthly fares are part of current habits and therefore likely to support ridership

BEHAVIOURAL BIAS AND DESCRIPTION	REFERENCES AND EVIDENCE RELATED TO PRE-PAID MONTHLY PASSES / PAY-AS-YOU-GO	ANTICIPATED IMPACT ON RIDERSHIP UNDER FARE CAPPING	ANTICIPATED IMPACT ON RIDERSHIP UNDER PRE-PAID MONTHLY PASSES
Incentives - Frequently used as a method for changing behaviour	Incentives can highlight the desirable choice, but can also have adverse effects by undermining intrinsic motivation and backfire (Gneezy et al., 2011)	Using incentives can improve adherence to fare capping, via text messages, easy-to-use apps	The upfront cost associated with the pre-paid monthly pass can work as an incentive to encourage ridership
Reinforcement - Causes behaviour to be performed more frequently in the future	Environmental cues trigger health behaviours (eating, exercising) (Story et al., 2014)	Encouragements that people are approaching the fare cap or have earned free rides could encourage ridership	Pre-paid monthly passes require only one payment, this could reinforce preference for this option
Social norms - People act similarly to those around them	People care about what others do (Cialdini, 2003, 2007), and about equity (Gneezy & List, 2006)	Messages that most people support fare capping could increase public support	Pre-paid monthly passes are considered as the standard and socially dominant choice
Message framing - The way a set of options in a decision problem is formulated (i.e. ‘‘framed”) influences decision making.	Both negative framing and positive framing can influence behaviour: People tend to avoid risk when a positive frame is presented but seek risks when a negative frame is presented (Gravert & Collentine, 2019; Avineri & Waygood, 2013)	Can be leveraged to produce positive views of fare capping	Can be leveraged to produce positive views
Mental accounting - People place different value on money depending on subjective	Discrete mental accounts are used for fixed and variable costs- in particular in relation to transport (e.g., gas money, insurance,	Recurring small payments can be considered at the expense of something	Cost for the pre-paid monthly pass is considered as separate from other costs and

BEHAVIOURAL BIAS AND DESCRIPTION	REFERENCES AND EVIDENCE RELATED TO PRE-PAID MONTHLY PASSES / PAY-AS-YOU-GO	ANTICIPATED IMPACT ON RIDERSHIP UNDER FARE CAPPING	ANTICIPATED IMPACT ON RIDERSHIP UNDER PRE-PAID MONTHLY PASSES
criteria; economic outcomes are categorized	service fees) (Metcalfe & Dolan, 2012; Thaler, 2008)	else and decrease ridership	therefore less likely to produce negative views of monthly passes

Uncertainty

The wide range of shortcuts that humans use to understand the world indicate that transit riders will favour the predictability and convenience of flat rates. However, they also demonstrate the powerful influence of context on behaviour. As such, how options are presented and message framing can have a big impact on how discount schemes are perceived, and on ridership.

While there are clear reasons for adopting a behavioural approach to examine appropriate fare systems, the case for adopting fare capping is clouded by the multiple biases that favour flat rates. From a social equity perspective, low-income riders are largely dependent on public transport, but often unable to pay for trips that fulfil their daily necessities (Perrotta, 2017). This facilitates fare evasion, dependence on others to meet their needs, and lower community engagement. Fare capping could be an important tool to mitigate such effects. This highlights the importance of examining potential benefits and costs before introducing new fares systems. Multiple cities around the world have already adopted fare capping schemes, including Portland, London and Melbourne.

Case studies

Portland

Portland introduced fare capping in 2017 as a way to make the transit system fast, convenient, secure, accessible and equitable. A single bus trip costs $2.50, while a day pass costs $5. With the fare cap, a rider will not exceed $5 in fares in a day, even though they purchased each trip separately. In addition to the daily fare cap, there is a monthly fare cap of $100, whereby riders pay no more than $100 per month. Portland's system employs reloadable "Fastpass" cards, which track the number of trips that a cardholder makes. The card is available at retailers around the city. Fare capping is compatible with the virtual Hop card, Google Pay and Apple Pay, capping

fares at $5 per day and $100 per month. In addition, Samsung Pay, credit cards and debit cards are compatible with a $5 daily fare cap (TriMet, 2020). Fare capping replaced the daily and monthly pre-paid passes that were previously sold. TriMet (2016) estimated that fare capping could reduce revenues by 1- 1.5% compared to pre-paid passes, and that this could be minimized with less fare evasion under the new system. However, ridership changes associated with the transition from pre-paid fares to fare capping was not tracked, and data to determine the actual impacts of fare capping on ridership do not exist.

Portland's transition process to a fare capping system has been ongoing since 2015. TriMet used rider survey data to conduct a preliminary fare equity analysis and draft price proposals, payment methods and fare products (TriMet, 2016). Portland then conducted a public input on the new design of fares, and the underlying objective was that the new fares would have no disparate impact or disproportionate burden. This led them to eliminate the proposed 7-day pass and 14-day pass, and introduce new fare caps. Both technical analysis and public engagement informed the final design, with public engagement uncovering a number of aspects that had not previously been considered such as barriers to costs of the new card, demands for online registration and concerns around the necessity to provide an email address (TriMet, 2016).

London

London's transit system is extensive and includes multiple modes (e.g., bus, tube, tram, railway), numerous zones that radiate from the city centre (but buses only have one zone), various ticket possibilities (e.g., contactless pay, Oyster card or Travelcard), time variable fare caps (off-peak or peak) and several fare categories (children, adult). This results in a highly complex fare system. An overview of London's fares is displayed in Figure 1. The daily cap on Oyster cards for travel in central London is £7.20. A special cap applies for bus travel only; if all trips in a day are by bus the fare cap is £4.50. Buses also offer 'hopper fares' where trips are £1.50 with free transfer to another bus within one hour. These fares are designed to help riders on low incomes, who rely on buses more than other residents (Barrett et al., 2019). London's transit system includes daily and weekly caps for contactless cards, and daily caps for Oyster cards (unless traveling by bus and tram only, in which case a weekly cap is also applied) (Transport for London, 2020). The fare cap is calculated by logging every trip a rider takes, the time they spend in transit, the zones they travel through, and all fares they pay. Daily caps start at 4.30am and end at 4.29am the next day, whereas weekly caps run from Monday to Sunday. Transport for London (2020) recommends getting a 7-day Travelcard if trips are concentrated outside this time period (e.g., from Friday to Tuesday).

		1-day Travelcard		
Zones	**Oyster daily cap**	**Peak***	**Off-peak**	**7-day cap****
Zone 1-2	£7.20	n/a	n/a	£36.10
Zone 1-3	£8.50	n/a	n/a	£42.40
Zone 1-4	£10.40	£13.50	£13.50	£51.90
Zone 1-5	£12.30	£19.10	£13.50	£61.70
Zone 1-6	£13.20	£19.10	£13.50	£66.00

Figure 1. Overview of London's public transit fares.

A recent report from Centre for London concludes that London's transit system is not accessible for all Londoners, nor does the service and use have an equitable impact on all groups (Barrett et al., 2019). Recommendations to improve fair access for all include improving affordability of Travelcards; pay-as-you-go caps and rail fares; expanding access to public transit by offering consistent information, services and announcements; and prioritise social benefits and define equity more broadly to address barriers for people with a disability, ethnic minorities, seniors, young people and women (Barrett et al., 2019; Bosetti et al., 2020). In general, prioritising affordable transport options is key to increase accessibility and opportunities for low-income residents. An elaborate assessment of connectivity measures within price levels and modes of transport can help policy makers identify areas where connections are needed.

The public transport system in London shows that ridership, fare structure, access, housing affordability and sociodemographic factors are tightly interlinked. Londoners who have moved away from the city centre to find more affordable housing are penalized with higher transit fares and a longer commute under the current system. Suggested ways to revise the system in order to increase fairness include reducing the difference in fares between individual zones or reduce the number of zones; examine how fares freezes impact different rider groups; and offer low-income ridership cards or caps (Barrett et al., 2019). In the case of London, an accessible public transport system in terms of both fares and physical accessibility represents an opportunity to increase access and equity while at the same time increasing ridership. Moreover, public engagement and consultation is key in order to identify solutions and implementation methods (Bosetti et al., 2020). On the surface, a fare capping system provides benefits to riders by reducing boarding

times and automatically calculating the best fare, while the city benefits from reduced costs associated with fare administration through automated payment methods.

Data from London shows that low-income riders are less likely to have flexible work times that would allow them to benefit from off-peak fares, and that travelers taking longer journeys are less sensitive to price (summarized in Tourism & Transport Forum Australia, 2016). Thus, long-distance commuters have lower elasticity, which has been attributed to the lower competition of other modes of transportation. It is therefore important to consider whether off-peak fare caps contribute to social equity, and how fares increase according to distance. This highlights that fare initiatives that are intended to benefit low-income riders and increase ridership- such as off-peak fares- are not necessarily having the intended effects. London is not an evident case that fare capping has increased ridership or accessibility, and highlights the importance of evaluating how fare systems impact ridership.

Melbourne

Melbourne has had fare capping since 2012, while simultaneously offering transit passes. The transit system in metropolitan Melbourne consists of trains, trams and buses, and is divided into two zones- Zone 1 and Zone 2. The motivation to adopt fare capping has been largely driven by travellers' struggle to calculate which fare product to choose, and the objective to make public transit more accessible (Tourism & Transport Forum Australia, 2016). Moving to simplify the fare structure, the region's smart travel card, the Myki card, now automatically calculates the cheapest possible fare. The system offers daily and weekly caps when loading Myki Money onto the card, as well as off-peak discounts (summarized in Table 2). Trips are capped over a day and travel is free for the remainder of the day after spending 8.80 AUD (Public Transport Victoria, 2020). The daily cap is twice the value of the two-hour cap, so that a rider only has to make two trips in order to reach the daily cap. Those traveling only in Zone 2 enjoy a smaller cap. In addition, a touch-on after 6pm grants unlimited travel until 3am the following day, and travel prior to 07.15am on trains are free.

Melbourne continues to offer longer term fare products, which can be loaded onto a user's smartcard. The maximum time over which Melbourne's myki system caps fares is one day, thus the weekly Myki pass and other longer-term products do not compete against any cap (Tourism & Transport Forum Australia, 2016). A rider would have to make five weekdays' worth of travel before paying the cost of a weekly pass, and 17.5 weekdays' travel before realising the benefits of a monthly pass, which is available for 28 days. Melbourne thus employs a hybrid strategy of both fare capping and pre-paid fare options.

Similarly to Portland and London, there is no data available to determine how the introduction of fare capping in Melbourne impacted ridership. Although the daily caps simplify the fare structures for odd transit riders, regular riders can further benefit from long-term pre-paid passes and the associated discounts.

Table 2. Summary of type of fare caps in Portland, London and Melbourne. All cities use a value-based cap, rather than the optional trip-based or frequency-based fare cap.

CITY	FARE CAPS	TYPE OF CAP (VALUE OR FREQUENCY)
Portland	Daily, Monthly	Value
London	Daily, Weekly	Value
Melbourne	Daily, Weekly	Value

Part 2: Study methodology

Part 2: Study methodology

Introduction

Fare products, or how customers pay for transit, are an important policy instrument for transit agencies. They are the main contact point for customers and can be used to shape ridership patterns. Pre-paid passes, such as monthly passes, have long been offered as a convenient way to pay for transit while encouraging customer loyalty and additional ridership. TransLink's recent Transit Fare Review examined a range of fare products and highlighted fare capping as a potential future fare product. The Review also emphasized substantial uncertainties regarding how customers would react to fare capping, and thereby the impact of fare capping on transit ridership and revenue.

A subsequent literature review of human behavioural biases related to transportation revealed numerous human heuristics and biases that influence transit decision making, with the various biases acting in different directions with different anticipated magnitudes. Overall, the review suggested that fare capping may cause ridership to decrease, due to behavioural biases that favour flat rates. At the same time, messaging and feedback on usage can influence transit ridership.

Despite the large body of literature on transportation behavioural modification, research on the impacts of fare capping on ridership is lacking. It is therefore necessary to further examine the impacts of fare capping on ridership. At the same time, TransLink is interested in understanding how transit usage feedback can influence ridership. This section presents the methodology of an experimental study which aims to examine how fare capping and feedback on transit usage influences ridership. A summary of the methodology is attached in Appendix B. With recent technological advances and more sophisticated smart card systems, TransLink is able to gather ridership data by tracking Compass Card usage. By recruiting participants and evaluating their transit usage and reactions to different fare products, the study will contribute to knowledge of how fare capping and feedback on usage will influence transit ridership in Vancouver.

Aim and goal of study

The aim of this study is to understand the impact that fare capping will have on transit ridership, revenue and customer perceptions in the Vancouver area. The study will inform whether implementing fare capping as a new fare scheme is a practical, feasible and beneficial option for TransLink and its goals of promoting sustainable transportation and social welfare.

Research questions and hypotheses

The following research questions (RQ) and hypotheses were formulated to address this goal.

- RQ1: Does fare capping impact transit ridership in Vancouver?
  Hypothesis: Replacing monthly passes with fare capping leads to decreased ridership.
- RQ2: Does feedback on transit usage influence ridership?
  Hypothesis: Feedback in the form of text messages and notifications will produce higher ridership.
- RQ3: What are customers' perceptions of pre-paid monthly passes versus fare capping?
  Hypothesis: Customers prefer pre-paid monthly passes compared to fare capping.

Key concepts

There are multiple concepts and variables that are included in the study, each of which must be operationalized:

- Fare capping: Fare capping will be operationalized as the concept of paying a single, flat fare for every trip until a predetermined threshold has been reached, after which transit is free
- Pre-paid monthly passes: Pre-paid monthly passes refer to the fare product for which customers pay a flat fare at the beginning of the month and can thereafter take unlimited rides for the rest of the month
- Transit ridership: in the transportation industry there are multiple terms that could capture ridership.
    - A *boarding* refers to undertaking a single ride, in one direction, on one mode of transportation. For instance, a boarding would refer to boarding a bus, and end when exiting that same bus.
    - A *trip* refers to all boardings from when a rider starts their journey to when they reach their end destination. For instance, a trip would start when boarding a bus, continue once exiting the bus and boarding a SkyTrain, and end once the rider arrives at their office by the SkyTrain station. As such, a trip can include multiple boardings.
    - A *fare journey* refers to the period of time after paying a fare when the rider can undertake as many boardings and trips as they would like. In Vancouver, a fare grants unlimited ridership for 1.5 hours. As such, a rider can undertake multiple trips for 1.5 hours after paying a fare. It is estimated that trips constitute 98% of

fare journeys, however there are some short trips that would allow multiple trips within one fare journey (e.g., taking the bus from home to the library, picking up a library book, and boarding a new bus back home- this would be two trips within one fare journey).

- For the purposes of this study, *fare journeys* will be included as the variable that captures transit ridership, and serve as the dependent variable.

- Perception of value: it is likely that different fare structures influence the perception of value for transit. Riders' perception of value of fare products will be captured in the survey by their responses to questions surrounding the value of the fare product.

Concepts that are relevant but will not be included:

- Modes of transport: the public transportation system in Vancouver includes multiple modes, including buses and the SkyTrain. Although it would be interesting to examine how fare capping would influence the modal choice of riders, this would increase the number of variables to include and control for in the study. It would therefore add a layer of complexity that will not be included in the current methodology.
- Frequency and convenience of public transport: it is possible that the fare product can influence perceptions of convenience and frequency of transit. However, these variables are also influenced by numerous other factors that would be hard to isolate, and will not be included in this study.

Table 3 presents a summary of the variables included in the study. The current study fits under two types of research: experimental research and survey research. The study will sample participants from transit riders in Vancouver, randomly assign participants to use different fare products (pre-paid monthly passes and fare capping), and thereafter compare participants' ridership and perceptions about the fare products. Ridership will be compared using Compass Card data. The study will administer surveys to participants before and after the intervention period to examine their perceptions related to transit behaviour.

Table 3. Overview of variables in the study.

VARIABLE	TYPE OF VARIABLE	NOTES
Fare product	Independent Variable	Fare capping or Monthly Pass on Compass Card
Ridership	Dependent Variable	Number of fare journeys as captured by Compass Card data
Perceptions of fare products	Dependent Variable	Captured by survey questions
Method of buying fare products	Covariate	Captured by survey questions
Demographic variables - age, gender, income, residence area	Covariates	Captured by survey questions

Participants

To answer the research questions it is necessary to determine the population of interest and to recruit participants that accurately represent this population. It is therefore necessary to determine inclusion and exclusion criteria to ensure a representative and unbiased sample. Adult, English-speaking individuals who use transit in one zone only and who do not hold discount passes (such as youth, senior or U-pass) will be invited to participate. One option is to recruit participants from all transit riders who meet these requirements. In addition, there are multiple ways to segment the overall population of transit riders, where each segment could be studied to determine the impact of fare capping. This would require a larger sample, but allow for more nuanced data to be collected. Additional inclusion criteria would be necessary for this sampling strategy. Table 4 provides a summary of the possible segments and criteria of inclusion.

Table 4. Possible ways to segment the population and additional inclusion and exclusion criteria. Note: 41 is the number of trips at which a monthly pass would be financially beneficial.

SEGMENT OF POPULATION	ADDITIONAL INCLUSION CRITERIA	ADDITIONAL EXCLUSION CRITERIA	FEASIBILITY / CONCERNS
People who buy pre-paid monthly passes and make enough trips to make up for it	- Takes more than 41 trips per month	- Takes less than 41 trips per month	Concern with obtaining representative sample
People who use stored value almost enough to make up for a pre-paid monthly pass	- Takes between 30 and 41 trips per month	- Takes less than 30 or more than 41 trips per month	Concern with obtaining sufficient sample size; concern with sample representativeness
People who buy pre-paid monthly passes but do not make up for it	- Takes less than 30 trips per month	- Takes more than 30 trips per month	Concern with obtaining sufficient sample size
People who overuse stored value- paying for a monthly pass would be financially beneficial	- Takes more than 41 trips per month	- Travel across zones	Concern with obtaining sufficient sample size; concern with sample representativeness

Recruiting participants

After the population and segmentation is defined it is necessary to determine how to recruit the participants that will make up the study sample from the population. There are various approaches available to TransLink for recruiting participants. Figure 2 presents a multiple criteria analysis of five options. These options are described in text below, and should be considered according to the resources available when the study will be conducted.

1. Recruiting participants online and/ or on transit (posters in buses, on platforms, in SkyTrains, etc.)
    i. Social media channels and newsletters can be used to recruit participants.
    ii. This sampling method would likely reach a wide range of people and result in a representative sample. However, people would be self-nominating and therefore biased from the general population.
2. Recruit from TransLink Listens panel
    i. This would be a convenient way to recruit participants, although resulting in a biased sample of individuals who have already expressed willingness to participate

in research. One benefit is that they have pre-provided data which can be used to screen for a demographically representative sample.

   ii. This will be a pseudo-representative sample.

3. Recruit participants by phone
   i. In order to obtain a fully random and representative sample it would be necessary to reach a large number of individuals and recruit those who do not self-nominate. TransLink has done this previously: this strategy was used during the COVID-19 pandemic to conduct survey research. Although it would provide a random sample, this strategy would be expensive and time-consuming.
4. Reach out to transit riders who use registered Compass Cards
   i. One assumption is that there is a higher percentage of pre-paid monthly pass users that have registered their Compass Cards. However, this sampling method will not result in a random or independent sample. There may be particular inclinations and considerations that would cause biases and make this part of the population different from people who do not register their cards.
   ii. There is precedent in this method: TransLink has used it in a previous study related to bike locker usage.
5. Rely on a market research firm or external panel
   i. Outsourcing the participant recruitment would likely be the most expensive option, but would likely result in the most representative and unbiased sample.

SAMPLE SELECTION	COST	INDEPENDENCE/ RANDOMNESS	PRIVACY CONCERNS	TIME REQUIRED
Social media: Develop social media campaign for buses, stops, trains and stations to reach people riding transit	+	+	++	++
TL Listens panel: Recruit participants from TL Listens. Allows screening based on provided demographics to obtain representative sample	+++	--	+	+++
Phone: Recruit participants over phone to reach a completely random and representative sample	---	+++	++	--
Registered Compass Card users: Recruit participants from those who have registered Compass Cards	+++	+	-	++
Hire external market research firm: outsource sampling and group allocation	---	+++	++	--

Figure 2. Multiple criteria analysis of different methods for recruiting participants. Legend: +++ Very clearly positive, ++ Clearly positive, + Slightly positive, 0 Neutral, - Slightly negative, -- Clearly negative, --- Very clearly negative.

Sample size

A power analysis should be conducted in order to determine the appropriate sample size. This can be conducted using the software G*Power, with information derived from previous survey data that TransLink has conducted. One possible study is the hotel study, another option is the bike locker study. As a rough estimate based on previous transportation studies, sample sizes of

around 50-100 per condition (Portland study[1]: *N* = 297, four conditions; Swiss study[2]: *N* = 30, one condition; MIT Study[3]: *N* = 97, one condition) appear common. Attrition is also a concern in studies occurring over a longer time period. It is therefore a good idea to aim for a larger sample than what is considered necessary.

Description of study area

The region of the Greater Vancouver Area is the study area of the present work. The population of this area is 2,581,079[4]. The population density (km^2) is 22450, making it the most densely populated area in Canada (World Population Review)[4]. Bus and SkyTrain are the main public transit methods in this area. TransLink provided over 450 million boardings in 2019[5].

Pilot study

It is recommended to conduct a pilot study in order to determine whether the survey accurately captures the variables of interest, and whether participants adequately understand and respond to the survey. The pilot study could include studying a small number of participants for a month, administering the surveys and examining the responses. After the pilot study it may be necessary to make adjustments to the survey, the study design, and/or the hypotheses.

Survey

Surveys will be used to address the third RQ regarding customers' perceptions of pre-paid monthly passes versus fare capping. Written surveys are good sources for obtaining quantitative data, and if administered online they are relatively low cost and time effective. A survey software such as Qualtrics should be used to operate and administer the surveys, as this allows easy handling, storage and coding of data. The order in which certain questions are presented should be randomized to avoid bias in responding. A pilot study in which the survey is issued to a small

[1] Matthies et al. (2006), Applying a modified moral decision making model to change habitual car use: How can commitment be effective? Applied Psychology

[2] Abou-Zeid et al. (2012), Happiness and travel mode switching: Findings from a Swiss public transportation experiment, Transport Policy, 19, 93-104.

[3] Abou-Zeid et al. (2012), Travel mode switching: Comparison of findings from two public transportation experiments, Transport Policy, 24, 48-59.

[4] Vancouver Population 2020 (Demographics, Maps, Graphs)

[5] Ridership data, TransLink

number of respondents should be conducted to evaluate whether the information presented and the questions asked are interpreted by the respondents as intended.

The study will use two surveys: one pre-intervention survey and one post-intervention survey. The pre-survey will be administered after participants have agreed to participate in the study and provided their consent, and before the experimental period starts. The post-survey will be administered immediately following the experimental period. The proposed survey questions are intended to explore participants' perceptions of fare capping and monthly passes, understand preferences for the fare products, and how these might have changed following the experimental treatment. The content of the pre-survey can be found in Appendix A.

Experimental design

An experimental study will examine the effect of fare capping and transit usage feedback on ridership, and pre- and post-surveys will examine customer perceptions. Figure 3 illustrates the study design. Study participants will be randomly allocated into one of three possible conditions:

1. The experimental condition, in which they will receive a fare capping scheme and information about transit usage,
2. The survey + information condition in which they will receive a survey at the beginning of the study period, use their normal fare choice during the study period (i.e. no intervention), receive information about transit usage and receive a survey at the end of the study period, or
3. The control condition in which they will not receive surveys and not receive information.

Participants' ridership data as captured by their Compass Cards will be compared between the conditions in order to determine the effects of the different fare products and usage feedback on ridership. Survey responses will be compared between participants themselves (by comparing pre- and post-surveys) and between conditions to examine the perceptions of fare products.

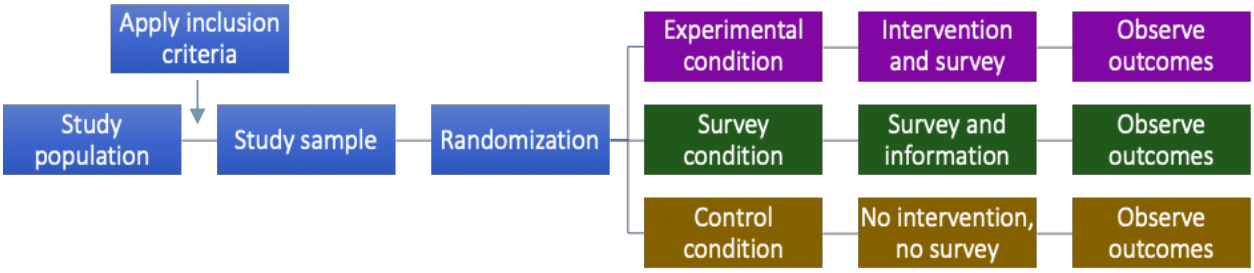


Figure 3. Overview of the study's three-group mixed research design. Illustration of current research design. After sampling, participants will be randomly allocated into one of three experimental conditions. Following randomization, participants will receive the pre-survey. Then, those in the experimental conditions will receive the intervention for a predetermined time period, whereas the control condition will not receive an intervention. After the intervention period all conditions will receive the post-survey. Finally, the ridership information and survey responses will be compared in statistical analysis.

Procedure

First, participants will receive the pre-intervention material which consists of a consent form and the pre-survey. Participants will be informed that their participation is voluntary and that they can withdraw at any time. They will also be informed of the ways in which their personal data will be handled, de-identified and stored. They will be provided with the pre-survey and invited to fill it out within a week. A reminder should be sent out on day five to remind those who have yet to complete the pre-survey.

At the beginning of the next calendar month, the condition-specific treatment will begin:

Experimental group: Participants will receive and answer the pre-survey. Fare capping will be activated on these participants' Compass Cards. They will be asked not to purchase a monthly pass and instead load Stored Value on their cards. They will receive information about their travel usage throughout the month. When they have undertaken sufficient travel in the month, a pass will be loaded on their card and they will receive communication indicating that they have 'earned' a monthly pass. At the end of each month, each customer will receive customized information that details how much travel was undertaken, what the total value of the travel would be using stored value and the total savings (if any) resulting from the fare cap.

Communication about transit usage and notification that they have reached the fare cap will be given via text message. The communication will be as follows:

- 1 message about the number of trips taken in the middle of the month, and how much travel must be completed to reach the fare cap
- 1 notification when 10 trips remain before reaching the fare cap
- 1 notification when the fare cap is reached and travel is free for the remainder of the month
- 1 message at the end of the month detailing usage and whether the fare cap was reached (and if not, how much travel remained)

Survey + information group: Participants will receive and answer the pre-survey. This group will receive the same survey as the experimental group, but fare capping will not be activated on their account. They will continue to use their normal fare products. They will receive communication throughout the month about their transit usage, and at the end of each month, customers will receive communication detailing how much travel they completed (identical to the experimental group). The communication will be as follows:

- 1 message about the number of trips taken in the middle of the month, and how much travel must be completed to make up for the value of the monthly pass
- 1 notification when 10 trips remain before making up for the value of the monthly pass
- 1 notification when the value of the monthly pass is reached and travel is "free" for the remainder of the month
- 1 message at the end of the month detailing usage and whether the value of the monthly pass was made up for (and if not, how much travel remained)

Control group: This group will not receive surveys, information or fare capping. They will continue to use their normal fare products. Customers will not receive communication that details how much travel they completed.

Once the intervention period is over, participants in the experimental group and the survey + information group will receive the post-survey by email communication. They should be invited to complete it within one week, and receive a reminder to complete it after five days.

Upon completing the post-survey, participants will receive a debrief package via email with a form explaining the full purpose of the study, what they were asked to do, and why. Participants in the control condition will not receive post-surveys, and should receive the debrief package immediately. Contact information for the Principal Investigator as well as for the Research Ethics Board that granted ethics approval should be included. Participants will be thanked for their participation.

Intervention period

The intervention should be administered for a predetermined time period. Three months is appropriate for customers to understand their monthly usage, the costs related to transit and to make reasonable adaptations, while controlling for any sampling error or tendency to continue data collection until an effect is observed. As transit behaviour varies throughout the year- in particular in relation to holidays and school breaks such as Christmas and summer- the study should be conducted during stable periods of the year. Based on previous analyses conducted by TransLink September- November is a stable time period, alternatively January- March is another three-month period to consider for the study.

Analysis

The groups' ridership information from the Compass Cards will be analysed using a two-way ANOVA. This will determine if there is any difference in the number of fare journeys between the experimental groups. The data from the survey will be compared using multiple regression. This will examine whether customers' satisfaction can be predicted from the type of fare product they use.

Outcomes and implications

It is anticipated that fare capping will result in significantly less revenue overall from the experimental group. The impact on ridership is highly uncertain, though the anticipated result is less ridership from both the control and experimental groups. The potential revenue impact of fare capping is highly significant, and real-world experimental evidence will improve decision-making related to the implementation of this fare product.

Part 3: Summary and recommendations

Summary

Fare products are a key policy instrument for transit agencies. Pre-paid passes have been offered as a convenient way to pay for transit while encouraging ridership loyalty and frequency. Recently, fare capping has emerged as a possible tool to encourage ridership while improving affordability and equity. The transport system is a choice environment associated with uncertainty and a myriad of options, making traditional economic accounts poorly suited to predict behaviour. The consequences of introducing changes to fares and fare products should be assessed using a behavioural approach. Behavioural insights contribute alternative and comprehensive accounts of why people act the way they do and help explain why it is challenging to change transportation behaviour. This lens is useful when assessing how fare capping influences transit ridership. The product provides similar benefits to pre-paid passes, while at the same time adding flexibility, simplicity and removing large up-front costs.

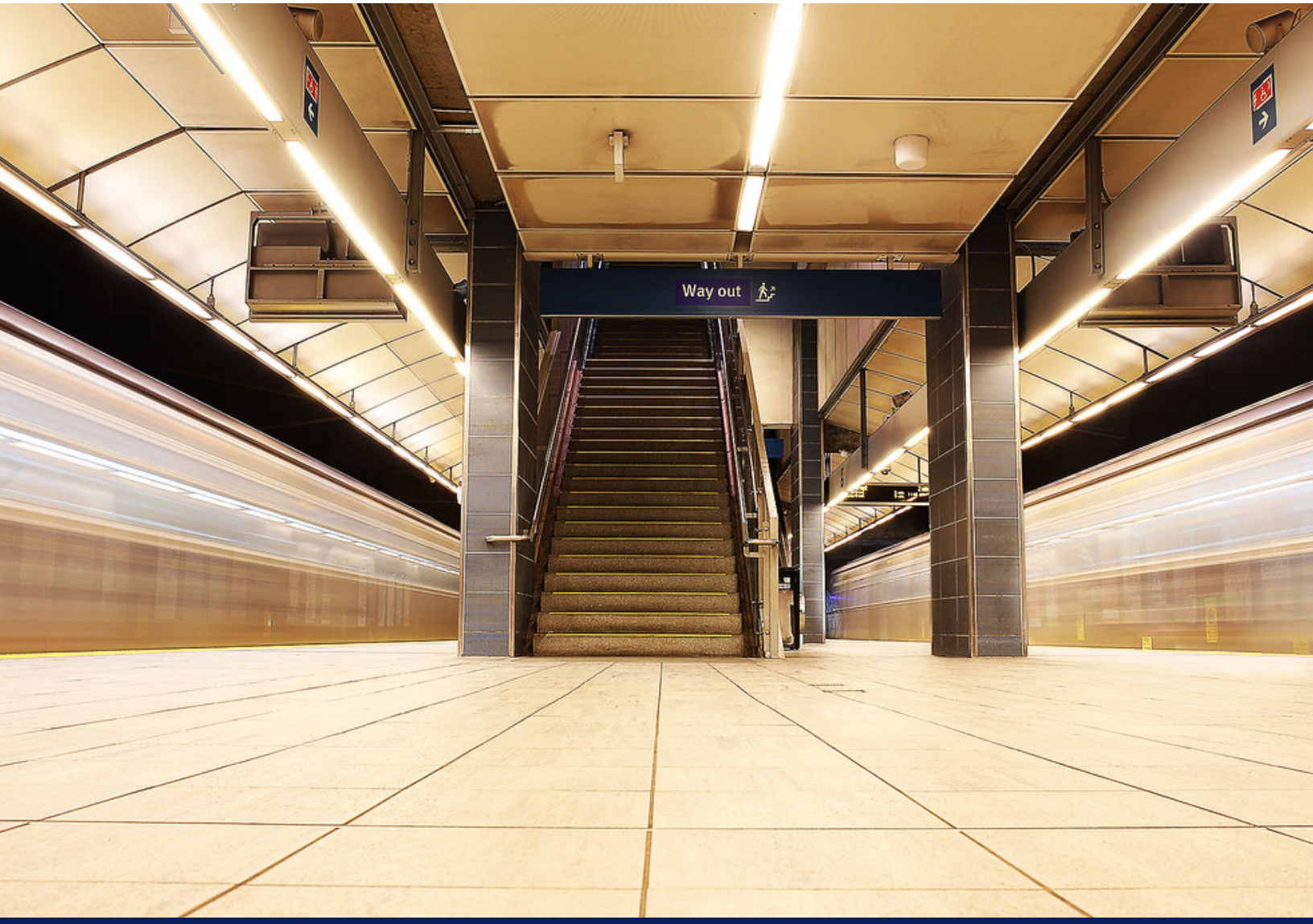
The literature review addressed human behavioural biases that might influence riders' perceptions and acceptance of fare capping. It showed that the flat rate bias, effects such as the insurance effect, convenience effect, pre-commitment effect and loss aversion exert powerful cognitive effects on behaviour. It further highlighted that social norms and message framing can be important leverage points in order to successfully introduce fare capping. It presented case studies from Portland, London and Melbourne. These cases highlighted that it is important to collect data to evaluate whether and how fare capping influences ridership, and to conduct community consultations in order to develop fare structures and caps that are publicly accepted.

There is still a need to explore and document the possible benefits and implications of fare capping. While fare programs that incorporate insights from behavioural science can be a powerful tool for increasing ridership, they cannot be used in isolation, and should be coupled with other strategies to improve access and equity in the transit system. To address the uncertainty surrounding fare capping, TransLink can study its effect on ridership by using the methodology developed in the second part of this report. This will provide quantitative data to answer the questions of whether fare capping can increase transit ridership, whether feedback on transit usage influences ridership, and what perceptions customers hold in relation to fare capping and pre-paid monthly passes.

Recommendations

Based on the findings in this report, the recommendations for TransLink are to:

- Base future decisions related to fare products on the notion that human behaviour is governed by heuristics and biases, and that any policy must consider and be tailored to these biases.
- Develop convenient, intuitive and equitable fare products.
- Strategically present fare choices according to human biases, and consider how and what type of information is presented to riders.
- Adopt a social equity lens to determine just fares for low-income riders who depend on public transit to meet their daily needs.
- Conduct comprehensive community consultations to develop fare products, and in the case of fare capping, fare caps that are publicly accepted.
- Consider transit riders as a heterogeneous group with dissimilar needs based on area of residence, socioeconomic status and accessibility concerns. Fare products must be based on these various needs and part of a comprehensive policy to improve transit opportunities.
- Develop fare capping systems with simple eligibility requirements that include mechanisms for monitoring ridership. This will be important for both riders and for the agency, in order to track riders' progress towards the fare cap and any change in ridership.
- Adopt technological solutions for payment and make fare capping compatible with options beyond fare cards, such as Apple Pay, Google Pay and Samsung Pay. This will increase the ease and economic benefits of public transport, and make it more competitive with the increasing number of actors in the transport sector such as Uber and Lyft.
- Conduct further studies including pilot studies to understand how fare capping will influence transit ridership, and to determine what human behavioural biases influence transit ridership.



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Appendices

Two appendices are included in this report: The pre-intervention survey (Appendix A) and the summary of the study methodology (Appendix B).

Appendix A Pre-intervention survey

Transit Fare Capping Research
Pre-intervention survey
2020-06-10

Landing Page

Welcome to the fare products study!
Affordable and accessible public transportation is important for thriving communities. TransLink aims to promote sustainable transportation and social welfare through their services. Appropriate fare products, the way in which customers pay for transit, are important for meeting these goals. This survey will explore transit users' opinions of two fare products: pre-paid monthly passes and fare capping.

[Privacy statement]
Your responses will be used to help TransLink assess what fare products are best suited to meet the goals of affordable and accessible public transportation and increasing transit usage in Vancouver. The results will be used in future strategic planning of the fare products offered by TransLink. Your responses to this survey are anonymous.The information you provide in the study surveys will be anonymized and linked back to your transit usage data in order to understand how transit usage and perceptions of fare products are related. The information will not be traceable back to you. TransLink will only be able to access aggregate information, such as the average number of transit trips taken and how much money is spent on transit.

The survey is composed of three sections and will take approximately 10-15 minutes to complete. The three sections are:

1. Your transit usage
2. Fare products
3. Demographic information

1. Please enter your Compass Card serial number from the back of the card *(must enter to proceed)*

Section I Your transit usage [New Screen]

Questions

1. How do you pay for transit? (*single response only - could include* "if you use multiple payment methods, please select the one you use most frequently")
    1. Monthly Passes (not on auto-load)

2. Monthly Passes on auto-load
3. Compass Card Stored Value
5. Single use tickets (including Compass Tickets, cash fare on the bus,
6. Tap to Pay (including contactless American Express, Mastercard or Visa credit card or mobile device)

Why do you pay for transit this way? *(Optional)*

2. How much do you spend on transit per month on average? *(Drop down menu)*

1. $1-10
2. $11-20
3. $20-30
3. $31-50
4. $51-70
5. $71-90
6. $91-100
7. $101-110
8. $111-120
9. $121-130
10. $131-140
11. $141-150
12. $151-160
13. $161-170
14. More than $170

3. Reflecting on the way you pay for transit, to what extent do you agree or disagree that you get good value through your chosen payment method?

1. Strongly agree
2. Somewhat agree
3. Neither agree nor disagree
4. Somewhat disagree
5. Strongly disagree

Why?

Section II Fare products [New Screen]

Today, we offer several fare products for customers to meet different travel needs. Monthly Passes offer discounts for frequent riders, while Stored Value and Compass Tickets offer flexibility for paying as you

go. New technology is providing more options for how we could structure fare products to offer benefits to frequent riders.

Let's look at the two options for fare products.

Option 1: Pre-paid Monthly Pass: pay in advance for unlimited travel for the month

Monthly Passes are purchased in advance, and offer unlimited travel for a calendar month.

Option 2: Fare Capping: pay-as-you-go with a fare cap, after which point travel is free

Under the fare capping option, you pay for each individual trip using Stored Value on your Compass Card until you've taken enough trips to earn a Monthly Pass. Once you reach this threshold or "cap" all remaining travel for the month is free.

What do you think about these options? Answer the questions below to let us know.

Questions ***(randomly ask 1-2 and 3-4 in blocks)***

1. **To what extent do you agree or disagree with TransLink offering pre-paid Monthly Passes?**
    1. Strongly agree
    2. Somewhat agree
    3. Neither agree nor disagree
    4. Somewhat disagree
    5. Strongly disagree

    Why? *(Optional)*

2. **The following section presents statements referring to possible benefits and drawbacks of pre-paid Monthly Passes. On a scale of 1-5, where 1 is 'strongly disagree' and 5 is 'strongly agree,' please indicate to what extent you agree with each statement.** *(questions to be presented separately - options to be randomized)*

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly agree
The upfront cost of a pre-paid Monthly Pass at the beginning of the month presents a financial burden for me and prevents me from buying a pass.	1	2	3	4	5
The pre-paid Monthly Pass offers good value for money.	1	2	3	4	5
I ride transit more with my pre-paid Monthly Pass than paying for each trip separately because it is free after I pay for the cost of the Monthly Pass.	1	2	3	4	5
I find it easy to predict if the pre-paid Monthly Pass will offer good value for me based on the number of transit trips I will take each month.	1	2	3	4	5
I value the freedom of not having to worry about paying for each trip when I use a pre-paid Monthly Pass.	1	2	3	4	5
With the pre-paid Monthly Pass it is easy to understand how much money I spend on transit per month.	1	2	3	4	5
I buy a pre-paid Monthly Pass to encourage myself to take transit more.	1	2	3	4	5
I buy a pre-paid Monthly Pass to make sure I don't spend too much on transit.	1	2	3	4	5
I buy a pre-paid Monthly Pass out of habit.	1	2	3	4	5

Are there other possible benefits? *(Optional)*

Any comments? *(Optional)*

3. **To what extent do you agree or disagree with TransLink offering fare capping?**
    1. Strongly agree
    2. Somewhat agree
    3. Neither agree nor disagree
    4. Somewhat disagree

5. Strongly disagree

Why? *(Optional)*

4. The following table lists statements referring to possible benefits of fare capping. On a scale of 1-5, where 1 is 'strongly disagree' and 5 is 'strongly agree,' please indicate to what extent you agree with each statement. *(options to be randomized)*

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly agree
Fare capping offers good value for money.	1	2	3	4	5
I would be likely to take more trips with fare capping than with no fare capping because I know that fares will be capped when I have taken enough trips.	1	2	3	4	5
I would find it easy to calculate when I would reach the cap to earn free transit each month under fare capping.	1	2	3	4	5
Having to pay for each trip until I reach the fare cap is likely to reduce the likelihood of me taking transit.	1	2	3	4	5
With fare capping it is easy to understand how much money I spend on transit per month.	1	2	3	4	5
I would value a cap so that I know the maximum I can spend on transit each month.	1	2	3	4	5

Are there other possible benefits? *(Optional)*

Any comments? *(Optional)*

5. Do you prefer fare capping or pre-paid Monthly Passes?

1. Strongly prefer Fare capping
2. Slightly prefer Fare capping
3. No preference
4. Slightly prefer Monthly passes
5. Strongly prefer Monthly passes

Why?

6. Fare capping offers a guaranteed best price. You will pay for the transit trips you take using Stored Value, and never pay more than the fare cap. In other words, you will pay as you go, and ride transit for free after you hit the fare cap. Pre-paid Monthly Passes differ in that they must be bought ahead of time, and you may not make enough trips to equal the value of the Monthly Pass. This question asks about how much you value the guaranteed best price offered by fare capping.

For this imaginary exercise, assume the costs cover travel in one transit fare zone, and you only travel within that zone.

If you had to choose between each of the following fare products at the prices presented, which would you choose? *(Answer each question) (options to be randomized and presented on separate screens)*

1. A) A Monthly Pass for $100 OR B) pay as you go, with fares capped at $90
2. A) A Monthly Pass for $100 OR B) pay as you go, with fares capped at $95
3. A) A Monthly Pass for $100 OR B) pay as you go, with fares capped at $100
4. A) A Monthly Pass for $100 OR B) pay as you go, with fares capped at $105
5. A) A Monthly pass for $100 OR B) pay as you go, with fares capped at $110
6. A) A Monthly pass for $100 OR B) pay as you go, with fares capped at $115
7. A) A Monthly pass for $100 OR B) pay as you go, with fares capped at $120

Section III Demographic Questions [New Screen]

You're almost done. Before you finish, please tell us a bit about yourself so we have a better understanding of who is sharing their feedback.

D1. Which age group do you belong to?

1. Younger than 14
2. 14-18
3. 19-24
4. 25-34
5. 35-44
6. 45-54
7. 55-64
8. 65-74
9. 75-84
10. 85+
11. Prefer not to say

D2. How do you describe yourself? *[single response]*

1. Male
2. Female

3. Transgender
4. Identify as _____ [open-ended]
5. Prefer not to answer

D3. What municipality do you live in?

1. Anmore
2. Belcarra
3. Bowen Island
4. Burnaby
5. Coquitlam
6. Delta (North)
7. Delta (South)
8. Tsawwassen First Nation
9. Langley (City)
10. Langley (Township)
11. Lions Bay
12. Maple Ridge
13. New Westminster
14. North Vancouver (City)
15. North Vancouver (District)
16. Port Coquitlam
17. Port Moody
18. Pitt Meadows
19. Richmond
20. Surrey
21. Vancouver/University Endowment Lands
22. West Vancouver
23. White Rock
24. Other (Specify: ___)

D4. What mode of transportation do you use most often?

1. Public transit
2. Driving alone
3. Carpooling/Car with one or more passengers
4. Walking
5. Biking
6. Motorcycle/Scooter
7. Other

D5. How often do you use the following transit services? *[structure as a grid]*

A. SkyTrain
B. Bus
C. SeaBus
D. West Coast Express
E. HandyDART

1. Every day
2. At least once a week
3. At least once a month
4. At least once a year
5. Rarely or never

D7. How did you hear about the Fare Capping Research? Please select all that apply.

1. Bus shelter advertisement
2. Buzzer blog
3. Email from an organization
4. I work for TransLink, CMBC, BCRTC, West Coast Express, Transit Police or InTransitBC
5. LCD screen at transit station
6. News media (Newspaper article, radio or television news story)
7. Newspaper advertisement
8. Print material (brochure)
9. TransLink booth in the community
10. TransLink eNewsletter
11. TransLink Listens panelist email
12. TransLink website
13. TransLink Social Media (Twitter, Facebook)
14. Word of mouth (email/heard from family, friend or colleague)
15. Online ads
16. None of the above [EXCLUSIVE]
17. Don't recall [EXCLUSIVE]

Finally, if you have further comments to TransLink related to this study and/or their fare products, please feel free to add them below.
(optional, open-ended)

Conclusion

Thank you for participating! Your responses have been recorded. We value your time and appreciate your input. You will shortly receive an email with information about the study, and what you will be invited to do. In the meantime, if you have any questions or concerns please feel free to contact [insert information about PI/RA or who to contact] or head to our **online discussion forum** [link] to ask and have your questions answered.

Thank you for your time!

Appendix B Study methodology summary

1. Aim and purpose

The aim of this study is to understand the impact that fare capping will have on transit ridership, revenue and customer perceptions in the Vancouver area. The study will inform whether implementing fare capping as a new fare product is a practical, feasible and beneficial option for TransLink and its goals of promoting sustainable transportation and social welfare.

2. Research questions and hypotheses

The following research questions (RQ) and hypotheses were formulated to address this aim.

- RQ1: Does fare capping impact transit ridership in Vancouver?
  Hypothesis: Replacing monthly passes with fare capping leads to decreased ridership.
- RQ2: Does feedback on transit usage influence ridership?
  Hypothesis: Feedback in the form of text messages and notifications will produce higher ridership.
- RQ3: What are customers' perceptions of pre-paid monthly passes versus fare capping?
  Hypothesis: Customers prefer pre-paid monthly passes compared to fare capping.

3. Variables

The independent variable will be the fare product, which will be either fare capping (experimental intervention) or monthly pass (no intervention). The dependent variable will be ridership, as measured by the number of fare journeys registered on participants' Compass Card in a given month. In addition, surveys will capture perceptions of the fare products.

4. Participants

The study will recruit participants from the transit population, and there are various segmentations that should be considered in order to determine the impact on the specific group. One option is to recruit participants from all transit users. Another options is to segment the population based on which fare product they choose and usage, into four different segments:

1) people who buy monthly passes and travel equal to or more than enough to make up for it;
2) people who use stored value almost enough to make up for a monthly pass;
3) people who buy monthly passes but do not travel equal to or more than enough to make up for it; or

4) people who overuse stored value.

English-speaking individuals who use transit in one zone only will be invited to participate. Participants can be recruited from the pool of registered Compass Card users.

5. Experimental design

An experimental study conducted over a time period of three months will examine the effect on ridership. Pre- and post-intervention surveys will examine customer perceptions. Study participants will be randomly allocated into one of three possible conditions:

1) Experimental condition: participants will use fare capping, receive information about their usage and complete pre- and post-intervention surveys;
2) Survey + usage information condition: participants will use their normal fare choice during the study period (i.e. no intervention) and receive pre- and post-intervention surveys;
3) Control condition: participants will not receive a different fare product nor surveys.

The intervention should be administered for a predetermined time period. Three months is appropriate for customers to understand their monthly usage, the costs related to transit and to make reasonable adaptations to the fare product. Fare capping will be activated on participants' Compass Cards in the experimental condition. At the end of each month, each participant will receive customized information that details how much travel was undertaken. The survey + information group will receive the same usage information, but fare capping will not be activated on their account. They will continue to use their normal products. Two surveys will be given to these groups: one before the study period and one at the end of the three months. The control group will not receive surveys or fare capping. They will continue to use their normal products, and will not receive communication that details how much travel they completed. Ridership data and survey responses will be compared in order to determine the effects of the different fare products on ridership and perceptions of fare products.

The pre-survey will be administered after participants have agreed to participate in the study and provided their consent, and before the experimental period starts. The post-survey will be administered immediately following the experimental period. The proposed survey questions are intended to probe what features of fare products are most important to customers, explore participants' perceptions of fare capping and monthly passes, understand preferences for the fare products, and how these might have changed following the experimental treatment.

6. Analysis

Ridership information from the Compass Cards will be analysed using a two-way ANOVA. This will determine if there is any difference in the number of fare journeys between the experimental groups. The data from the survey will be compared using regression. This will examine whether customers' satisfaction can be predicted from the type of fare product they use.

7. Outcomes and implications

It is anticipated that fare capping will result in less revenue overall from the experimental group. The impact on ridership is highly uncertain, though the anticipated result is less ridership from both the control and experimental groups. The potential revenue impact of fare capping is highly significant, and real-world experimental evidence will improve decision-making related to the implementation of this fare product.

8. Figure of study procedure