Enjoying the Ride:

Experience, Motivation, Satisfaction, and Loyalty in Public Transit

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ABSTRACT

The development of high-quality, equitable, and accessible public transit systems is a planning challenge that many cities recognize as being a fundamental aspect in the development of socially, environmentally, and economically sustainable communities. Accordingly, many cities and transportation agencies are aiming to develop public transit systems that are competitive with regard to speed, comfort and reliability, in order to retain and attract users to increase overall public transit usage. Nevertheless, regardless of the efforts to stimulate increases in transit mode share, current transit usage in many cities still lags behind the use of personal motorized vehicles and many transit agencies are losing ridership due to a variety of reasons. Therefore, novel strategies are needed to retain existing passengers and attract new users. Accordingly, this dissertation uses a multifaceted approach to ask fundamental questions about the drivers of customer satisfaction and loyalty among existing transit users in order to provide insight into how transit agencies and cities can motivate and increase overall transit rider retention.

While traditionally cost, time, and distance were believed to have been the most significant drivers of mode choice, in recent years, researchers have begun challenging traditional applications of utility-maximization that are solely based on these factors. Furthermore, in recent years researchers have suggested that diverse individuals react differently to cost, time and distance due to personal or societal motivations and values, factors which have historically been placed in the error term in statistical models. Recent work has shown that issues relating to personal motivation and values affect levels of satisfaction, and are accordingly associated with decision-making processes. Moreover, many researchers have begun exploring unconventional aspects of travel including the relationship between service quality, customer service expectations, and customer satisfaction.

The goal of this dissertation is to contribute to increasing satisfaction and loyalty among existing transit users. This research acknowledges the importance that users' perceptions and personal motivations have on their likeliness to be satisfied and loyal to public transit, and therefore sets out to identify what are the factors that contribute to transit users' satisfaction with and loyalty to public transit by addressing the following research objectives:

- To determine, based on an analysis of existing literature, the causes of satisfaction and loyalty in public transit, and to assess the implications that different service factors have on ridership retention.

- To identify the key market segments (and their characteristics) that transit agencies should account for when developing strategies aimed at increasing ridership retention.

- To measure the relationship between satisfaction and loyalty among different key public transit market segments, and accordingly prescribe strategies that can be implemented to increase overall ridership retention.

- To go beyond analyses of passengers' reported satisfaction by determining how data obtained from automatic vehicle location (AVL) and automatic passenger counter (APC) systems can be merged with the results of customer satisfaction surveys in order to predict overall customer satisfaction.

- To go beyond assessing clearly defined service attributes to determine whether the image that passengers have of public transit has an influence on users' satisfaction and intention to continue using the service in the future.

- To suggest, based on the findings of these studies, appropriate strategies that transit agencies can implement to increase overall ridership retention.

These research objectives are met using a multifaceted mixed-method approach, and the results are presented in seven interrelated chapters addressing fundamental questions about how transit agencies can encourage passenger loyalty by increasing satisfaction among different populations of riders. The questions build on each other, and both qualitative and quantitative research methods are used to assess the research questions presented in each of the chapters. More specifically, the first chapter frames the research presented in this dissertation in the context of urban public transit research more generally, and discusses how this research can be useful for improving current and future public transit systems. The second chapter systematically analyses the relevant literature regarding the causes of satisfaction and loyalty in public transit. Next, the third chapter uses data from two Canadian transit agencies (Montreal's Société de transport de Montréal and Vancouver's TransLink), in order to segment the transit markets in Vancouver, British Columbia, and Montreal, Quebec, and identifies the factors influencing satisfaction and loyalty among different groups. Chapter four builds directly on the results of chapter three to examine how, among the different groups identified in the previous chapter, transit users'

perceptions of service quality and user satisfaction influence loyalty. Chapter five departs from basing analyses solely on data coming from transit agencies' customer satisfaction questionnaires and analyzes the drivers of public transit satisfaction among users based on both customer satisfaction questionnaires, as well as operations data obtained from AVL/APC systems for an express bus route in Vancouver, Canada. While chapters three, four and five rely on data coming from public transit agencies to better understand the factors influencing transit users' reported satisfaction and loyalty, chapter six uses primary data collected by the author in order to explore how users' views and opinions about public transit relate to user satisfaction and future behavioural intentions.

Overall, this dissertation offers a multifaceted approach to better dissect and understand the drivers of customer satisfaction and loyalty among existing transit users, and contributes to expanding knowledge in the field of public transit research by:

- Deepening the understanding of how improvements to particular service factors and users' image of public transit influence satisfaction and loyalty among different groups of transit users, in order to develop targeted strategies that maximize overall ridership retention.

- Comprehensively reviewing and clearly redefining the concept of 'loyalty' in public transit in order to allow transit agencies and researchers to measure loyalty in a more valid and reproducible manner, i.e., the re-operationalization of the concept of 'loyalty.'

- Developing a methodology for assessing, contrasting and integrating customer satisfaction surveys (i.e., user's perception of service) with operations data (i.e., actual service), which is reproducible and implementable in many regions.

By addressing these issues, this dissertation fills important gaps in the current literature on satisfaction, loyalty, and ridership retention. Overall, the results of the research presented in this dissertation can be helpful for transit agencies aiming to develop specific strategies in order to benchmark user satisfaction and loyalty among different groups and maximize overall ridership retention. Insight into how passengers perceive transit services can be useful for helping transit agencies and cities generate better public policy as making improvements to public transit systems is one way to assist in the development of more socially, environmentally, and economically sustainable communities.

RESUMÉ

Le développement de réseaux de transport en commun de haute qualité, équitables et accessibles est un défi de taille pour le développement de communautés durables, tant du point de vue social environnemental et économique. Conséquemment, plusieurs villes et agences de transport visent à développer des réseaux de transport en commun qui soient compétitifs en termes de vitesse, de confort et de fiabilité afin de retenir et d'attirer des usagers pour augmenter l'utilisation du transport en commun. Néanmoins, malgré les efforts pour augmenter la part modale du transport en commun, l'utilisation de celui-ci reste en déclin à travers le monde. Ainsi, des stratégies innovatrices sont requises afin de retenir les usagers actuels, et d'attirer de nouveaux usagers. Dans ce contexte, cette dissertation utilise une approche à multiples facettes afin de répondre à certaines questions fondamentales à propos des moteurs de la satisfaction et de la loyauté des usagers actuels et ainsi mieux comprendre comment les villes et agences de transport peuvent supporter et augmenter la rétention des usagers.

Alors que traditionnellement, le coût, le temps et la distance étaient perçus comme les moteurs les plus importants du choix modal, les chercheurs ont commencé, dans les dernières années, à questionner les applications traditionnelles de maximisation de l'utilité se basant uniquement sur ces facteurs. De plus, les chercheurs ont souligné que différents individus réagissent différemment face au coût, au temps et à la distance étant donné leurs valeurs et motivations personnelles ou sociales. Ces dernières ont historiquement été considérées comme des termes d'erreurs dans les modèles statistiques. Par ailleurs, de récents travaux ont démontré que les enjeux liés aux valeurs et motivations personnelles affectent les niveaux de satisfaction, et par le fait même, les processus décisionnels quant aux choix de déplacements. De plus, plusieurs chercheurs ont commencé à explorer les aspects non-conventionnels des déplacements, tels que la relation entre la qualité du service, les attentes des usagers et leur satisfaction.

L'objectif de cette thèse est de contribuer à augmenter la satisfaction et la loyauté des usagers du transport en commun. Cette recherche reconnaît l'influence qu'ont les perceptions et les motivations personnelles sur la probabilité d'être satisfait et loyal envers le transport en commun, et vise donc à identifier quels facteurs contribuent à la satisfaction et à la loyauté envers le transport en commun en abordant les objectifs de recherche suivant:

- Déterminer, en se basant sur une analyse de la littérature existante, les causes de la satisfaction et de la loyauté envers le transport en commun, et évaluer les implications qu'ont différents facteurs de service envers la rétention des usagers.

- Identifier les principaux segments du marché (et leurs caractéristiques) que les agences de transport en commun devraient prendre en considération lorsqu'elles développent des stratégies visant à augmenter la rétention des usagers.

- Mesurer la relation entre la satisfaction et la loyauté parmi les différents segments du marché, et ainsi recommander des stratégies qui peuvent être implantées pour augmenter la rétention des usagers.

- Aller au-delà des analyses de satisfaction des usagers en déterminant comment les données AVL (*Automated Vehicle Location)* et APC (*Automatic Passenger Count)* peuvent être combinées avec les résultats des sondages de satisfaction des usagers pour prédire la satisfaction globale.

- Aller au-delà des facteurs de service clairement définis pour déterminer si l'image qu'ont les passagers du transport en commun a une influence sur leur satisfaction et leur intention de continuer à utiliser le service dans le futur.

- Suggérer, en se basant sur les résultats de cette étude, des stratégies appropriées que les agences de transport en commun peuvent implanter pour augmenter la rétention des usagers.

Ces objectifs de recherche sont atteints en utilisant une approche à multiples facettes, et les résultats sont présentés dans sept chapitres interconnectés abordant certaines questions fondamentales cherchant à comprendre comment les agences de transport en commun peuvent encourager la loyauté des usagers en augmentant la satisfaction des différents groupes. Des méthodes de recherches quantitatives et qualitatives sont utilisées pour répondre aux questions de recherches complémentaires présentées dans chacun des chapitres. Plus spécifiquement, le premier chapitre situe cette recherche dans la littérature scientifique liée au transport en commun en milieu urbain, et aborde la pertinence de cette recherche pour améliorer les réseaux de transport en commun actuels et futurs. Le deuxième chapitre analyse de façon systématique la littérature en lien avec les moteurs de la satisfaction et de la loyauté envers le transport en commun. Ensuite, le troisième chapitre utilise les données de deux agences de transport en commun canadiennes (la Société de transport de Montréal et TransLink à Vancouver), afin de segmenter le marché du transport en commun à Vancouver (Colombie-Britannique) et à Montréal (Québec), et d'identifier les facteurs influençant la satisfaction et la loyauté pour les différents segments du marché. Le quatrième chapitre s'appuie sur les résultats du précédent

chapitre et examine comment, parmi les différents segments identifiés, la perception de la qualité du service et la satisfaction des usagers influencent la loyauté. Le cinquième chapitre va au-delà des analyses des données des sondages de satisfaction des agences de transport et analyse les moteurs de la satisfaction des usagers à partir des données des questionnaires de satisfaction et des données d'opérations obtenues par le biais des systèmes AVL et APC pour une ligne d'autobus express de Vancouver. Alors que les chapitres 3, 4 et 5 reposent sur les données des agences de transport pour mieux comprendre les facteurs influençant la satisfaction et la loyauté, le sixième chapitre utilise les données primaires collectées par l'auteure afin d'explorer comment les perceptions et opinions des usagers par rapport au transport en commun influence leurs satisfaction et intentions futures de choix modal.

De façon générale, cette thèse offre une approche à multiples facettes afin de mieux décortiquer et comprendre les moteurs de la satisfaction et de la loyauté parmi les usagers actuels du transport en commun, et contribue au développement des connaissances dans le domaine de la recherche liée aux transports en commun en:

- Approfondissant la compréhension de l'influence spécifique des divers facteurs de service et de l'image qu'ont les usagers envers le transport en commun sur la satisfaction et la loyauté des différents groupes d'usagers, afin de développer des stratégies ciblées qui maximisent la rétention des usagers.

- En révisant et en définissant le concept de 'loyauté' dans le contexte du transport en commun afin de permettre aux agences de transport en commun et aux chercheurs de mesurer la loyauté de façon plus valide et reproductible (ré-opérationnalisation du concept de 'loyauté').

- En développant une méthodologie, reproductible et implantable dans plusieurs régions, pour évaluer, comparer et intégrer les données des sondages de satisfactions des usagers (i.e., perception du service par les usagers) avec les données d'opérations (i.e., service réel).

En abordant ces enjeux, cette thèse comble d'importantes lacunes dans la littérature existante sur la satisfaction, la loyauté et la rétention des usagers du transport en commun. De façon générale, les résultats de cette recherche peuvent être utiles pour les agences de transport visant à développer des stratégies spécifiques afin de mesurer l'atteinte d'objectifs en lien avec la satisfaction et la loyauté des différents groupes d'usagers et de maximiser la rétention des usagers. Une compréhension approfondie de la perception qu'ont les usagers des services de transport en commun peut être utile pour les villes et agences de transport désirant générer de

meilleures politiques publiques, étant donné que l'amélioration du transport en commun contribue au développement de communautés durables d'un point de vue social, environnemental et économique.

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

AUTHOR CONTRIBUTIONS

This dissertation consists of five peer-reviewed manuscripts. Three have been accepted for publication in peer-reviewed journals, and two have been peer-reviewed and accepted for presentation at an international conference; these articles are currently also under review for publication in academic journals. All of the chapters included in this dissertation are original scholarship and distinct contributions to knowledge. The manuscripts are co-authored with my supervisor, Prof. Ahmed El-Geneidy, who guided me in conceptualizing and setting the goals and objectives of the dissertation research. Prof. Madhav Badami is also a co-author as he provided me with valuable feedback on the conceptualization and objectives of the literature review chapter. Details of author contribution for every manuscript are given below:

Chapter two "What influences satisfaction and loyalty in public transport? A review of the literature" by Dea van Lierop, Madhav Badami, and Ahmed El-Geneidy. Dea van Lierop was the primary author of the manuscript. She reviewed the literature, and carried out the data analysis and writing. Prof. Badami and Prof El-Geneidy critically revised the paper, provided comments and approved the final version.

Chapter three "A new market segmentation approach: Evidence from two Canadian cities" by Dea van Lierop and Ahmed El-Geneidy. Dea van Lierop was the primary author of the manuscript. She performed all of the statistical analysis, interpretation of the results, and writing. Ahmed El-Geneidy contributed intellectually and provided comments and edits to the manuscript.

Chapter four "Enjoying loyalty: The relationship between service quality, customer satisfaction, and behavioral intentions in public transit" by Dea van Lierop and Ahmed El-Geneidy. Dea van Lierop was the primary author of the manuscript. She performed all of the statistical analysis, interpretation of the results, and writing. Ahmed El-Geneidy contributed intellectually and provided comments and edits to the manuscript.

Chapter five "Perceived reality: Understanding the relationship between customer perceptions and operational characteristics" by Dea van Lierop and Ahmed El-Geneidy. Dea van Lierop was the primary author of the manuscript. She performed all of the statistical analysis, interpretation of the results, and writing. Ahmed El-Geneidy contributed intellectually and provided comments and edits to the manuscript.

Chapter six "Public image: Determining the effects of users' image of public transit on loyalty" by Dea van Lierop and Ahmed El-Geneidy. Dea van Lierop was the primary author of the manuscript. She performed all of the statistical analysis, interpretation of the results, and writing. Ahmed El-Geneidy contributed intellectually and provided comments and edits to the manuscript.

PUBLICATION DETAILS AND PERMISSIONS

Chapter two "What influences satisfaction and loyalty in public transport? A review of the literature" has been re-submitted for review at *Transport Reviews* (Taylor & Francis Group), and has been presented at the *96th Annual Meeting of the Transportation Research Board*, which will be held in Washington, D.C. from January 8th-12th 2017.

Chapter three "A new market segmentation approach: Evidence from two Canadian cities" is published in the *Journal of Public Transportation*, Volume 20.1: 20-43, 2017 and is included with permission of the National Center for Transit Research. Available at:

http://scholarcommons.usf.edu/jpt/vol20/iss1/2

Chapter four "Enjoying loyalty: The relationship between service quality, customer satisfaction, and behavioral intentions in public transit" is published in the journal of *Research in Transportation Economics*, Volume 1.10, 2016 with permission from Elsevier.

Chapter five "Perceived reality: Understanding the relationship between customer perceptions and operational characteristics" has been accepted for publication in the *Transportation Research Record: Journal of the Transportation Research Board*.

Chapter six "Public image: Determining the effects of users' image of public transit on loyalty" is currently under review at *Transportation* (Springer), and has been presented at the *96th Annual Meeting of the Transportation Research Board*, which will be held in Washington, D.C. from January 8th-12th 2017.

DISCLAIMER

While the research and analysis included in Chapters three, four, and five of this dissertation are based on data obtained from two large public transit agencies in Canada: Montreal's Société de transport de Montréal (STM) and Vancouver's TransLink under a data sharing agreement to be used in academic research, the opinions expressed in this dissertation do not represent the views of these agencies.

1 CHAPTER ONE: DISSERTATION INTRODUCTION AND OBJECTIVES

1.1 OVERVIEW OF INTRODUCTORY CHAPTER

This dissertation uses a multifaceted approach to ask fundamental questions about the drivers of customer satisfaction and loyalty among existing transit users. The studies included in this dissertation focus on providing insight into how transit agencies and cities can motivate and increase overall transit rider retention. Using both primary and secondary data, it carefully and critically assesses which factors contribute to transit users being satisfied and loyal to the mode. Chapter 1 frames this dissertation in the context of urban public transit research more generally, and discusses how this research can be useful for improving current and future public transit systems. This chapter also offers a brief overview of the definitions of satisfaction, loyalty and ridership retention, and discusses how these concepts are used in public transit research. After introducing these topics, the gaps in the knowledge that this dissertation aims to address are identified, as are the goals and objectives of this doctoral research. This introductory chapter concludes with a detailed description of the subsequent chapters.

1.2 URBAN PUBLIC TRANSIT

Urban public transit influences city dwellers' quality of life. The development of high-quality, equitable, and accessible public transit systems is a planning challenge that many cities recognize as being a fundamental aspect in the development of socially, environmentally, and economically sustainable communities. Accordingly, developing transit systems that are competitive with regard to speed, comfort and reliability, is a popular and practiced strategy to attract existing and potential users to the mode (Cervero 2013). Nevertheless, regardless of the efforts to stimulate increased transit mode share, in many cities current transit usage still lags behind the use of personal vehicles (Statistics Canada 2014). In addition, transit usage has decreased globally over

the last century (Garrison and Levinson 2006, Vuchic 2007), and therefore, in order to promote the use of transit in the development of sustainable urban environments, novel strategies are needed to attract people to use the mode.

1.2.1 Public transit from the past to the present

To assess public transit ridership trends today, and to understand how public transit influences the overall social, environmental, and economic sustainability of cities, it is important to provide a brief overview of its evolution. Public transit systems have been an important element influencing the well-being of city-dwellers' lives for nearly 200 years, and changes in how individuals have moved through cities have always been closely linked to technological advancements. The presence of intra-urban public transit technologies first emerged in cities in the form of horse-drawn omnibuses in the early nineteenth century in many European and American cities (Vuchic 2007). Over the course of the century, technologically improved steam locomotives and cable cars were used to replace horsepower in urban areas until the invention of the first electric railway in the late nineteenth century (Vuchic 2007). Soon after, once electrification was popularized throughout Europe and the United States, this innovative technology promoted an expansion of transit infrastructure, and led as well to the introduction of electrically run trains on existing commuter train networks (Garrison and Levinson 2006). By the beginning of the twentieth century, tramway technologies and vehicle design improved, allowing public transit to service more areas in cities and suburbs, and therefore also become more popular (Vuchic 2007, Neff and Dickens 2013).

However, this communal way of moving through urban areas changed in the 1920s and early 1930s, when the invention of the private automobile presented a new way of moving around the city. The competition between modes significantly decreased public transit ridership,

and the popularity of the automobile increased traffic congestion, road accidents and pollution in cities. Furthermore, these two modes were not compatible to share roads as the overwhelming presence of automobiles significantly slowed down the tramways (Vuchic 2007). Buses, however, could move through the congested streets more freely, and did not require expensive rail maintenance (Vuchic 2007). Public policies encouraging the replacement of tramways with buses quickly gained popularity in many cities (Garrison and Levinson 2006). Motorized vehicles such as automobiles and buses were seen as being modern and the auto and oil industries successfully weakened the image of public transit which eventually decreased transit ridership during the 1950s and 1960s, first in North America, and eventually also in other places (Black 2006). In many cities throughout the world, transit ridership continued to decrease as the mode share of private vehicles rose. However, the beginning of the twenty-first century saw a brief reversal of this trend; yet, transit usage today has stabilized, and in some regions actually begun to decline once again (Polzin and Chu 2005, Curry 2016). For example, in the United States overall public transit ridership has ceased to increase (Polzin and Chu 2005). In Canada, while governmental efforts to stimulate transit ridership resulted in increases in the use of public transit in the early 2000s' (Statistics Canada 2014), transit usage in many cities has recently begun to decline, or continues to fluctuate without clear growth (TransLink 2014, Curry 2016). For example, in Montreal, ridership peaked in 2013, and in Vancouver ridership has fluctuated in recent years (Curry 2016). While the post-recession economy of the 2010s has been linked to increases in overall vehicle miles travelled (VMT) (United States Department of Energy 2016), the rise of car-sharing and ride-sharing services may also be influencing decreases in public transit usage in the twenty-first century (Chan and Shaheen 2012).

Overall, transit mode share is strongly associated with the availability of different mobility options, and advances in technology and technical innovations clearly play a role in how people travel in cities. Therefore, it is important to recognize that as new transportation technologies are developed and introduced onto city streets, there is a strong need to promote sustainable modes that will consistently improve city dwellers' overall well-being in both the short- and long-term.

1.2.2 Public transit in the future

Today, innovations in transportation technologies are continuing to influence the development of cities and how people move through them. In recent years researchers have acknowledged that mode choice can have an impact on commuters' health (Sallis, Frank et al. 2004, Jacobson, King et al. 2011, Wasfi, Ross et al. 2013), and city planners and policy makers have developed significant efforts to promote the use of sustainable modes such as walking, bicycle, and transit (Cervero, Ferrell et al. 2002, Ogilvie, Egan et al. 2004). City planners, policy makers, and transportation professionals face the important challenge of planning for multi-modal cities that will allow for the successful integration of one of the early twenty-first century's most revolutionary technological innovations: automated vehicles (AVs). More specifically, policy makers are facing a new challenge of setting the framework in which AVs will interact with existing and future urban systems (Fagnant and Kockelman 2015, Guerra 2015, Miller and Heard 2016), and deciding how public transit and active modes can best be used in combination with new automated technologies. Moreover, while much research has focused on the introduction of AVs in the form of private vehicles (Fagnant and Kockelman 2015), and freight (Kunze, Ramakers et al. 2009), AV technology will likely also be integrated and applied to public transportation systems.

It is not yet clear what the various adaptations of AV technologies will mean for cities. For example, while the introduction of personal AVs, or shareable AV fleets, on city streets could generate potential competition for public transit, others could help deploy transit where service is currently low. Several researchers have predicted that the presence of AVs will increase overall mobility, accessibility, and overall VMT (Anderson, Nidhi et al. 2014, Fagnant and Kockelman 2015). Others have claimed that AVs will improve urban areas by reducing the amount of space reserved for parking, and predicted environmental benefits due to reductions in greenhouse gases and smog (Bridges 2015). In addition, economic benefits have also been predicted to be a major benefit of the integration of AVs (Sullivan 2015). Overall, the presence of AVs is expected to have an enormous social, environmental, and health impacts on cities, but the specificities of these expected effects remain largely unknown. Therefore, while there are many positive changes expected to result from the presence and integration of AVs on city streets, there may also be negative consequences. For example, if the integration of AVs does result in more cars on the road and higher VMT, the overall social well-being and health of city dwellers could be negatively influenced due to potential equity issues as well as decreases in daily physical activity. Higher VMT would also be a result of vehicles moving around the city empty, after dropping off passengers at a given destination. Accordingly, the presence of empty vehicles on roads could increase overall congestion in cities (Levinson and Krizek 2015).

The impact that AVs will have on cities largely depends on how city planners and transportation professionals prepare for the integration of these vehicles into existing and future urban systems. Since increases in VMT, social inequity, and sedentary lifestyles are possible negative consequences of the wide-scale presence of AVs, cities and public transit agencies must carefully plan how AVs can be well-integrated with the use of other modes (including public

transit), in order to plan for an accessible and multi-modal future. Moreover, the integration of transportation networks that include AVs, public transit, and active modes is essential for the development of healthy cities. Future cities with mode shares distributed between AVs, public transit, cycling and walking are not only likely to see reductions in VMTs, but also to experience increases in the health of populations, as researchers have found that it is possible to achieve the recommended daily physical activity levels through commuting by public transit due to walking to and from transit stations (Wasfi, Ross et al. 2013). However, in order for cities to benefit from the integration of AVs, it is also important to simultaneously ensure the attractiveness and use of public transit and active modes. Therefore, it is essential for cities and public transit agencies to develop strategies that encourage transit ridership both today and in the future era of AVs (Levinson and Krizek 2015). Strategies need to be developed which motivate transit usage so that competition between AVs and public transit will not result in non-drivers shifting from public transit to personalized AVs. Accordingly, new strategies should focus on motivating satisfaction and loyalty among transit users and on ensuring that transit is viewed as a desirable mode in order to retain existing users and attract new users both today and in the future.

Public transit will be especially important along major corridors, as well-planned transit can be competitive with regard to cost and time-savings (Vuchic 2002). Accordingly, if transit along major corridors is developed as both a viable and desirable mode, then it will become possible for cities to encourage the use of active modes to reach transit stops and stations so that active modes, AVs, and public transit can conveniently be used in combination. Therefore, to develop effective policies and plans for the future of integrated transportation, it is essential for cities and public transit agencies to better understand what motivates individuals to choose

public transit, and strategically develop policies according to the needs and desires of (potential) public transit users.

Increases in transit mode share both today and in the future will result from attracting new users, as well as from motivating loyalty and the continued usage of current users. Accordingly, transit agencies and city officials must assess how to attract potential users and, among current users, evaluate who is using transit and how the motivations and experiences of different user groups affect transit use and overall satisfaction. Furthermore, it is necessary for transit agencies to understand how transit users' personal opinions and perceived levels of satisfaction with transit are associated with passengers' future mode choice, in order to motivate loyalty to public transit and avoid a mass shift towards the use of single-occupied AVs. Understanding the impacts of transit users' satisfaction while taking into account service characteristics is essential to developing transit systems that are built based on loyalty rather than necessity. This approach can be helpful in creating better policies that can promote transit as a preferred mode across the socio-economic spectrum both today and in the future of AV dominated urban areas. Planning for multi-modal systems that are well-integrated into their urban environments and have the flexibility to adapt to new technologies is essential for the positive social, environmental, and economic development of future of cities.

1.3 A NEW FOCUS: CUSTOMER SATISFACTION AND LOYALTY

Traditionally cost, time, and distance were believed to have been the most significant drivers of behaviour in the selection of an individual's transportation mode (Button 2010). Additionally, these tangible, or objective, trip characteristics were also typically considered key determinants of commuter satisfaction (Turcotte 2011). Yet, in recent years, researchers have begun challenging traditional applications of utility-maximization that are solely based on these factors.

The reasons diverse individuals react differently to cost, time and distance may be related to personal or societal motivations and values, factors which have historically been placed in the error term in statistical models (Bohte, Maat et al. 2009). However, recent work has shown that issues relating to personal motivation and values affect levels of satisfaction and accordingly influence decision-making processes (Gountas and Gountas 2007). In addition, many researchers have begun exploring non-utilitarian aspects of travel including the relationship between service quality, customer service expectations, and customer satisfaction (Ory and Mokhtarian 2005, Tyrinopoulos and Antoniou 2008, Eboli and Mazzulla 2009, Eboli and Mazzulla 2010, Páez and Whalen 2010, Chen and Chao 2011). These studies have principally focused on the perception of transit service, while accounting for variables such as age, gender, or work status. They often concentrate primarily on understanding user satisfaction with no consideration for personal motivations or values. Research on satisfaction is important for the economic well-being of transit agencies, and many studies have shown that a customers' level of satisfaction with a service influences their behavioural intentions, or loyalty to a mode (Fornell, Johnson et al. 1996, Abou-Zeid, Witter et al. 2012).

One example of altering the traditional approach taken towards understanding trip satisfaction is a study by Ory and Mokhtarian (2005) which questioned whether commuters always seek to minimize travel time and other associated costs. They found that trip practicality is not necessarily the primary factor explaining satisfaction, but that subjective factors specific to an individual commuter may also have an effect on overall trip satisfaction. Páez & Whalen's (2010) research yielded similar results, showing that trip satisfaction did not have the expected relationship with external factors such as the travel time associated with the mode. Findings from these studies demonstrate that trip satisfaction with a mode is based on aspects beyond simply

cost, time, and distance, and that other factors such as personal characteristics, behaviour, and preferences should be considered when analyzing transit users' satisfaction. Other researchers have also begun to accept that non-mode specific factors are associated with trip satisfaction. For example, van Acker, van Wee et al. (2010) make clear that basic socio-demographic features must be considered. Additionally, a recent study by St-Louis, Manaugh et al. (2014) shows that trip characteristics, personal characteristics, time, travel preferences and mode preferences are determinants of trip satisfaction that influence specific modes differently.

As previous research has suggested that satisfaction increases loyalty, the research presented in this dissertation sets out to assess how to increase transit users' levels of satisfaction. Furthermore, because trip satisfaction is based not only on passengers' perceptions of trip and mode characteristics, but also on individuals' experiences with transit, socio-demographic information, personality characteristics, and travel and mode preferences, research on customer satisfaction and loyalty is more likely to be effective if these attributes are taken into account. Therefore, both customers' perceived values and levels of satisfaction should be analyzed as users' perceptions of service quality are positively related to satisfaction (Jen and Hu 2003, Petrick 2004, Chen 2008), and strongly influence consumer loyalty and behaviour (Olsen 2007). Consequently, transit agencies aiming to understand how to increase overall ridership retention should analyze users' intentions, perceived values and levels of satisfaction (Joewono, San Santoso et al. 2012).

1.4 DEFINING SATISFACTION, LOYALTY, AND RIDERSHIP RETENTION

1.4.1 Satisfaction

According to the Merriam-Webster dictionary the word "satisfy" means "*to cause (someone) to be happy or pleased*" or "*to provide, do, or have what is required by (someone or something)*"

(2016). In the context of public transportation the concept of satisfaction with travel originated from customer satisfaction research, which has been a popular field of study in domains such as marketing (Fornell, Johnson et al. 1996). Trip satisfaction is a type of customer satisfaction, which often results from the service offered (in this case, the trip and mode characteristics), but also from the transit user's experience with the service, which varies depending on an individual's attitudes, personality, and predispositions (Friman and Fellesson 2009).

The importance of understanding what influences customer satisfaction stems from the fact that it is an indicator of a person's intention to continue using a service, to increase spending, or to promote the service through word of mouth (Dixon, Freeman et al. 2010). This concept is not specific to transportation planning, but can be applied to transport markets to understand the role of customer satisfaction in the pursuance of promoting public transit. An individual's reported customer satisfaction indicates how a customer's overall experience with a service compares to his or her pre-defined expectations (Morfoulaki, Tyrinopoulos et al. 2010). According to Hayes (1997), customer satisfaction can be understood by summarizing observations of a customer's actions that are a consequence of using a product or service. As customer satisfaction increases, so does customer loyalty, meaning that customers are more likely to continue using a service, and also recommend the service to others. Therefore, when a customer is both satisfied with, and loyal to a service, the agency providing the service tends to be positively affected (Loveman 1998, Rigby and Ledingham 2004, Heskett, Jones et al. 2008).

1.4.2 Loyalty

The dictionary definition of "loyal" is "*having or showing complete and constant support for someone or something*" (2016). Transit market researchers often use Oliver's (1999) definition, which similarly describes loyalty as "*a deeply held commitment to rebuy or repatronize a*

preferred product/service consistently in the future." Loyalty is an important focus for many transit agencies as, ultimately, the goal for transit agencies is to increase mode share through rider retention.

In transportation research, the concept of loyalty has been gaining attention since the Transportation Research Board's (TRB) Transit Cooperative Research Program (TCRP) report on customer satisfaction suggests that transit agencies should analyze satisfaction and loyalty as a way to understand what makes a secure customer. To do this, the report suggested a method for defining who is a secure customer that includes combining individuals' scores based on their levels of satisfaction, likeliness to repeat, and likeliness to recommend (Transportation Research Board 1999). The TCRP report suggested that one way to assess an impact score is by developing a "Secure Customer Index" that aims to understand both customer satisfaction and loyalty by comparing how many customers are negatively influenced by particular attributes (see Figure 1). Accordingly, as is shown in Figure 1, a secure, or loyal, customer is defined as a transit user who is very satisfied, who would definitely repeat using the service, and who would definitely recommend the service to others (Transportation Research Board 1999). More recently, there have been several researchers who have presented ideas about the drivers of loyalty among public transit users (Minser and Webb 2010, Li, Xiong et al. 2013, Carreira, Patrício et al. 2014, Chou, Lu et al. 2014, Zhao, Webb et al. 2014, Shiftan, Barlach et al. 2015, van Lierop and El-Geneidy 2016). One example, is a paper by Lai and Chen (2011) in which the authors reiterate the importance of understanding loyalty in the context of transportation by stating that, "*by better understanding the passenger behavior marketers and managers of transit systems will be better equipped to develop more appropriate marketing strategies and tailor their products and services to attract new passengers, as well as retain existing ones*." Chapter 2

of this dissertation will provide a detailed discussion about how present-day researchers define and use the concept of loyalty in transport research.
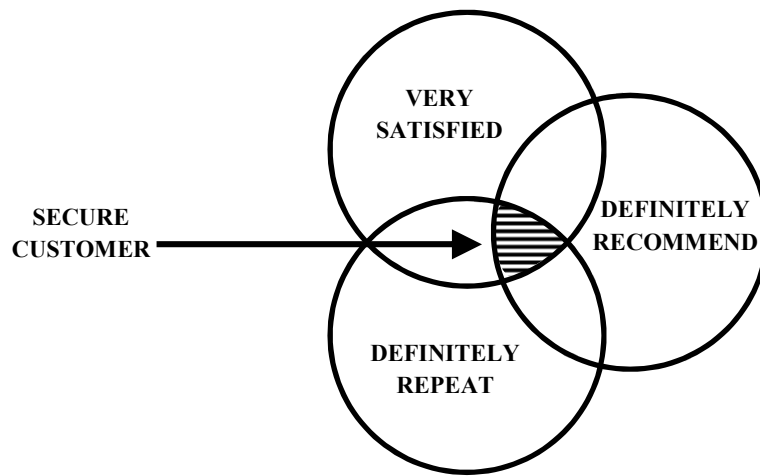
Figure 1: Secure Customer Index from TCRP report 47 (Transportation Research Board 1999)

1.4.3 Ridership retention

Figure 1 suggests that transit users who are highly satisfied, willing to repeat, and would recommend the service to others can be considered secure customers. Furthermore, accordingly to the Transportation Research Board (1999) secure customers are positively associated with transit ridership retention, which is defined as the continuation of current transit riders' use of the system.

Although many people go through periods in their lives when they take public transit regularly, the primary reasons for transit users to stop using the system is because they gain access to a car, change the location of their job or home (sometimes associated with changes in family size), or are dissatisfied with the transit service (Perk, Flynn et al. 2008). Service interruptions such as strikes and breakdowns have also been related to mode shifts away from transit (Van Exel and Rietveld 2009, Pnevmatikou, Karlaftis et al. 2015), making ridership retention a difficult feat for transit agencies. On the other hand, because at any given time there

are always people entering different lifecycle phases, new riders will always make up a proportion of transit markets (Barlow and Clark 2006). Therefore, Perk, Flynn et al. (2008) state that "*because even a small reduction in turnover would add significantly to the growth of the transit market, strategies designed to increase ridership should focus as much on retaining current riders as on attracting new ones*." This dissertation, hence, focuses on understanding how to increase overall satisfaction and loyalty as these concepts are key motivators of ridership retention (Perk, Flynn et al. 2008, Lai and Chen 2011, van Lierop and El-Geneidy 2016).

1.5 GAPS IN THE KNOWLEDGE

The discussion above has brought attention to important gaps in the literature concerning transit users' satisfaction, loyalty, and ridership retention. The first gap is the lack in clarity regarding the term 'loyalty.' Accordingly, this dissertation represents a framework to comprehensively review and clearly redefine the concept of 'loyalty' in public transit to allow transit agencies and researchers to measure loyalty in a more valid and reproducible manner, i.e., the re-operationalization of the concept of 'loyalty.' Furthermore, the research sets out to clearly discuss and identify the relationships between users' satisfaction with various service attributes, overall satisfaction, loyalty and ridership retention as there is a gap in the research regarding the association between these concepts – especially in the Canadian context. Furthermore, while the factors influencing satisfaction have been identified in various studies (Tyrinopoulos and Antoniou 2008, Eboli and Mazzulla 2009, Githui, Okamura et al. 2010, Das, Ladin et al. 2013), there is a gap in the literature regarding how satisfaction can best be assessed among different groups of transit users. Accordingly, this dissertation considers that satisfaction with service attributes may differ across transit market segments, and therefore fills this gap in the literature by developing a generalizable framework for segmenting transit markets.

In addition, existing research has assessed transit systems by analysing either customer satisfaction surveys or operations data in isolation, and there has been limited research conducted to develop strategies to analyse these two data sources together. Therefore, this dissertation fills an important methodological gap in the literature by developing a methodology for assessing, contrasting and integrating customer satisfaction surveys (i.e., user's perception of service) with operations data (i.e., actual service) that is both useful for transit agencies and researchers as it is reproducible and implementable in many regions.

Finally, because very little is known about whether the image that passengers have of public transit is related to users' satisfaction and intentions to continue using the service in the future, this dissertation assesses the relationships between image, satisfaction, and future usage of transit users. Overall, this dissertation addresses several gaps in the literature by using both primary and secondary data and testing research hypotheses in the Canadian context. The gaps in the literature are specifically addressed by the research goals, questions, and objectives discussed below.

1.6 RESEARCH GOALS AND OBJECTIVES

My PhD research aims to develop a multifaceted approach to better dissect and understand the drivers of customer satisfaction and loyalty among existing transit users.

My **policy goal** is: *To contribute to increasing satisfaction and loyalty among transit users*. This goal can be achieved by answering the following **overarching research question**: *What are the factors that contribute to transit users' satisfaction with and loyalty to the mode?*

My dissertation aims to contribute and expand knowledge in my field by addressing the following research objectives:

- To determine, based on an analysis of existing literature, the causes of satisfaction and loyalty in public transit, and to assess the implications that different service factors have on ridership retention.

- To identify the key market segments (and their characteristics) that transit agencies should account for when developing strategies aimed at increasing ridership retention.

- To measure the relationship between satisfaction and loyalty among different key public transit market segments, and accordingly prescribe strategies that can be implemented to increase overall ridership retention.

- To go beyond analyses of passengers' reported satisfaction by determining how data obtained from automatic vehicle location (AVL) and automatic passenger counter (APC) systems can be merged with the results of customer satisfaction surveys to predict overall customer satisfaction.

- To go beyond assessing clearly defined service attributes to determine whether the image that passengers have of public transit influence users' satisfaction and intention to continue using the service in the future.

- To suggest, based on the findings of these studies, appropriate strategies that transit agencies can implement to increase overall ridership retention.

Figure 2 illustrates the structure of the dissertation and the relationship between various

research questions that are derived from the objectives that are listed above.
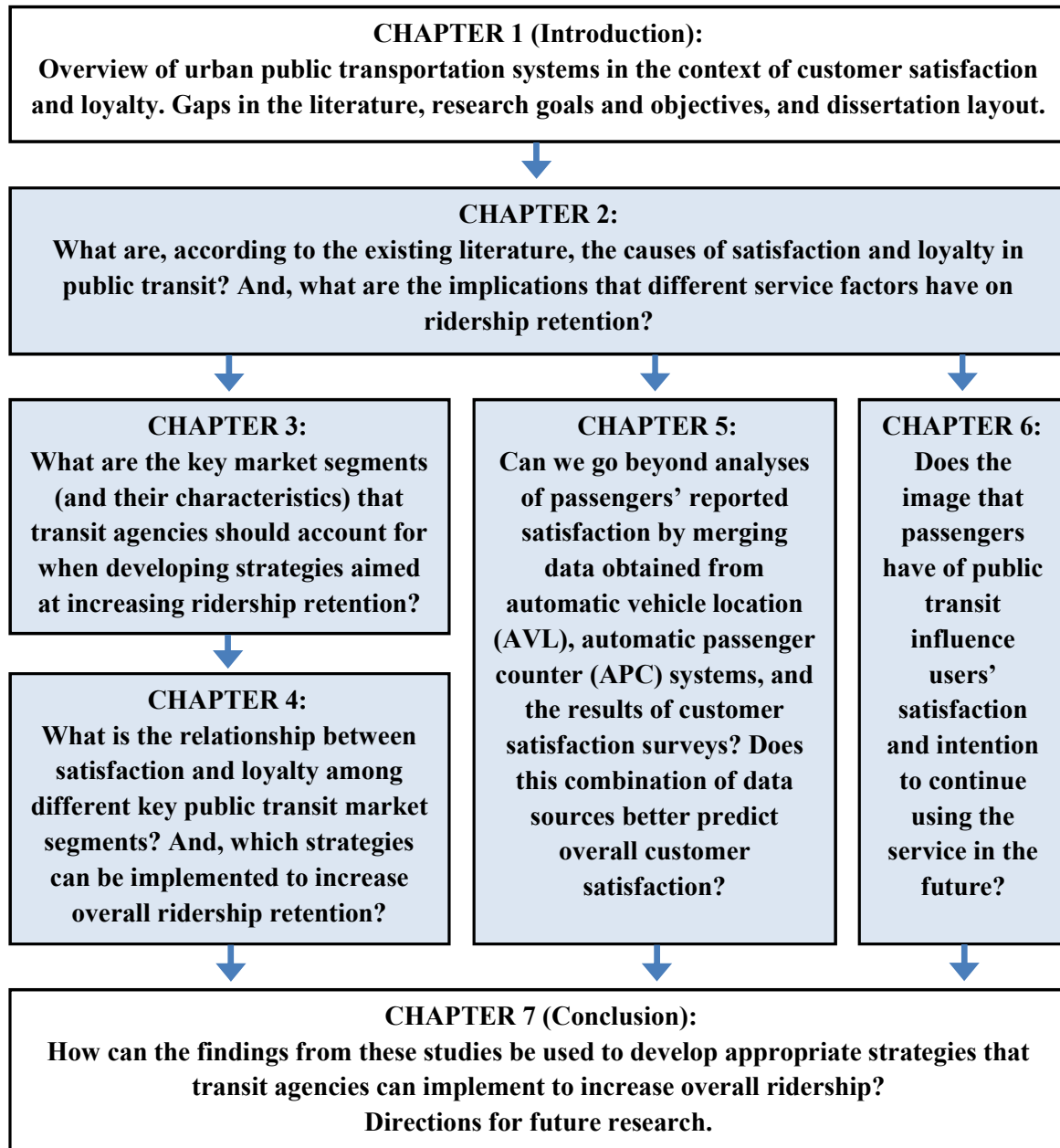
Figure 2: Schematic diagram of workflow and conceptual links

1.7 DISSERTATION STRUCTURE AND OVERVIEW OF CHAPTERS

This doctoral thesis is structured according to McGill University's guidelines for a manuscript-based dissertation. It is comprised of five manuscripts that address the research objectives and questions outlined in the previous section, and each chapter includes a brief overview of the research prior to the manuscript text. Accordingly, each chapter includes a separate introduction, literature review, methodological section, analysis, and conclusion. Limitations and future research are also discussed within the context of each of the chapters. Chapter 7 contextualizes the results of the research within the broader research objectives, and provides insight into how the results of this dissertation can be used by transit agencies seeking to increase ridership retention. This dissertation concludes with a discussion of the contributions to knowledge and directions for future research. It should be noted that throughout this dissertation the terms "public transport" and "public transit" are used interchangeably.

Each chapter is briefly outlined below:

- **Chapter two** systematically analyses the relevant literature regarding the causes of satisfaction and loyalty in public transport. The findings suggest that the service factors most influencing overall satisfaction are on-board cleanliness, comfort, safety, courteous and helpful behaviour from the public transport agencies' personnel, as well as the punctuality and frequency of service. On the other hand, loyalty is associated with users' perceptions of value for money, on-board safety and cleanliness, interactions with personnel and the image and commitment to public transport that the user feels. Furthermore, the results of this review elucidate that the concept of loyalty is best defined based on a user's intention to continue using the service, willingness to recommend it to others,

17

overall satisfaction, but also and most importantly, a user's image of and involvement with public transport. Public transport users who have a positive image of the agency and consider public transport an integral component of a city dweller's daily life are more likely to demonstrate loyalty and act like ambassadors for public transport agencies as they will recommend the service to others.

- **Chapter three** begins by reviewing the established literature on captive and choice riders, in order to suggest that market analyses that depend on such broad categories are likely to overlook important details about the needs and desires of their customer base. The chapter provides a framework to better understand the complexities of the different groups who take transit by using information from five years of customer satisfaction questionnaires collected by two Canadian transit providers. Employing a series of clustering techniques, the analysis reveals that nine market segments are present across different modes in both transit agencies. Three different overarching groups of transit users are identified based on income and vehicle access: choice users (~69%), captive users (~18%), and captive by choice users (~13%). The groups are consistent across transit modes and in different geographical regions, and are generalizable enough to be widely applicable as a conceptual framework for segmenting and understanding public transit users.

- **Chapter four** examines how transit users' perceptions of service quality and user satisfaction influence loyalty. Using information from five years of customer satisfaction questionnaires collected by two Canadian transit providers, this study attempts to better understand the complexities of several factors influencing passenger satisfaction and behavioural intentions. It uses a Structural Equation Modelling approach to develop a series of models that reflects the different groups using transit; captive riders (users who are dependent on transit), choice riders (car owners who choose to take transit), and captive-by-choice riders (users who are dependent on transit but could own a car) are accounted for. The findings from this study are used to define areas where transit agencies can develop specific strategies in order to benchmark user satisfaction with the aim of growing patronage among the different groups. Insight into the perceptions of passengers provides useful information that can help transit agencies understand what inspires customers' perceptions of satisfaction and loyalty in general.

- **Chapter five** begins by explaining that, traditionally, transit agencies have assessed customer satisfaction using questionnaires designed to collect information about users' personal characteristics and perceptions of service. However, these questionnaires only assess individuals' perceptions of transit services, without accounting for the service that users actually experienced. With this in mind, the purpose of this chapter is to analyze the drivers of public transit satisfaction among users based on an analysis of customer satisfaction questionnaires, as well as operations data obtained from AVL/APC systems for an

express bus route in Vancouver, Canada. It provides a framework to identify the main factors influencing customer satisfaction, and question whether using operations data in parallel with passengers' perception data is useful to understand customer satisfaction. Using a series of logit models we find that both actual crowding and users' reported satisfaction with crowding are associated with how transit users perceive overall satisfaction with the bus service. Furthermore, the models reveal that car access, age, past use, and users' perceptions of frequency, on-board safety, and cleanliness are also related to overall satisfaction. This study could be useful for public transit planners as it provides new insights into how data derived from customer satisfaction surveys and bus operations can be used to identify which modifiable components of the service can be prioritized in order to effectively increase riders' overall satisfaction.

- **Chapter six** explores the relationship between users' views and opinions about public transit and future behavioural intentions. Based on an analysis of survey data collected along a bus route in Montreal, Canada, this chapter assesses whether users' image of public transit is associated with their satisfaction and intention to continue using public transit in the future. Two binary logit models are developed and the results reveal that having a positive image of transit increases users' odds of being satisfied and of intending to continue using transit in the future. Furthermore, results suggest that previous transit usage is a good indicator of intended future usage. This chapter also explores whether users' image of transit should be considered when assessing loyalty. The findings of this

chapter suggest that loyalty constructs in public transit research should be composed of users' image of public transit, their overall satisfaction with a particular service, and passengers' intentions to continue using the service in the future. Overall, the results of this chapter are useful for researchers and transit agencies aiming to better understand and increase loyalty among current and future public transit users.

- **Chapter seven** contextualizes the results of chapters two to six within the broader research objectives that were presented in Chapter one, and provides insight into how the results of this dissertation can be used by transit agencies seeking to increase ridership retention. Finally, the dissertation concludes with a discussion on areas for future research.

2 CHAPTER TWO: WHAT INFLUENCES SATISFACTION AND LOYALTY IN PUBLIC TRANSPORT? A REVIEW OF THE LITERATURE

2.1 OVERVIEW OF CHAPTER

Public transport ridership retention is a continuous challenge for cities around the world. In order to develop comprehensive strategies aimed at retaining riders, it is necessary to understand the aspects of public transport that influence users to become loyal to the system. This chapter systematically analyses relevant literature regarding the causes of satisfaction and loyalty in public transport. We find that the service factors most influencing overall satisfaction are on-board cleanliness and comfort, courteous and helpful behaviour from public transport agencies' personnel, safety, as well as punctuality and frequency of service. On the other hand, loyalty is associated with users' perceptions of value for money, on-board safety and cleanliness, interactions with personnel and the image and commitment to public transport that the user feels. Furthermore, the results of this review elucidate that the concept of loyalty is best defined based on a user's intention to continue using the service, willingness to recommend it to others, overall satisfaction, but also and most importantly, a user's image of and involvement with public transport. Public transport users who have a positive image of the agency and consider public transport an integral component of a city dweller's daily life are more likely to demonstrate loyalty and act like ambassadors for public transport agencies. Finally, it should be noted that this chapter provides the theoretical base on which the following chapters in this dissertation are built.

This chapter has been accepted for presentation at the 96th Annual Meeting of the Transportation Research Board, which will be held in Washington, D.C. from January 8th-12th 2017.

2.2 INTRODUCTION

Public transport is a service that many cities recognize as being an important aspect in the development of socially, environmentally, and economically sustainable communities. However, current public transport usage is still much lower than automobile usage in many regions around the world, and thus, novel strategies need to be developed to promote the use of this sustainable mode. One way to increase public transport mode share is to face the continuous challenge of retaining current users while at the same time attracting new ones. Although many people go through periods in their lives when they use public transport regularly, common reasons for public transport users to stop using the system include becoming dissatisfied with the service, gaining access to a car, or changing the location of their job or home which is sometimes associated with changes in family size (Perk, Flynn et al. 2008). One example of a study that illustrates the effects that lifecycle changes have on mode shift away from public transport is a cohort analysis of public transport users in Montreal, Canada, by Grimsrud and El-Geneidy (2014). This study not only found that public transport use decreases with age, but also that cohorts which have higher usage in their youth tend to decrease their public transport mode share less than cohorts that rely more on other modes when they are young. These findings are rather insightful and useful, as they suggest that lasting ridership via sustained loyalty could be stimulated through the implementation of policies that address the changing mobility needs of public transport users as they proceed through lifecycle changes. In addition, new riders will also always make up a proportion of public transport markets (Barlow and Clark 2006), and efforts should be made to attract and retain this group as well. Therefore, Perk, Flynn et al. (2008) state that *"because even a small reduction in turnover would add significantly to the growth of the*

transit market, strategies designed to increase ridership should focus as much on retaining current riders as on attracting new ones."

In order for practitioners and policy makers to develop comprehensive strategies aimed at retaining riders, it is necessary to understand and identify which aspects of public transport influence satisfaction and loyalty (Fornell, Johnson et al. 1996, Friman and Fellesson 2009). In this context, the purpose of this chapter is to review studies that provide insight into the causes of satisfaction and loyalty in public transport with the goal of identifying key strategies that can be implemented to increase ridership retention.

First, to clarify the distinction between satisfaction and loyalty we discuss how these concepts have been defined and used in previous literature. Second, we describe the methodology that is used to select the relevant literature that is reviewed. Next, based on the review of the literature, we discuss and analyse which service factors we find to be the most important with regard to both satisfaction and loyalty. We discuss recommendations for increasing satisfaction and loyalty throughout the text, and recognize that strategies influencing satisfaction tend to address trip specific issues, and those motivating loyalty often address larger, agency-wide issues. Finally, we provide suggestions for further research.

2.2.1 Defining Satisfaction and Loyalty

Customer satisfaction in public transport has been studied since the mid-1960s (Transportation Research Board 1999, Transportation Research Board 2002), and since the 1990s, the application of marketing techniques has provided transportation researchers with a tool to study satisfaction with respect to travel (Fornell, Johnson et al. 1996). The concept of satisfaction with travel has therefore been well-established over time, and frequently discussed and used in the literature. More recently, since the beginning of the twenty-first century a number of studies have focused

on aiming to understand what drives satisfaction compared to loyalty, and it has become important to understand the differences between these two commonly-used terms.

In the context of public transport, satisfaction is defined as a customer's overall experience with a service compared to his or her pre-defined expectations (Morfoulaki, Tyrinopoulos et al. 2010), and loyalty as a customer's intention to use the service in the future based on previous experiences (Transportation Research Board 1999). Although it is possible to measure satisfaction without considering loyalty (Stuart, Mednick et al. 2000, Tyrinopoulos and Antoniou 2008), the results of recent studies suggest that the reverse would be theoretically illogical as satisfaction tends to influence loyalty (Chou and Kim 2009, Lai and Chen 2011, van Lierop and El-Geneidy 2016). In addition, the concept of satisfaction is well-established in the literature and it may relate to one specific component of the overall transport service, a combination of components, or the overall service as a composite. Loyalty, however, is more complex to define, and debate exists about how this concept should be measured.

2.2.2 The loyalty debate

The concept of loyalty is not well defined in the transport literature, and due to the fact that it is a more recent topic of study, researchers have not yet agreed on how to measure it. While some researchers claim that satisfaction should be included in the definition of loyalty, others claim that it should not. For example, several authors have suggested that public transport users who (1) are satisfied overall, but also (2) have the intention of continuing to use public transport, and (3) are willing to recommend the service to others, will demonstrate behavioural and emotional loyalty towards public transport (Transportation Research Board 1999, Allen and Allen 2004, van Lierop and El-Geneidy 2016). However, although these three aspects are important in generating loyal customers overall, most authors make the claim that overall customer

satisfaction strongly influences customer loyalty rather than being a part of the loyalty construct itself, and therefore should not be included in the definition (Bloemer, De Ruyter et al. 1998, Oliver 1999, Olsen and Johnson 2003, Chou and Kim 2009, Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014). More generally, Zhao, Webb et al. (2014) suggest that loyalty can be divided into two aspects: the first being related to a person's continuous behaviour to purchase or use a product or service, and the second having to do with the consumer's attitudes and emotions towards a service on an ongoing basis. This means that many authors claim that loyalty should be based only on (1) intended future usage, and (2) willingness to recommend (Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014). This two-part definition of loyalty is commonly used because intention to use is often considered a proxy for actual future usage (Lai and Chen 2011), and users who are willing to recommend the service to others are commonly loyal customers (Reichheld 2003). There is an underlying assumption throughout the literature that users will continue to use public transport and recommend it to others only when they are satisfied with the service performance (van Lierop and El-Geneidy 2016).

However, researchers who believe that it is not enough to define loyalty with only variables that describe intended future usage and willingness to recommend, often insist that users' overall satisfaction with the public transport agency should be included in the definition of loyalty; this is because it is possible that some public transport users continue to use the system because they do not have an alternative choice, but are not actually satisfied with the system they are dependent on (Transportation Research Board 1999, Figler, Sriraj et al. 2011). These "captive users," who in contrast to "choice users," tend to use transport out of necessity, (Krizek and El-Geneidy 2007, van Lierop and El-Geneidy 2017), may change their mode if given an

alternative option that they prefer. Yet, in contrast, Zhao, Webb et al. (2014) comment that a reverse effect also can take place when highly satisfied passengers defect from the system simply because a preferred mode becomes available. There may also be people who never have used, or will never use, public transport, but yet are strongly committed to supporting it in their communities. For these reasons, many authors who do not include overall satisfaction as part of the loyalty variable recognize that overall satisfaction with the public transport agency strongly influences loyalty (Lai and Chen 2011, Kim and Ulfarsson 2012, Carreira, Patrício et al. 2014, Zhao, Webb et al. 2014).

In addition to the debate about whether or not overall satisfaction should be included in a loyalty construct, several authors developed loyalty variables that include additional aspects that complement likeliness to use and willingness to recommend. For example, Carreira, Patrício et al. (2014) developed a loyalty variable that in addition to asking about future usage and positively discussing the agency's service with other people, also assessed whether users considered the service provided by the public transport agency to be their first choice to travel from an origin to a destination. Other researchers asked survey participants to evaluate different travel scenarios and assessed the likeliness to continue using public transport based on the responses (Imaz, Habib et al. 2015). In addition, some studies have used single-question variables to assess public transport users' likeliness to continue using the system (Kim and Ulfarsson 2012, Şimşekoğlu, Nordfjærn et al. 2015). Because of this on-going debate about how loyalty should be measured, and whether satisfaction should be seen as contributing to loyalty, this chapter reviews studies that define loyalty in a variety of ways.

2.3 METHODOLOGY

This study utilizes the realist literature review method to identify and systematically analyse all of the relevant literature regarding the causes of satisfaction and loyalty in public transport. Rather than the solely critical approach of conventional systematic reviews, the realist method incorporates a more explanatory focus (Pawson, Greenhalgh et al. 2005). The realist review method is an iterative process, and compared to systematic reviews which tend to base judgment on statistical synthesis, the realist review process aims to be more explanatory and places a greater emphasis on theoretical reasoning (Pawson, Greenhalgh et al. 2005). To define the relevant literature, we conduct a three phase search strategy. The first phase consisted of gathering literature through an extensive search utilizing Scopus, Web of Knowledge, and the Transportation Research Board archive, TRID. During the second phase, the inclusion and exclusion criteria presented in Table 1 were applied to the search results. The final phase used snowballing techniques to track down and gather other relevant sources from the reference lists of the selected literature. Accordingly, the same inclusion and exclusion criteria were applied to articles found through this method.

Table 1: Inclusion and exclusion criteria for the literature review

Included	Excluded
English language	Non-English language
January 1999 – October 2015	Before January 1999 – after October 2015
Full journal articles	Conference proceedings, lectures, grey literature, presentations, policy documents
Peer-reviewed	Not peer-reviewed
Empirical qualitative and quantitative studies that focus on a case	Studies that focus on simulation techniques, mathematical optimization methods, mode choice models, or a quality management framework such as SERVQUAL
Focuses on urban public transportation (Bus, Rail, Subway, Metro, Monorail, Streetcar, Light Rail)	Focuses on walking, cycling, automobiles, freight, airlines or other modes
Main focus is on the service factors that measure the quality of service	Main focus is on users' characteristics or emotions
Local modes, intra-urban travel	High Speed Rail, coach buses, inter-urban travel
Focuses on everyday usage of the mode	Focuses on tourism
Focuses on satisfaction, loyalty, or quality of service	If no mention of satisfaction, loyalty, or quality of service
Empirical model driven analysis or in-depth and systematically analysed interviews	Summary statistics only

The search criteria for studies assessing public transport user satisfaction and loyalty consisted of the following terms within the "title" search field: "(satisfaction OR loyalty) AND (transit OR transport* OR bus OR rail) NOT (Marine OR Air)" In addition the searches were limited to English, being categorized as (Research Area = Transportation), and being published between January 1999 and October 2015. This timeframe was chosen as the Transit Cooperative Research Program (TCRP) report on Customer Satisfaction and Service quality was published in 1999, and this document made a call for increased research in this area (Transportation Research Board 1999). A total of 116 papers were found in the first phase of the search, of which 100 were excluded after the inclusion and exclusion criteria were applied to the title and key words (Table 1). The second phase of the search yielded an additional five papers, and a final number of 21

were read in full. The final selection of papers that met the inclusion and exclusion criteria has been separated into two tables. Table 2 lists 13 articles that focus on gaining a better understanding of the service attributes influencing overall satisfaction, and Table 3 shows eight articles focusing specifically on the drivers of loyalty.

Table 2: Literature review results for satisfaction

Year	Author(s)	Title	Location	Kind of transportation	Sample size	Data Source	Type of analysis
2000	Stuart, K., Mednick, M., & Bockman, J.	Structural Equation Model of customer satisfaction for the New York City subway city	New York City, USA	Subway	1,500	Transportation Panel of the MTA's NYC Transit (Telephone interviews)	Structural Equation Modelling (SEM)
2000	Weinstein, A.	Customer Satisfaction among transit riders: How customers rank the relative importance of various service attributes	San Francisco, USA	Rail	>5000	On-board customer satisfaction survey	Bivariate correlation analysis and factor and regression analysis
2003	Burkhardt, J.	Critical measures of transit service quality in the eyes of older travellers	United States	Bus	88	Focus groups	Qualitative
2007	Krizek, K. & El-Geneidy, A.	Segmenting preferences and habits of transit users and non-users	Minneapolis-St. Paul-Bloomington, Minnesota, USA	Bus users and non-users	4408	Metro Transit users and non-users surveys	Factor analysis & cluster analysis
2008	Tyrinopoulos, Y. & Antoniou, C.	Public transit user satisfaction: Variability and policy implications	Athens & Thessaloniki, Greece	Bus, trolley bus, & rail/metro	1,473 (202, 556, 177, 165, 374)	Passenger questionnaires from five transit agencies	Factor analysis & Ordered logit model
2010	Githui, J., Okamura, T., & Nakamura, F.	The structure of users' satisfaction on urban public transport service in developing country: The case of Nairobi	Nairobi, Kenya	Bus & matatu (mini-bus)	140	Questionnaires (home and office-based interviews)	SEM
2011	dell'Olio, L., Ibeas, A., & Cecín, P.	The quality of service desired by public transport users	Santander, Spain	Bus	305	Focus groups & stated preference surveys	Discrete choice models
2013	Das, A., Ladin, M., Ismail, A., & Rahmat, R.	Consumers satisfaction of public transport monorail user in Kuala Lumpur	Kuala Lumpur, Malaysia	Monorail	400	Questionnaires at rail stations	Importance Performance Analysis
2013	de Oña, J., de Oña, R., Eboli, L., & Mazzulla, G.	Perceived service quality in bus transit service: A structural equation approach	Granada, Spain	Bus	1,200	Transport Consortium of Granada's customer satisfaction survey	SEM
2014	Grujičić, D., Ivanović, I., Jović, J., & Đorić, V.	Customer perception of service quality in public transport	Belgrade, Serbia	Bus	449	Surveys at stops	Importance Performance Analysis
2014	Nwachukwu, A.	Assessment of passenger satisfaction with intra-city public bus transport services in Abuja, Nigeria	Abuja, Nigeria	Bus	300	Questionnaires, field observations, & oral interviews	Principal Component Analysis & regressions

Year	Author(s)	Title	Location	Kind of transportation	Sample size	Data Source	Type of analysis
2014	Susilo, Y. & Cats, O.	Exploring key determinants of travel satisfaction for multi-modal trips by different traveller groups	Eight European cities	Public transport, car, bicycle, and walking (61% use PT as main mode)	554	European-wide survey: in-person, online, and phone	Multi-variate statistical analyses
2015	Mouwen, A.	Drivers of customer satisfaction with public transport services	The Netherlands	Bus, tram, train, & metro	180,000	Nation-wide on-board survey	Linear regression

Table 3: Literature review results for loyalty

Year	Author(s)	Title	Location	Kind of transportation	Sample size	Data Source	Type of analysis
2010	Minser, J., & Webb, V.	Quantifying the benefits: Application of customer loyalty modeling in public transportation context	Chicago, USA	Bus and train	264	Chicago Transit Authority Customer Satisfaction Survey	SEM
2011	Figler, S., Sriraj, P., Welch, E. & Yavuz, N.	Customer loyalty and Chicago, Illinois Transit Authority buses: Results from 2008 customer satisfaction survey	Chicago, USA	Bus	364	Chicago Transit Authority Customer Satisfaction Survey	Quadrant Analysis, Multivariate regression
2011	Lai, W. & Chen, C.	Behavioural intentions of public transit passengers – The roles of service quality, perceived value, satisfaction and involvement	Kaohsiung, Taiwan	Rail	763	Self-administered questionnaire at transit stations	SEM
2012	Kim, S. & Ulfarsson, G.	Commitment to light rail transit patronage	St. Louis, Missouri & Illinois, USA	Light rail	824	On-board customer satisfaction survey	Binary logit model
2014	Carreira, Rui, Patrício, L., Jorge, R., & Magee, C.	Understanding the travel experience and its impact on attitudes, emotions and loyalty towards the transportation provider – A quantitative study with mid-distance bus trips	Portugal	Bus	1,226	On-board questionnaires	SEM
2014	Zhao, J., Webb, V., & Shah, P.	Customer loyalty differences between captive and choice transit riders	Chicago, USA	Bus and rail	264	Chicago Transit Authority Customer Satisfaction Survey	Multiple-Indicator Multiple Cause Analysis and Multiple Group Analysis
2015	Imaz, A., Habib, K., & Shalaby, A., Idris, A.	Investigating the factors affecting transit user loyalty	Toronto, Canada	Subway, streetcar, and bus	270	Revealed and Stated Preference Commuting survey	Binary logistic regression model
2015	Şimşekoğlu, Ö., Nordfjærn, T., & Rundmo, T.	The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public	Six urban regions of Norway	Public transport (bus, train, tram & metro)	546	Self-administered mail questionnaires	SEM & logistic regression

2.4 FINDINGS

2.4.1 Summarizing the Literature

The goal of this review of the literature is to identify which service attributes are most commonly associated with satisfaction and loyalty in local public transport. Accordingly, studies about long distance modes and modes such as walking and cycling are not included, and instead the review focuses on intra-urban bus and rail systems, with several papers including analyses of multiple modes. Table 2 shows that the majority of the literature attempts to understand which service factors derive satisfaction among bus users (7), while fewer focus specifically on rail (3), or multiple modes (3). It is unsurprising that more satisfaction papers focus specifically on bus use; bus is often cited as being the least favourable mode, yet, because it is more economical compared to rail, many transport authorities and cities would benefit from increasing passenger satisfaction among bus users. On the other hand, it is also logical that researchers who focus on loyalty would assess multiple modes, as it is more interesting to know which service factors encourage overall passenger loyalty to public transport services as a whole, and not just to a single mode or specific route. While understanding user satisfaction of specific routes or modes can be useful to encourage and plan specific service changes, it is likely more useful for public transport agencies to focus on increasing loyalty among all kinds of users – including both "captive" and "choice" passengers – as it serves as a reflection of how individuals experience public transport overall. However, as previously discussed, satisfaction is often related to loyalty and therefore it is important to understand specifically which factors increase satisfaction among public transport users.

This review of the literature is not geographically constrained, and papers from different continents have been included. For example, with regard to satisfaction, the majority of the

34

papers come from Europe (6), but studies from North America (4), Africa (2), and Asia (1) are also included. With regard to loyalty, however, the large majority are North American cases (5), with only a few coming from Europe (2) and Asia (1). We have included studies from all regions as they represent cases that assess formal public transport services in cities that have a developed central business district. Another notable difference between the studies presented in Table 2 and Table 3 is that they have a wide variety of sample sizes, ranging from Burkhardt's (2003) qualitative research of focus groups that yielded 88 participants, to Mouwen's (2015) nation-wide study with 180,000 participants. The variation in sample sizes stems from the difference in data sources as some researchers used data collected by transport authorities and others collect their own primary data. Data for these studies was collected in a variety of ways including, telephone interviews, on- and off-board surveys, focus groups, and mixed-methods. While different forms of regression analysis are the most common, Structural Equation Modelling (SEM), Importance Performance Analysis, Factor-Cluster Analysis, and focus groups have been used.

2.4.2 Defining service factors

The studies included in Table 2 and Table 3 are based on different data sources, and accordingly, each study assesses different variables influencing satisfaction and loyalty. There are overarching themes present throughout the literature, and based on the variables presented in the included studies, we have identified seven overarching categories, which we present in Table 4 with each service variable being defined according to the literature. The definitions are derived from the discussions present in the reviewed literature, and we use the categories presented in Table 4 as a framework for our discussion about which service attributes, according to the reviewed literature, will have the strongest effect on overall satisfaction and loyalty.

Table 4: Overarching categories and service factor definitions

ONBOARD EXPERIENCE	SERVICE DELIVERY	WAITING CONDITIONS
Cleanliness: *the level of cleanliness and lack of garbage inside the vehicle* **Comfort**: *the comfort of the seats, ceiling height, leg space available on-board* **Seating capacity**: *the number of seats on-board* **Accessibility** (physical): *the ease with which people can board and alight the vehicle* **On-board information**: *the presence of maps and stop announcement on-board* **Crowding**: *passengers' personal space on-board* **Quality of vehicle**: *the physical condition and age of the vehicle* **Safety**: *passengers perception of being safe from crime and traffic while on-board* **Temperature**: *on-board temperature control such as ventilation, air conditioning and heating*	**Reliability**: *the consistency of a vehicle's punctuality and travel time according to scheduled departures and arrivals* **On-time performance / punctuality**: *the punctuality of the service* **Frequency**: *the scheduled frequency of the service* **Travel time**: *how quickly passengers travel from their origin to destination using a specific mode* **Access time**: *the time it takes passengers to get from their origin to the public transport stop or station* **Network coverage**: *the extent to which the transport system provides passengers with access to the different locations in the region* **Number of transfers**: *the number of times that a passenger has to change from one vehicle to another in a single trip* **Service provision hours**: *the operating hours of the system*	**Waiting conditions**: *the quality of the waiting environment at stops and stations* **Information at stops**: *the information provided at stops and stations including the presence of real-time-information systems* **Safety at stops**: *passengers perception of being safe from crime and traffic while waiting at a stop of station*
		COSTS
		Value: *passenger perception of value-for-money* **Types of tickets and passes**: *the existence of a variety of ticket types such as student passes or day, week, and month passes* **Ticket selling network**: *the availability of vending locations*
CUSTOMER SERVICE	**Convenience**: *the extent to which the agency provides an effective and easy-to-use service* **Stop location**: *whether the location of the stops is convenient for users* **Station parking**: *the availability of park-and-ride facilities at public transport stations* **Waiting time**: *the amount of time a passenger must wait before boarding a vehicle*	**QUALITY OF TRANSFERS**
Driver and personnel's attitudes: *the attitude of the driver and personnel as well as the courteousness of the staff and personnel* **Personnel skills**: *the ability of the driver and other staff* **Complaint dealing**: *the way in which the agency deals with passengers' complaints*		**Transfer time**: *the amount of time it takes a passenger to transfer between vehicles* **Ease of transfer**: *the ease at which a passenger transfers between vehicles*
		IMAGE
		Image: *how a passenger views public transport or their involvement with the service* **Environmentally friendly**: *whether a passenger chooses the mode because it is more ecologically responsible compared to a private car*

2.4.3 The presence of specific service factors

Table 5 demonstrates which service factors are statistically significant or deemed to be important for increasing satisfaction according to the studies included in this review of the literature. Additionally, Table 6 shows the results for loyalty. The outcome is based on our analysis of the statistical outputs, summary charts, and qualitative findings of the papers presented in Table 2 and Table 3 taken all together. More specifically, in the tables an "x" represents that the service factor has been found to be statistically significant in the analysis or discussed by the authors as being important. When no "x" is assigned, it means that either the result was not statistically significant, or that it was not accounted for in the analysis. Because negative results are not often published due to, and contributing to, publication bias (Easterbrook, Gopalan et al. 1991), it is not possible to report what has been tested but not been included in final publications, and therefore we can only include what the authors have reported in their models and other results. Nevertheless, we analyse and interpret the results of each paper, and thereby go beyond the results published in the abstracts and conclusions of the included literature to avoid bias. The following section uses the results of Table 5 and Table 6, to frame our discussion of the service factors influencing satisfaction and loyalty.

Table 5: Service factors influencing satisfaction

X= statistically significant in the analysis or discussed by the authors as being important	On-board Experience									Service Delivery												Waiting conditions			Transfers		Customer service			Costs			Image	
	cleanliness	comfort	seating capacity	accessibility (physical)	on-board information	crowding	quality of vehicle	safety	temperature	reliability	on-time performance/ punctuality	frequency	travel time	access time	network coverage	number of transfers	service provision hours	convenience/ effective	stop location	station parking	waiting time	waiting conditions	info at stops	safety at stops	transfer time	ease of transfer/distance	driver and personnel's behaviour and attitudes	personnel skills	complaint dealing	value	types of tickets and passes	ticket selling network	image	environmentally friendly
Stuart, Mednick et al. (2000)	X	---	---	---	---	X	---	X	---	X	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	---	X	---	---	---	---
Weinstein (2000)	X	X	X	X	X	---	X	X	X	---	X	X	---	---	---	X	---	---	---	X	---	X	---	X	X	X	X	---	---	---	---	X	---	---
Burkhardt (2003)	---	X	X	X	X	---	---	X	---	X	---	---	---	X	---	---	X	---	---	---	---	X	X	---	---	---	X	---	X	X	---	X	---	---
Krizek and El-Geneidy (2007)	X	X	---	---	X	---	---	X	---	X	X	---	X	---	X	---	X	---	---	X	X	---	---	---	X	X	X	X	---	---	---	---	---	---
Tyrinopoulos and Antoniou (2008)	X	---	---	X	X	---	X	X	---	---	X	X	---	---	X	---	---	---	---	---	X	X	X	---	---	X	X	---	---	X	X	---	---	---
Githui, Okamura et al. (2010)	---	X	---	---	---	---	---	X	---	---	X	X	---	---	X	---	---	---	X	---	X	X	---	---	---	---	X	---	---	X	X	---	---	---
dell'Olio, Ibeas et al. (2011)	X	X	---	---	---	X	---	---	---	---	---	---	X	---	---	---	---	---	---	---	X	---	---	---	---	---	X	---	---	---	---	---	---	---
Das, Ladin et al. (2013)	X	X	X	X	X	---	---	X	---	---	X	---	---	---	X	---	---	---	X	---	---	X	---	---	---	---	---	---	---	---	---	---	---	X
de Oña, de Oña et al. (2013)	X	X	---	X	X	X	---	X	X	---	X	X	X	X	---	---	---	---	---	X	---	---	---	---	---	---	X	---	---	X	---	---	---	---
Grujičić, Ivanović et al. (2014)	X	---	---	---	---	X	---	---	X	---	X	---	---	---	X	---	---	---	---	---	X	---	---	---	---	---	X	---	---	X	---	---	---	---
Nwachukwu (2014)	X	X	X	X	---	---	X	---	---	---	---	X	X	X	---	---	---	---	---	---	X	X	---	---	---	---	---	---	---	---	---	---	---	---
Susilo and Cats (2014)	---	X	X	---	---	---	---	---	---	X	---	X	X	---	---	---	X	---	---	---	---	X	---	X	---	X	---	---	---	---	---	---	---	---
Mouwen (2015)	X	X	X	X	X	---	---	X	---	---	X	X	X	---	---	---	---	---	---	---	---	---	X	X	---	---	X	---	---	X	---	X	---	---
TOTAL	10	10	6	7	7	4	3	9	3	4	8	8	7	3	5	1	3	0	2	3	5	7	3	3	2	4	10	1	1	7	2	3	0	1

Table 6: Service factors influencing loyalty

x= statistically significant in the analysis or discussed by the authors as being important	On-board Experience										Service Delivery											Waiting conditions			Transfers		Customer service			Costs			Image	
	cleanliness	comfort	seating capacity	accessibility (physical)	on-board information	crowding	quality of vehicle	safety	temperature	reliability	on-time performance/ punctuality	frequency	travel time	access time	network coverage	number of transfers	service provision hours	convenience/ effective	stop location	station parking	waiting time	waiting conditions	info at stops	safety at stops	transfer time	ease of transfer/distance	driver and personnel's behaviour and attitudes	personnel skills	complaint dealing	value	types of tickets and passes	ticket selling network	image	environmentally friendly
Minser and Webb (2010)	X	X	---	X	---	---	---	X	---	X	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	X	---	---	X	---	---	X	---
Figler, Sriraj et al. (2011)	X	---	---	---	---	---	---	X	---	X	X	X	X	---	---	---	---	X	---	---	---	X	---	X	X	---	X	X	---	X	---	---	---	---
Lai and Chen (2011)	X	---	---	---	X	---	X	X	---	---	---	X	---	---	X	---	X	---	---	---	---	X	X	X	---	---	X	---	X	X	---	X	X	---
Kim and Ulfarsson (2012)	---	---	---	---	---	---	---	X	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---
Carreira, Patrício et al. (2014)	X	X	---	---	X	---	X	---	X	---	---	---	---	---	---	---	---	---	---	---	---	X	---	---	---	---	X	X	---	X	---	---	---	---
Zhao, Webb et al. (2014)	---	X	---	---	X	---	---	X	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---	---	X	---
(Imaz, Habib et al. 2015)	---	---	---	---	---	X	---	---	---	---	X	---	X	---	---	X	---	---	---	---	X	---	---	---	X	---	---	---	---	X	---	---	---	---
Şimşekoğlu, Nordfjærn et al. (2015)	---	---	---	---	---	---	---	X	---	---	---	X	---	X	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X	---
TOTAL	4	3	0	1	3	1	2	6	1	3	3	3	2	1	2	1	1	2	0	0	1	3	1	2	2	0	4	2	1	7	0	1	4	0

2.4.4 Key Variables

The results presented in Table 5 clearly demonstrate that the service attributes most commonly influencing satisfaction are: on-board cleanliness (10/13 papers) and comfort (10/13), the behaviour and attitudes of the personnel (10/13), safety (9/13), as well as the punctuality (8/13) and frequency of the service (8/13). Consequently, these service factors should be the focus of public transport agencies who intend to increase ridership satisfaction in the short-term. However, with regard to long-term planning, it is important that public transport agencies focus on the service attributes which are strongly associated with overall loyalty. Accordingly, the service factors that are important to motivating loyalty in the long-term both overlap and are different from those affecting satisfaction and are: the perception of value for money (7/8), on-board safety (6/8) and cleanliness (4/8), interactions with personnel (4/8) and the image and commitment to public transport that the user feels (4/8).

These service attributes are discussed in detail in the sections below. For example, because cleanliness and comfort are categorized as being on-board service attributes in Table 4, these factors are discussed in the context of other factors that are associated with passengers' on-board experiences. Furthermore, the following subsections present analyses not only of the most frequently assessed and important service factors influencing satisfaction and loyalty, but also include a discussion of other less-researched, and sometimes also less influential, service attributes that have been presented in the literature.

2.4.4.1 On-board experience
On-board experience is based on the level of overall comfort that passengers experience while on-board a public transport vehicle. Whereas at its most basic, on-board comfort can be determined by the comfort of the seats inside the vehicles (Lee, Jin et al. 2009), it generally will encompass the quality of the overall on-board experience. On-board experience is therefore often

a reflection of on-board comfort and ranges from the physical aspects such as vehicle quality (Weinstein 2000, Tyrinopoulos and Antoniou 2008, Lai and Chen 2011, Carreira, Patrício et al. 2014), to interpersonal interactions such as those with drivers and other personnel (Burkhardt 2003, Krizek and El-Geneidy 2007, Figler, Sriraj et al. 2011, Lai and Chen 2011).

In-vehicle cleanliness and comfort are, according to the review of the literature, the most important factors influencing users' on-board experiences and are significant factors influencing perceived satisfaction and loyalty overall (Das, Ladin et al. 2013, de Oña, de Oña et al. 2013, Carreira, Patrício et al. 2014, Mouwen 2015). Weinstein (2000) groups cleanliness along with comfort as it influences how individuals perceive the inside of the vehicle, and both cleanliness and comfort may also vary depending on seasonality (Jacques, Manaugh et al. 2013).

Users' perceptions of safety are also associated with overall satisfaction and loyalty (Krizek and El-Geneidy 2007, Githui, Okamura et al. 2010, Şimşekoğlu, Nordfjærn et al. 2015), and it can relate to safety from traffic (Peden, Scurfield et al. 2004), or safety from crime (Smith and Clarke 2000). Overall, safety appears to be a stronger indicator of satisfaction outside of Europe (Krizek and El-Geneidy 2007, Githui, Okamura et al. 2010, Das, Ladin et al. 2013), even though this factor is commonly included in surveys in European studies (dell'Olio, Ibeas et al. 2011, Eboli and Mazzulla 2012, Carreira, Patrício et al. 2014, Mouwen 2015). However, further research is needed to understand why safety performs strongly in non-European studies.

In-vehicle crowding is also an important factor influencing passengers' experiences in public transport and is related to overall comfort and safety (dell'Olio, Ibeas et al. 2011, Carreira, Patrício et al. 2014, Imaz, Habib et al. 2015), as crowded vehicles can be perceived as an encroachment on personal space, and a personal safety concern (Cox, Houdmont et al. 2006). A similar measure to crowding is the seating capacity of the vehicle, and while seating capacity

influences satisfaction (Mouwen and Rietveld 2013, Nwachukwu 2014), on-board crowding has a stronger effect on loyalty (Carreira, Patrício et al. 2014, Imaz, Habib et al. 2015). The most common way to decrease crowding is to increase service frequency, a topic that will be discussed later in this chapter.

Other factors that are related to passengers' on-board experiences include in-vehicle temperature (Chou and Kim 2009, de Oña, de Oña et al. 2013), and the quality and physical accessibility of the vehicle (dell'Olio, Ibeas et al. 2011, Lai and Chen 2011, Carreira, Patrício et al. 2014, Hussein and Hapsari 2015). These factors will likely influence the satisfaction of riders in different ways, with seniors, for example, being more strongly influenced by the physical accessibility of the service (Rosenbloom 2004).

Accessible and accurate on-board information is also essential to increase satisfaction among users. For example, Weinstein (2000) found service information to be the most critical aspect needed to motivate satisfaction. One way that on-board information could be improved is by increasing the availability of scheduling information and maps; furthermore, several researchers have suggested that on-board information that is either displayed or announced can be an effective way to increase overall satisfaction (Burkhardt 2003, Krizek and El-Geneidy 2007). Good communication and effective wayfinding can also serve as helpful tools to assist passengers in optimizing their experience with the overall public transport network.

2.4.4.2 Service delivery

While on-board experience is an essential determinant influencing satisfaction and loyalty among public transport users, improvements to on-board comfort will only be beneficial if passengers are satisfied with the reliability of the service. The review of the literature shows that, passengers who are satisfied with the frequency of service and the on-time performance or punctuality are very likely to be satisfied with the service overall (Weinstein 2000, Tyrinopoulos

and Antoniou 2008, Githui, Okamura et al. 2010, de Oña, de Oña et al. 2013, Mouwen 2015). The fact that compared to frequency and on-time performance, reliability tends to be a weaker indicator of satisfaction, may stem from the fact that assessing whether a bus or train is generally on-time, or whether it runs frequently tends to be an easier task for a passenger to comment on compared to assessing the vaguer concept of reliability. Assessing reliability is a comparatively more complex issue as it involves knowledge of the full public transport schedule over time. With this in mind, Chakrabarti and Giuliano (2015) define a reliable service *"as one which consistently operates according to its schedule or plan."* To clarify this further, a frequently operating service that is punctual at the beginning of the route may not be considered reliable if there often is variation in on-time performance farther along the route. Therefore, a user may have reported that a service was punctual and frequent, but may be unreliable due to inconsistencies in journey times from day to day. While waiting time is related to overall satisfaction (Tyrinopoulos and Antoniou 2008, dell'Olio, Ibeas et al. 2011, Nwachukwu 2014), waiting time due to unreliability can have especially negative consequences and be burdensome to passengers with several transfers (Rietveld, Bruinsma et al. 2001). Passengers are likely to be especially vulnerable to unexpected waiting times associated with unreliable services, compared to expected waiting times that are clearly communicated to passengers. However, the studies included in the review did not include information about passengers experience with and without the use of real-time arrival tracking on personal mobile phones, which may be changing transport users' waiting experiences and opinions about transport reliability. Overall, while on-time performance and frequency have been found to be associated with overall satisfaction, to ensure loyalty to transport in the long-term, agencies should also focus on increasing users' perceptions of reliability.

Several other service factors also influence service delivery, and according to Stuart, Mednick et al. (2000), travel time, or speed, is at least as important as the frequency of service. Other authors also agree that total travel time is an important factor influencing passenger satisfaction (dell'Olio, Ibeas et al. 2011, Susilo and Cats 2014, Mouwen 2015), and speed is often a determinant in choosing public transport over another mode (Şimşekoğlu, Nordfjærn et al. 2015). Therefore, Figler, Sriraj et al. (2011) suggest that it is good news for a public transport agency when there are *"riders who use the bus because of its convenience and not because it is the lesser evil of transportation modes."* Convenience will, however, only be viewed positively if the network coverage allows passengers to travel from their origin to destination at a time of their preference with minimized access time (Burkhardt 2003, de Oña, de Oña et al. 2013), waiting time (Tyrinopoulos and Antoniou 2008, dell'Olio, Ibeas et al. 2011), travel time (Stuart, Mednick et al. 2000, Mouwen 2015), and number of transfers (Susilo and Cats 2014, Imaz, Habib et al. 2015). In addition, convenience could also be increased by developing station amenities such as park-and-ride facilities (Krizek and El-Geneidy 2007, Das, Ladin et al. 2013). Accordingly, service delivery improvements should include developing waiting areas that are well thought-out, as they are an integrated aspect of the public transport network.

2.4.4.3 Waiting conditions

Many researchers have surveyed passengers about how they experience waiting conditions, and although several studies found that the quality of waiting conditions influenced both overall satisfaction and loyalty (Tyrinopoulos and Antoniou 2008, Lai and Chen 2011, Nwachukwu 2014), in many studies it did not. More specifically, the quality of the information, including real-time information on personal mobile phones, and at stops and stations does not have a strong track record of influencing overall satisfaction and loyalty. Further research is needed to assess the relationships between access to different mediums of information and variation in the quality

of information have on passenger satisfaction and loyalty. This is in contrast to on-board information which is reported as influencing satisfaction in a greater number of studies (Weinstein 2000, Burkhardt 2003, Tyrinopoulos and Antoniou 2008, Lai and Chen 2011, de Oña, de Oña et al. 2013). These results demonstrate that waiting conditions may not be as important as researchers previously anticipated, or that the wrong questions about waiting conditions are being asked in researchers' surveys. Moreover, mode type does not appear to be a factor and waiting conditions seem to be more important outside of Europe, which may be due to harsher temperatures in the non-European examples included in this study (Weinstein 2000, Burkhardt 2003, Githui, Okamura et al. 2010, Das, Ladin et al. 2013, Nwachukwu 2014). In addition, none of the studies included information about passengers accessing information through their own mobile phones while at the stops. Perhaps these findings demonstrate that the way that passengers' access information about public transport at stops and stations is changing; rather than using the information available at stops and stations passengers may be relying more on personal public transport apps on their mobile phones. However, to better understand how information at stops and stations influences overall satisfaction and loyalty further studies are needed.

2.4.4.4 Quality of transfers
Transferring between vehicles is often considered undesirable and a burden to public transport users (Iseki and Taylor 2009). Nevertheless, few studies survey passengers about their satisfaction with transfer times or the ease of transferring between vehicles. However, when researchers have asked about passengers' transferring experiences, they usually highlight the importance of planning for a smooth and seamless transfer between vehicles. For example, Tyrinopoulos and Antoniou (2008) found that both transfer distance and waiting time influence overall satisfaction, and several other European and American studies revealed that the ease of

transferring relates to overall satisfaction (Weinstein 2000, Krizek and El-Geneidy 2007, Susilo and Cats 2014). In the future, transport agencies and public transport researchers could incorporate detailed questions about passengers' transfer experiences in order to better understand which aspects of a transfer are most strongly associated with overall satisfaction.

2.4.4.5 Customer service

Customer service is an important aspect deriving customers' overall satisfaction with public transport. How a public transport user perceives his or her interaction with a public transport agency's bus drivers and personnel is an important indicator of overall satisfaction (Stuart, Mednick et al. 2000, Weinstein 2000, Burkhardt 2003, Krizek and El-Geneidy 2007, Tyrinopoulos and Antoniou 2008, Githui, Okamura et al. 2010, de Oña, de Oña et al. 2013, Grujičić, Ivanović et al. 2014, Mouwen 2015). For example, de Oña, de Oña et al. (2013) found that the behaviour of the staff responsible for Granada, Spain's bus services was one of the main factors explaining passengers' perceptions of overall service quality. In addition, Carreira, Patrício et al. (2014) found passengers' perceptions of staff skills influenced overall loyalty. Interestingly, passengers' perceptions of the behaviours and attitudes of drivers and personnel appear to be more strongly related to satisfaction than loyalty. This might be because in many cases users do not interact with personnel on a regular basis, and instead judge customer service based on an experience they had with a particular bus driver or staff member. When a user perceives poor customer service, they are likely to become unsatisfied, but might not become disloyal. However, the finding that users' perceptions of staff skills influence loyalty may be related to the fact that skills are often representative of road safety, and if safety conditions are found to be poor, users might switch modes.

The way in which agencies deal with customer complaints is also associated with both satisfaction and loyalty (Burkhardt 2003, Lai and Chen 2011). Some authors recognize the

importance of agencies' abilities and willingness to deal with customer complaints in a responsive and efficient matter as a contributor to overall satisfaction and loyalty. While customer complaints are often perceived as a negative reflection of an agency's services, it is important to recognize that customer complaints can be used as a tool to improve overall customer satisfaction. For example, in the context of South Korea and Taiwan, Chou and Kim (2009), measured the impact of customer complaints on loyalty, and found that as passenger complaints increased in Korea, loyalty decreased and that in Taiwan, passengers' complaints increased loyalty. Although Chou and Kim's (2009) research was not included in either Table 2 or Table 3 because of its focus on high-speed rail, these findings are likely to be helpful for agencies operating different modes as they suggest that in the Taiwanese context, complaints are handled well, turning them into an asset for passenger loyalty. Other public transport agencies can learn from the Taiwanese example by developing strategies that aim at using customer complaints as a tool for improving customer satisfaction and loyalty.

2.4.4.6 Costs

For many users the cost of using public transport is a major determinant of their likeliness to be satisfied with the system. For example, Tyrinopoulos and Antoniou (2008) demonstrate that it is important for public transport agencies to offer a variety of tickets and passes with different price structures to reflect the needs of the users. Furthermore, these authors also discuss the importance of having a ticket selling network that is efficient and easy to use and is available at various vending locations. In addition, Lai and Chen (2011) discussed the importance of distinguishing between actual and perceived travel costs, and their results demonstrated that it is important for public transport agencies to distinguish between actual costs, users' perceptions of service value, and users' understanding of public transport agency spending.

Customer satisfaction and loyalty are related to users' perceptions of the costs associated with public transport services (Stuart, Mednick et al. 2000, Tyrinopoulos and Antoniou 2008, Githui, Okamura et al. 2010, de Oña, de Oña et al. 2013, Grujičić, Ivanović et al. 2014, Mouwen 2015). For example, the variety of tickets and passes (Tyrinopoulos and Antoniou 2008, Githui, Okamura et al. 2010) and the ticket selling network of a transport agency is associated with how satisfied users are overall (Weinstein 2000, Das, Ladin et al. 2013). Yet, while these factors are related to overall satisfaction, they do not clearly influence user loyalty which is more strongly associated with users' opinions about whether they are receiving the service they believe they should be, given the amount of money they are spending. For example, out of the eight loyalty papers included in Table 3, all – except for one (Şimşekoğlu, Nordfjærn et al. 2015) – revealed the importance that users' perceptions of value have on loyalty. This likely has to do with the fact that for public transport users who also have access to a car, and who are spending on the upkeep of a personal vehicle, public transport costs are often viewed as an addition to their monthly transport costs.

2.4.4.7 Image

The concept of image is based on how passengers view public transport as contributing not only to their own welfare, but to society at large. Having a positive image of public transport influences customer satisfaction (Minser and Webb 2010), but more importantly, it is strongly associated with loyalty (Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014, Şimşekoğlu, Nordfjærn et al. 2015). The review of the literature has revealed that recent research has found that passengers' positive attitudes towards using public transport are a significant predictor of their intention to use the mode and therefore also of their overall loyalty (Zhao, Webb et al. 2014, Şimşekoğlu, Nordfjærn et al. 2015). In addition, positive attitudes towards using public transport also increase passenger involvement and significantly affect behavioural

intentions towards continuing to use public transport in the future (Lai and Chen 2011). Therefore, Lai and Chen (2011) suggested that public transport agencies should focus on developing strategies that aim to motivate passengers to strongly identify with public transport. Using strategies to motivate customers to develop a positive connection with a product or service is a commonly discussed marketing strategy that involves the development of schemes that influence potential customers to have an emotional association with a product or service (Zaichkowsky 1994, Mahajan and Wind 2002). While these types of strategies are common within the automobile industry (Sheller 2004), they are not frequently used to promote public transport, even though they are likely to increase loyalty to the mode (Lai and Chen 2011), and should be a focus of future studies.

Furthermore, when public transport agencies and transportation researchers survey users about their satisfaction and loyalty, questions regarding passengers' perceptions of a given public transport agency are rarely included. Similarly, customer satisfaction questionnaires seldom ask respondents whether using public transport constitutes a part of their personal identity. However, when customer satisfaction surveys do include questions about passengers' image or involvement with public transport, the results demonstrate that these concepts are exceptionally important for increasing loyalty among public transport users. Moreover, other researchers have suggested that passengers emotional feelings towards a mode are associated with their mode choice (Shiftan, Barlach et al. 2015). Therefore, due to the finding that image or involvement with public transport is associated with loyalty, public transport agencies should focus on developing communication strategies that influence users' emotional attachment to public transport.

2.5 CONCLUSIONS

This review of the literature has revealed which service factors are frequently cited as increasing satisfaction and loyalty among public transport bus and rail users. While there is evidence that there is a large variety of service attributes influencing public transport users' reported satisfaction, the discussion above has highlighted the ones that are most commonly discussed in the literature. Accordingly, Figure 3 illustrates which service factors are most associated with satisfaction and loyalty by pictorially representing the relative importance of service attributes that, according to the selected literature, contribute the most to increased overall satisfaction and loyalty among public transport users. The figure includes only the service factors which were deemed to be important in at least half of the papers assessed in this review of the literature (present in $\geq$ 50% of the papers in Table 2 and Table 3). Also, the larger the font size of a word, the more frequently it occurs in the literature, meaning that the larger words appear in a higher number of papers. The following section discusses how transport agencies can use these findings to improve (1) passengers' experiences, and (2) passengers' perceptions of public transport.
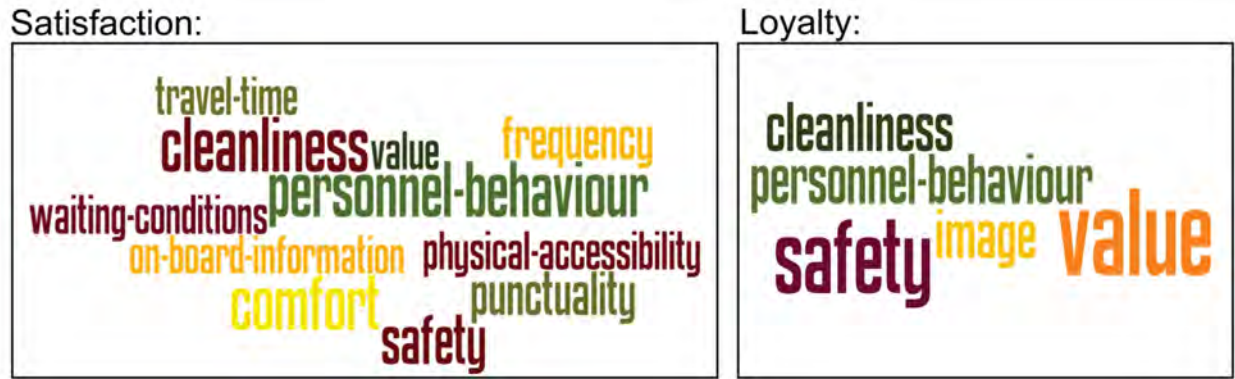
Figure 3: Service factors to focus on for improving satisfaction (left), and loyalty (right)

2.5.1 Passenger Experience

Experiencing a high level of comfort has been found to increase overall satisfaction with public transport. However, the context in which researchers assess this service attribute varies greatly across studies; for example, while several authors highlight the importance of decreasing crowding (dell'Olio, Ibeas et al. 2011, Carreira, Patrício et al. 2014, Imaz, Habib et al. 2015), others focus on developing comfortable seats (Das, Ladin et al. 2013, Nwachukwu 2014) desirable temperature and airflow (dell'Olio, Ibeas et al. 2011, Grujičić, Ivanović et al. 2014), or good waiting conditions (Tyrinopoulos and Antoniou 2008, Susilo and Cats 2014). Yet, regardless of context, transport agencies must strive to develop services that are clean, safe, and physically accessible to those who wish to use them. Another aspect of comfort can be related to the customer experience that a public transport user has with the driver and staff. For example, dell'Olio, Ibeas et al. (2011) suggests that to increase passenger comfort, drivers should be given a course on calm driving, and Burkhardt (2003) emphasizes the need for polite and courteous drivers who would exhibit good customer service by, for example, calling out stops. Users who have a positive perception of personnel behaviour are more likely to be satisfied overall

(Grujičić, Ivanović et al. 2014). The results of these studies demonstrate the need for public transport agencies to improve trip comfort in a multifaceted manner.

On time performance, frequency, and travel time have also been found to be associated with overall satisfaction (Tyrinopoulos and Antoniou 2008, Figler, Sriraj et al. 2011, de Oña, de Oña et al. 2013). Krizek and El-Geneidy (2007) discuss specific interventions such as the use of swipe cards in order to decrease travel times by speeding-up the boarding process. These authors also suggest the use of next arrival systems in order to improve passengers' perceptions about punctuality. dell'Olio, Ibeas et al. (2011) similarly develop suggestions to improve passengers' perceptions with regard to service quality by providing better information about schedules and routes. Most interestingly, several authors have argued that the key to overall satisfaction is to offer a personalized service where transport is closely geared to the individual user so that each traveller can have his or her needs met for every specific trip (Burkhardt 2003, Susilo and Cats 2014). Personalizing users' travel experiences with regard to mode, fare, and schedule will be important for the future of public transport as it would present options for travellers to choose which service features they prefer to maximize for a specific trip. With this in mind, agencies should work strategically to ensure that personalized travel does not motivate competition between public transport modes, but instead maximizes the use of each mode based on the specific temporal and utilitarian needs of each user.

Although factors that are related to the service delivery and on-board comfort appear to be conceptually unrelated, operationally they are rather connected. For example, increasing service frequency would likely lead to increased comfort as crowding would decrease. In addition, passenger comfort would likely also be increased with shorter journey times and improvements to driver and personnel behaviour. In addition, drivers might be able to provide

better customer service if their schedule increased their chances of being consistently punctual. Users' perceptions of the drivers might also improve if the names of stops were to be announced electronically and payment did not involve interactions with the driver.

2.5.2 Passenger Perception

The above discussion has demonstrated that strategies which aim to improve overall satisfaction directly target user experience. However, those implemented to increase loyalty aim to involve users by improving their overall perceptions of different aspects of public transport services. For example, rather than providing a discussion about actual value-for-money, Lai and Chen (2011) claim that customers' perceptions of value is important, and that it is the role of the public transport agency to effectively communicate cost savings (compared to other modes) to their users. In addition, to increase passenger loyalty, public transport agencies should communicate the societal benefits of public transport as a public good to both users and potential users. Minser and Webb (2010) further demonstrate this point by revealing that users who have a positive perception of service quality will also have a better public image of the system. These authors make clear that a customer's loyalty is not based on a singular positive trip experience, but rather that loyalty, like trust, takes time. Minser and Webb (2010) also claim that loyalty is also not only a result of consistent service delivery, but that loyalty is *"the development and maintenance of trust in the agency's customer base."* This reveals that while satisfaction can be instant, loyalty is developed over time. Accordingly, it is in the best interest of public transport agencies to manage customer expectations by providing customers with the services that they expect to receive.

For example, with regard to reliability, Tyrinopoulos and Antoniou (2008) comment that the goal of public transport agencies should be to develop a service in which public transport

users perceive service frequency and trip time as being implicitly guaranteed. These authors place a greater emphasis on increasing passenger perception of reliability rather than developing goals based on frequency and travel time that do not involve the perception of the passenger. Such a strategy is one way for an agency to communicate to its users that it can fulfil specific travel needs. Furthermore, Lai and Chen (2011) recognize that it is important to develop strategies that influence users to identify with using public transport. These authors suggest that public transport agencies use advertisements and even celebrity endorsements as a way to motivate passenger involvement with public transport. Similarly, Zhao, Webb et al. (2014) reminds agencies of the importance of developing market-specific strategies for different populations of public transport users. And finally, Şimşekoğlu, Nordfjærn et al. (2015) highlight the importance of promoting the benefits of using public transport in general.

2.5.3 Recommendations for Future Research

This review of the literature discussed the service factors that are most associated with overall satisfaction and loyalty in urban public transport. Furthermore, the analysis has revealed that whereas overall satisfaction is primarily related to travel experience, loyalty is a result of a longer-term and trusting relationship between the user and the agency. While the majority of studies focusing on understanding loyalty in public transport develop variables based on a user's intention to continue using public transport in the future as well as on his or her likeliness to recommend it to others, future research may benefit from incorporating agency trust and an assessment of the image and commitment to public transport that a user experiences. In addition, future studies should aim to improve the understanding of what is not being measured, as researchers are always limited to analysing only the questions that were included in the customer satisfaction questionnaires. Although a debate exists about how loyalty should be defined, we

have attempted to highlight common threads and have elucidated that the concept of loyalty is best defined based on a user's intention to continue using the service, willingness to recommend it to others, overall satisfaction, and most importantly, the user's image of or involvement with public transport. However, further research is needed to resolve the debate on how loyalty should be defined in the context of public transport research. Future studies should also attempt to quantify which service factors most influence satisfaction and loyalty in specific geographic and cultural contexts in order to clarify to practitioners how to prioritize service improvements, and similar research could be applied to intercity, long-distance, travel. Finally, because the results of this review suggest that public transport users who have a positive image of the agency and consider public transport an integral component of a city dweller's daily life are more likely to demonstrate loyalty, more research is needed to explore how users' image of public transport influences loyalty across modes, populations, and geographic regions.

3 CHAPTER THREE: A NEW MARKET SEGMENTATION APPROACH: EVIDENCE FROM TWO CANADIAN CITIES

3.1 OVERVIEW OF CHAPTER

This chapter sets out to identify the factors influencing satisfaction and loyalty in the Canadian context. It uses the results of the literature review chapter to frame the research presented in this chapter, and recognizes that traditionally transit market research has categorized passengers into two distinct groups: captive and choice riders. Transit market analyses that depend on such broad categories are likely to overlook important details about the needs and desires of their customer base. This study attempts to better understand the complexities of the different groups who take transit by using information from five years of customer satisfaction questionnaires collected by two Canadian transit providers. Employing a series of clustering techniques, the analysis reveals that nine market segments are present across different modes in both transit agencies. Three different overarching groups of transit users are identified based on income and vehicle access: choice users (~69%), captive users (~18%), and captive by choice users (~13%). The groups are consistent across transit modes and in different geographical regions, and are generalizable enough to be widely applicable as a conceptual framework for segmenting and understanding public transit users.

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3.2 INTRODUCTION

While transportation agencies and public policy makers have brought attention to the importance of increasing transit mode share, transit usage still lags significantly behind that of the car. Thus, in order to increase ridership, transit agencies and governments first need to understand what motivates individuals to utilize environmentally and socially sustainable forms of transportation such as public transit. Although much research attempts to elucidate what motivates drivers to switch to taking transit (Curtis and Headicar 1997, Abou-Zeid, Witter et al. 2012), fewer studies attempt to understand how to maintain and increase ridership among existing transit users. It is important for transit agencies to focus on retaining existing users as it is known that individuals stop using transit for many reasons, including changes in income, family size, the availability of another mode, as well as reasons related to the quality of service (Evans 2004, Perk, Flynn et al. 2008, Grimsrud and El-Geneidy 2014).

One way to motivate existing users to remain loyal to the transit system is through increasing their satisfaction by taking into account their needs, perceptions, and desires with respect to transit. It is important to understand how to motivate loyalty in transit as it *"involves a commitment on the part of the customer to make a sustained investment in an ongoing relationship with transit service (p. 18)"* (Transportation Research Board 1999). However, before developing strategies that attempt to increase satisfaction and loyalty among current transit users, it is beneficial to segment the market. Traditionally, transit market research has categorized riders into two distinct groups: captive and choice riders. Captive transit riders are commonly defined as individuals who do not have an alternative transportation choice, while choice riders are those who choose to use transit even though another mode, such as a car, is available to them (Wilson, Stevens et al. 1984, Beimborn, Greenwald et al. 2003, Krizek and El-

Geneidy 2007, Jacques, Manaugh et al. 2013). While it is important for transit agencies to acknowledge the presence of these two groups, analyses that depend on these broad categories are likely to overlook details about the needs and desires of their customer base. Therefore, rather than taking an approach to market segmentation that relies only on an analysis of whether or not transit users have access to alternative modes, the present study attempts to better understand the complexities of different groups who use transit. This is executed by using information about transit users' socioeconomic statuses, personal preferences, and perceptions of satisfaction with transit services.

Nearly a decade ago, Krizek and El-Geneidy (2007) identified the habits and preferences of captive and choice transit users. Since then, transit markets have changed and new groups have emerged. Figure 4 demonstrates Krizek and El-Geneidy's (2007) conceptual framework. This study uses these authors' transit market segmentation as a base on which to expand knowledge about transit user markets. The purpose of this study is to expand the left side of Krizek and El-Geneidy's (2007) framework by assessing the different types of current transit users present in the two geographically distinct Canadian cities of Montreal, Quebec, and Vancouver, British Columbia and update Krizek and El-Geneidy's (2007) transit market segmentation model. This manuscript begins with a review of the relevant literature related to market segmentation. Next, based on an analysis of customer surveys collected by transit agencies in both cities over a five year period, statistical clustering techniques are used to uncover market segments that are consistent in both geographic contexts. This is followed by a discussion of policy recommendations aimed at increasing ridership among the different clusters. In doing so, this chapter illustrates how already existing data can be used productively to inform public transit research, policy, and managerial practice.
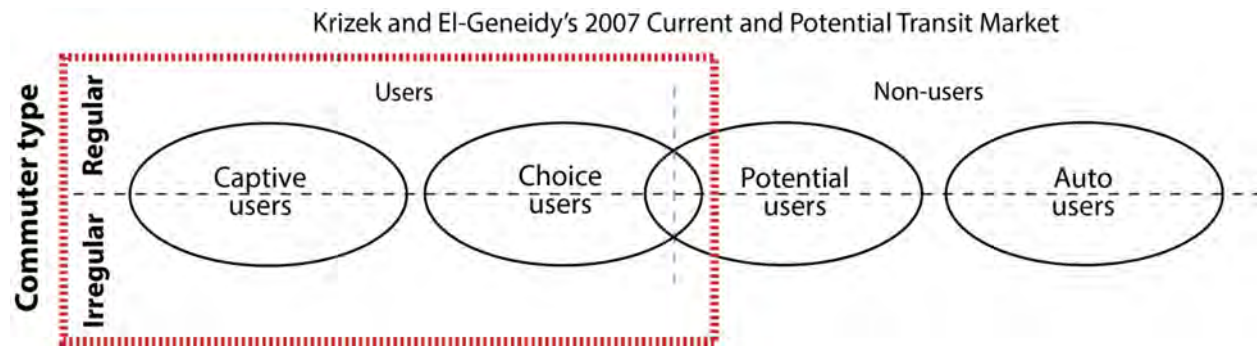
Figure 4: Krizek and El-Geneidy's (2007) Transit Market Segmentation

3.3 LITERATURE REVIEW

3.3.1 Market Segmentation

Transit agencies are showing growing interest in understanding consumer behaviour and have recognized that market-orientated research in public transit is likely to result in increases in users' satisfaction (Transportation Research Board 1998, Transportation Research Board 1998, Molander, Fellesson et al. 2012). A first step toward identifying ways to increase customer satisfaction is to develop a market segmentation strategy to understand the needs and desires of the different groups using transit. While market segmentation analysis can be a difficult task for practitioners (Palmer and Millier 2004), it can serve as a research base on which other marketing strategies can be built (Weinstein 2004).

Within the field of transportation planning there have been a limited number of studies assessing transit market segments. One of the earliest examples of grouping types of transit users is the Transportation Research Board's TCRP report on customer satisfaction (1999). This report made suggestions for developing analyses that group current transit users as 'secure,' 'favorable,' 'vulnerable,' and 'at risk' to accordingly develop appropriate marketing strategies.

59

Several empirical studies have attempted to segment the transit markets in various regions (Jensen 1999, Anable 2005, Beirão and Cabral 2008). For example, Beirão and Cabral (2008) determined six unique traveller segments with different attitudes, demographic profiles, and intentions for using public transit in Porto, Portugal. Furthermore, Wilson, Stevens, and Robinson (1984) developed four market segments to account for variation in choice and captive riders, and McLaughlin and Boyle (1997), identified transit-dependent populations in Los Angeles County, United States by segmenting based on car availability and income. Beimborn and Greenwald (2003) segmented the transportation market in Portland, Oregon into what they call choice and captive riders based on mode preference and mode options. These authors recommended that transit agencies use these categories to improve forecasting and service design. Based on this study, Krizek and El-Geneidy (2007) evaluated the habit and preferences of users and non-users of transit to segment the market in the Minneapolis – St. Paul metropolitan area of the United States. They found eight different segments of transit users and non-users including captive and choice users. These authors recommended that policies should be based on an understanding of commuters' attitudes and preferences, and emphasized that the retention of current riders is as important as the attraction of new ones. Jacques, Manaugh, and El-Geneidy (2013) extended the concept of choice versus captive riders further, and found four segments that they claim are more representative of the market: 'convenience,' which describes choice riders, 'true captivity,' which describes captive riders, and 'utilitarian,' and 'dedication' which are neither clearly captive or choice riders. These authors suggested that segments should not be viewed as static groups, but that individuals can move between categories.

Most of the abovementioned studies were derived from a sample of transit users or non-users residing within one region and were based on convenience samples. The present study

segments the transit market to avoid analyzing heterogeneous groups within a transit market. It adds to the literature by using a segmentation technique that identifies context-specific clusters, and then groups the identified clusters based on income and car access. Therefore, this study provides a nuanced approach to understanding current transit users that is generalizable enough to be widely applicable as a conceptual framework for segmenting and understanding public transit users. The findings can provide transit agencies with information necessary to better understand the needs and desires of different groups within a transit market (Demby 1994, Peter and Olson 1999, Weinstein 2004).

3.4 DATA

The data used for this study are obtained from two large public transit agencies in Canada: Montreal's Société de transport de Montréal (STM) and Vancouver's TransLink under a data sharing agreement to be used in academic research. In 2011, the population of the Montreal census metropolitan area (CMA) was 3.8 million with a transit mode share of 22.2 percent for work trips. In Vancouver, the CMA population was 2.3 million with 19.7 percent using transit for work trips (Statistics Canada 2014). The transit agencies in both cities provided the results of five years of customer satisfaction questionnaires that were conducted three or four times a year using telephone interviews. Telephone numbers were selected randomly, and respondents were filtered based on whether or not they use public transit. Only public transit users were interviewed and included in the sample. In addition, because participation was voluntary, non-response bias may be present. In both Montreal and Vancouver, these routine questionnaires are intended to evaluate the quality of the transit service provided by the transit agencies. They are used by the transit agencies to better understand perception of service quality and also as insight into where changes and/or improvements to service attributes could be accomplished to increase

customer satisfaction and, accordingly, increase overall ridership. To assess customer satisfaction with the transit service, the STM asks survey participants to report their experience with transit in general over the last 30 days. TransLink, however, takes a different approach by asking participants to specifically report their experience on their last and second to last trips. Although both strategies are appropriate for collecting information concerning customer satisfaction, the STM's approach to asking about individuals' experiences in general may lack detail, whereas TransLink's method of asking about the previous trip could result in capturing irregular travel, but it is likely negligible compared to those reporting regular travel behaviour. In addition, both agencies ask questions regarding travel frequency, making it possible to distinguish frequent versus infrequent users. Both agencies also assess transit users' access to a car. Furthermore, because the questionnaires asked similar as well as several identical questions, the differences in the method of the data collection are not problematic for this study and we only include data that were consistent between the two cities.

The STM provided information for a total 18,595 interviews, and TransLink for 42,061 interviews from 2009 to 2013. Not all questions were asked every year, and therefore inconsistent survey questions were removed from the database and not included in the analysis. The data were not weighted as it would require having auxiliary information for all transit users in the regions, and also because the sample did not contain geographic information such as origin and destination points. However, the data are collected by the STM and TransLink who attempt to collect representative random samples by ensuring that every transit user in each region with phone access has the same chance of being selected to be part of the survey following the basic rules of obtaining a representative random sample (Dunlop and Tamhane 2000).

Additional data cleaning was required to remove entries that were missing relevant information as well as apparent mistakes in the data. The surveys asked information including, but not limited to, transit users' socioeconomic statuses, personal preferences, perception of satisfaction and travel habits. However, information about household structure and the presence of children was not included.

Satisfaction questions were asked using a 10-point Likert scale, and categorical data were converted to a series of dummy variables before it was included in the analysis. Table 7 and Table 8 list the questions that were used in the surveys of the two transit agencies. Data were then separated into three modal categories: bus, metro/SkyTrain, and passengers who used the modes in combination. To clarify, bus users are individuals who only reported using the bus, metro/SkyTrain users travelled only by rail, and analyses of individuals who used both modes represent individuals who reported using both modes in the same trip. The analysis is conducted for every distinct modal category to account for the differences in mode-specific service attributes. After data preparations were completed, a total of 14,842 observations were found suitable for the STM analysis and 29,224 for TransLink. This sample size at the 95% confidence level is representing a margin of error of 1.8% for transit users in Montreal and 1.3% for users in Vancouver. For the STM, the analysis yielded 7,190 bus users, 3,778 metro users, and 3,874 individuals who used both modes in combination. For TransLink, the sample includes 9,850 bus users, 6,604 SkyTrain users, and 12,770 who use both modes.

3.5 ANALYSIS

3.5.1 Principal Component Factor Analysis

Using SPSS 17, principal component analysis (factor analysis) was employed for each modal category to understand how survey questions related to each other. This statistical method

considers the complete set of questions from the survey as well as their responses, and creates a certain number of groupings (factors) that capture the variability in the data and therefore aids in reducing the number of variables analyzed (Krizek and El-Geneidy 2007, Song and Knaap 2007, Doloreuxa and Shearmur 2013). Using varimax rotation to maximize the variance of the squared loadings and Eigen values greater than one, this type of factor analysis was employed for each modal category within each agency: bus, metro/SkyTrain, and users who combined modes. Table 7 and Table 8 demonstrate the results of the principal component analysis for the STM and TransLink, respectively, and they provide the factor loadings for the specific analysis of each modal category. These tables present the variables and corresponding survey questions used to build the components needed for the next phase of analysis. The numbers in the tables indicate the weight of each of the respective components; these factor loadings were grouped together when they were greater than 0.5 or less than -0.5.

Table 7 and Table 8 show that the categories for each of the grouped questions were given titles that could be applied to both the STM and TransLink data, where possible. However, variation in the wording of specific questions were observed even though the questionnaires from both transit agencies assess individual's socioeconomic profiles, travel behaviour, opinions about transit, and perceived satisfaction of transit. Furthermore, questions that could not be grouped due to statistically insignificant factor loadings were removed from the analysis. The next phase of the analysis uses the groups of questions, or factors as they are called, to define the market segments present in each transit agency.

Table 7: Factor Loadings: STM

STM: MONTREAL	Factor loadings		
SURVEY QUESTIONS	**BUS**	**METRO**	**BOTH**
CAR ACCESS			
I use public transit because I don't have a car	-.904	.882	-.904
I currently have car access	.531	-.650	.547
I use public transit because I don't like driving/traffic	.551		.540
FINANCIAL SITUATION			
My income is greater than $80,000	.664	.648	.652
Status = work (compared to student, other)	.747	.774	.747
LIFE PHASE			
What is your age?	-.854	-.810	-.843
Status = student (compared to work, other)	.882	.866	.871
TRAVEL DAY			
When during the week do you take the bus most often? (mainly on the weekend)	-.766	-.807	-.672
When during the week do you take the bus most often? (mainly during the week)	.800	.790	.783
LOYALTY			
I have been using STM public transit for at least one year as frequently as I do now	.697		
I plan to keep using the STM public transit network for a few or many more years	.810	.741	.804
Getting a new job, moving or having a child would make me use public transit less in the next year		-.709	-.732
FREQUENCY (REGULARITY)			
I am using STM public transit less than I used to	-.594	-.692	-.606
In the last 30 days, what percentage of your trips would you say you made using public transit?	.734	.763	.745
How many times did you take transit in the last 30 days?	.734	.736	.728
CONVENIENCE			
I use public transit because it is punctual/efficient	.899	.851	.914
I use public transit because I don't like driving/traffic		-.822	
IMPROTANCE OF LOW COSTS			
I use public transit because of the low costs	.964	.965	.961
SATISFACTION WITH SERVICES			
What is your level of satisfaction with the cleanliness inside the bus/ metro cars?	.518	.831	
What is your level of satisfaction with the cleanliness inside the metro stations?		.838	
What is your level of agreement with the statement: "In the last month, the métro service on the lines that I used was reliable."	.518	.539	.512
Last month, what was your level of security at any time you were on the bus or in metro installations?	.759	.541	.748
What is your level of satisfaction, out of 10, with the way in which drivers start, drive and stop their buses on the STM bus routes that you use?	.795		.830
What is your agreement with the statement: "I feel that the driver drives carefully while respecting traffic regulations."	.822		.842
SATISFACTION CLEANLINESS			
What is your level of satisfaction with the cleanliness inside the bus?			.592
What is your level of satisfaction with the cleanliness inside the metro stations?			.865
What is your level of satisfaction with the cleanliness inside the metro cars?			.881
Total variance (%)	65%	67%	68%
Blanks show that the question had a factor loading of <.5 or that it did not factor with the question group			

Table 8: Factor Loadings: TransLink

TRANSLINK: VANCOUVER	Factor loadings		
SURVEY QUESTIONS	**BUS**	**SKYTRAIN**	**BOTH**
CAR ACCESS			
I use public transit because I do not have a car (I have no choice)	-.715	-.772	-.748
Which of the following best describes your total household income before taxes? (Under $35,000)	-.513		
I use public transit because parking costs too much	.666	.531	.713
Do you have access to a car, van or truck as a driver or passenger for the trips you make using public transit? Yes	.726	.715	.718
FINANCIAL SITUATION			
Which of the following best describes your total household income before taxes? (More than $75,000)	-.559	-.781	.677
Which of the following best describes your total household income before taxes? (Between $35,000 - $75,000)	.920		
Which of the following best describes your total household income before taxes? (Under $35,000)		.740	-.686
LIFE PHASE			
What is your age?	-.821	.793	.800
What is the highest level of education you have completed? Some high school or less	.614		-.510
What is your present employment status? "Student"	.806	-.807	-.820
TRAVEL DAY			
Did you make your last one way trip on Monday to Friday between 5am and 9:30am or Monday to Friday between 3pm and 6:30pm?	-.802		-.693
Did you make your last one way trip on Saturday, Sunday or Holiday?	.784		.809
Did you make your last one way trip on Monday to Friday between 5am and 9:30am or Monday to Friday between 3pm and 6:30pm?		-.829	-.712
Did you make your last one way trip on Saturday, Sunday or Holiday?		.835	.814
LOYALTY			
Compared to six months ago, would you say you are now riding transit more regularly, less regularly, or about the same? (Less regularly than 6 months ago)	-.805	-.803	-.789
How likely are you to continue to take transit as often as you do now in the foreseeable future? (Probably or definitely continue as often as I do now)	.697	.705	.695
FREQUENCY (REGULARITY)			
Approximately how long have you been riding transit on a regular basis? (Number of years and months)	.723	.854	.743
Regular user (yes/no)	.817	.817	.800
CONVENIENCE			
I use public transportation because it is reliable and because it has a good schedule	.674	.883	.512
I use public transit because of the convenience of the stops and stations	.730		.761
LOW COSTS			
I use public transit because it is cheaper	.837	.715	.853
I use public transit because of the convenience of the stops and stations		.539	
SATISFACTION with SERVICES 1			
How would you rate the bus for having a direct route?	.676		
Trip duration from the time you boarded to the time you got off the bus?	.720		
How would you rate it in terms of providing on time reliable service?	.744		.694
How would you rate it in terms of frequency of service?	.797		.640
Feeling safe from crime onboard the bus?			.556
How would you rate it for feeling safe from crime at the bus stop or transit exchange where you boarded?			.599

How would you rate it in terms of being clean and graffiti free?			.684
How would you rate that station in terms of safety?			.776
How would you rate your trip in terms of feeling safe from crime onboard SkyTrain?			.795
SATISFACTION with SERVICES 2			
Having a courteous bus operator?	.561		.608
How would you rate it in terms on being clean and graffiti free?	.617		.586
How would you rate it for feeling safe from crime at the bus stop or transit exchange where you boarded?	.785		
Feeling safe from crime onboard the bus?	.830		
How would you rate the bus for having a direct route?			.682
Trip duration from the time you boarded to the time you got off the bus?			.752
How would you rate it in terms of frequency of service?			.767
How would you rate it in terms of providing on time reliable service?			.769
SATISFACTION (SKYTRAIN ONLY)			
How would you rate it in terms of frequency of service?		.727	
How would you rate it in terms of being clean and graffiti free?		.728	
How would you rate it in terms of providing on time reliable service?		.766	
How would you rate that station?		.786	
How would you rate your trip in terms of feeling safe from crime onboard SkyTrain?		.807	
Total variance:	64%	65%	61%
Blanks show that the question had a factor loading of <.5 or that it did not factor with the question group			

3.5.2 K-means Cluster Analysis

Based on the results of the principal component analyses for each agency, k-means cluster analyses were performed using SPSS 17 with the factors developed for each modal category in both cities. This type of analysis is common in the literature and it has been proven to be a good method for segmentation (Krizek and El-Geneidy 2007, Song and Knaap 2007, Jain 2010, Doloreuxa and Shearmur 2013, Damant-Sirois, Grimsrud et al. 2014). The factor scores that were generated for each variable included in Table 7 and Table 8 were grouped together in order to identify segments of transit users for each modal category in both cities. In other words, the goal of the cluster analysis is to identify different groups of transit users within the existing customer base of the STM and TransLink by grouping riders with similar socioeconomic profiles, personal values, levels of satisfaction, and travel habits. The analysis maximizes the differences between groups while minimizing the differences within groups. As the method used is an exploratory form of cluster analysis, it was important to set criteria to determine how many clusters to retain. While there are many approaches to judging the quality of segments (Dibb and Simkin 2010), because this analysis aims to update Krizek and El-Geneidy's (2007) Transit Segmentation Model, we used the transit-specific criteria set by these authors to guide our decision:

  (a) statistical output (cluster characteristics),

  (b) relevance and transferability to transport policy,

  (c) previous studies, and

  (d) common sense and intuition.

Clustering was tried with three to eight groups as has been suggested by Damant-Sirois, Grimsrud et al. (2014), and final clusters of six and seven groups were found to provide the best

qualitative descriptions for the groups using different modes in each city (Figure 5 and Figure 6). These clusters are not specific to individual modes and named based on the prevalence of different factors. The sample size of each cluster is included below the name, and the bars represent each of the factors presented in Table 7 and Table 8. Positive bar values represent that this factor is positively associated with the cluster and vice versa. For example, *economizing riders* are labelled as such because they tend to use transit due to the associated cost savings. Although the figures demonstrate that most categories are consistent across modes, some differences exist. For example, Figure 5 shows that for every cluster of bus and bus & metro users the first bar in every group is coloured in light pink and represents access to a car. However, this bar is not included for the metro users; instead, metro users' car access is determined by a white coloured factor representing that a user does not have access to a car. The reason for the difference between 'car access' and 'no car access' is due to the results of the factor analysis represented in Table 7.

Similar to the results of Krizek and El-Geneidy's (2007) segmentation analysis, Figure 5 and Figure 6 demonstrate whether a cluster is categorized as a choice or captive users based on their income and access to a car:

- Choice users: Car access
- Captive users: No car access, low income

However, the results of the present study revealed that the data described more than choice and captive users identifying a group of transit users present in the two cities that, to our knowledge, has not been previously identified in the literature. We named this new group 'captive by choice,' to reflect the fact that they are captive to transit because they do not have access to a car,

but likely have chosen this situation as they appear not to have as much of an income barrier compared to other clusters:

- Captive by choice users: No car access, do not have low income

Figure 5 and Figure 6 use the terms captive, choice, and captive by choice to describe the clusters present among all modes. Finally, a description of the results of the cluster analysis is provided in Table 9.
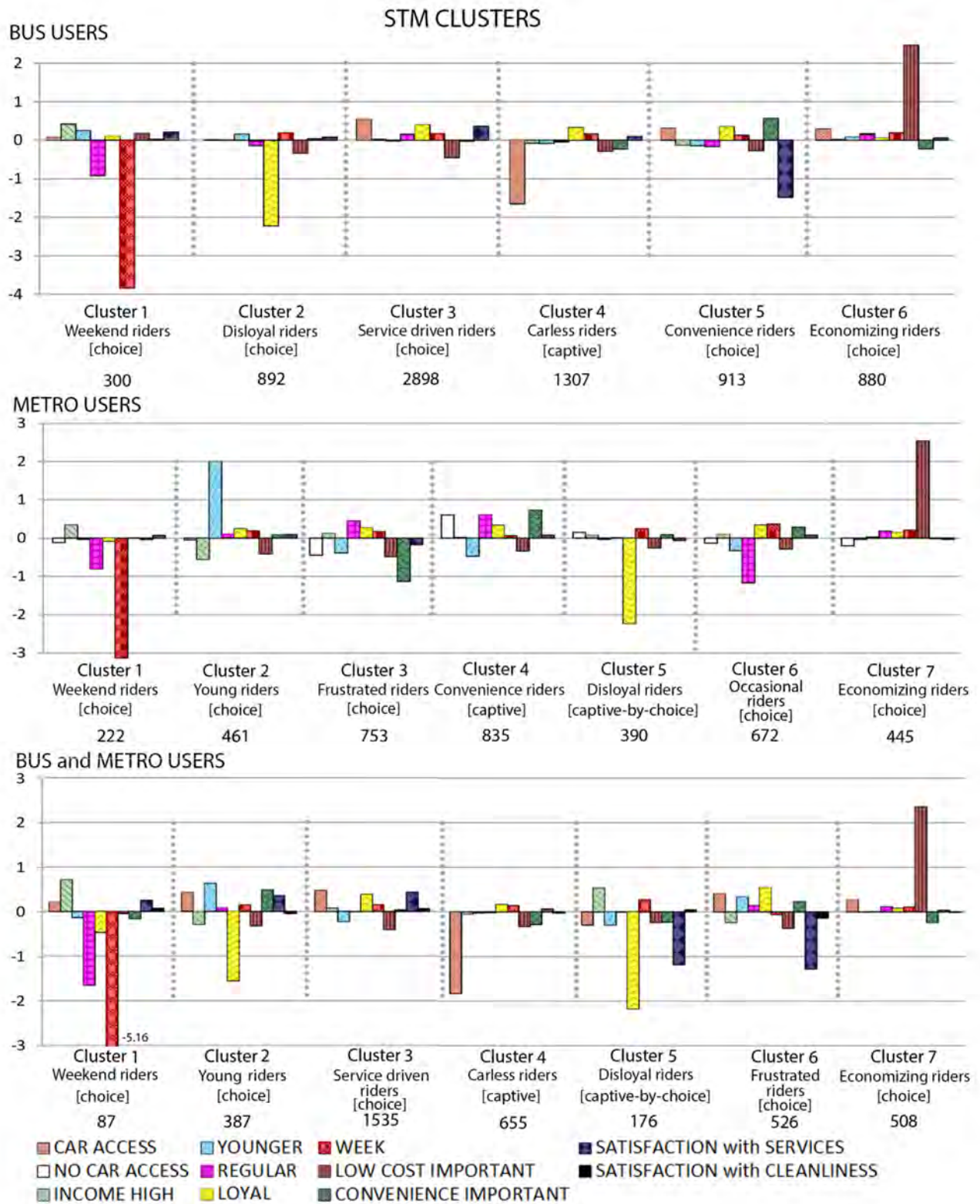
Figure 5: K-means Cluster Analysis for STM
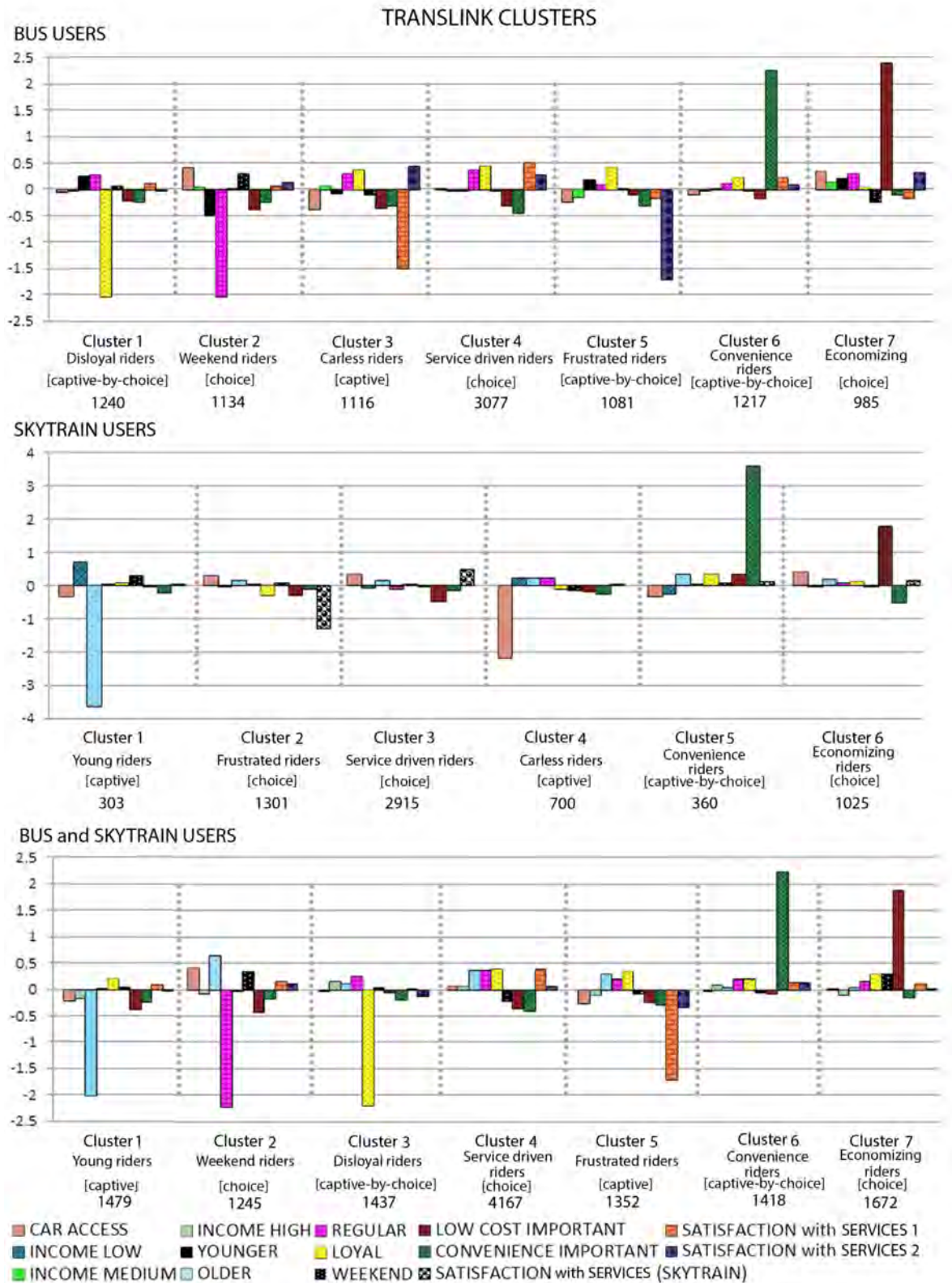
Figure 6: K-means Cluster Analysis for TransLink

Table 9: Société de Transport de Montréal and TransLink clusters

S=STM, T=TransLink			
	Bus users	**Metro/SkyTrain users**	**Bus and Metro/SkyTrain users**
Service-driven riders	These users have access to a car, do not have low incomes, are loyal and travel during the week. They are not influenced by the cost or convenience, satisfied with services. [S,T]	These users have access to a car, do not have low incomes and tend to be loyal. They are older, use the system occasionally, and are not influenced by the cost or convenience, satisfied with services. [T]	These users have access to a car, tend to be high income and loyal. They are older users who travel during the week, are not motivated by cost savings and are satisfied with services. [S,T]
Economizing riders	These users have access to a car, do not have a low income, and regularly commute during the week. They are largely motivated by cost savings. [S,T]	These users have access to a car and regularly travel during the week. They tend to be loyal and are strongly motivated by cost. [S,T]	These users have access to a car, and similarly are regular loyal users who are motivated by cost savings. [S,T]
Convenience riders	These users tend to be older, do not have high incomes, and travel during the week. They are loyal and are very motivated by convenience. [S,T]	These users are older, loyal, satisfied with services, and very motivated by convenience. These users do not have access to car. [S,T]	These users tend to be older, loyal, satisfied with services and motivated by convenience. They have high incomes and do not have access to cars. [T]
Weekend riders	These are occasional users who primarily take transit on the weekend, have access to cars, and tend to be loyal. They are generally satisfied with the services. [S,T]	These are occasional users who primarily take transit on the weekend, have access to cars, and tend to be loyal. They tend to be older and high income, and are generally satisfied with the services. [S]	These are occasional users who primarily take transit on the weekend. They are older and satisfied with services, but are not loyal or motivated by cost savings or convenience. [S,T]
Occasional weekday rider		These users occasionally use transit during the week. They have car access, high incomes, tend to be older, and are motivated by convenience, but not by cost savings. They are satisfied with the services. [S]	
Frustrated riders	These users are unsatisfied with the transit services, do not have access to a car, and are not medium income. They tend to be young and regular users who are loyal to the system and are not motivated by cost savings or convenience. [T]	These users are unsatisfied with the transit services and do not take the mode due to associated cost savings or convenience. They are older, regular users who do have car access. [S,T]	These users are unsatisfied with services and are not motivated by cost savings. They are low income, older, regular users who are loyal to the system. [S,T]

Disloyal riders	These users are not loyal to the system, even though they do not have access to a car. They tend to be younger, do not have low incomes, and are not motivated by cost savings. They are somewhat satisfied with services. [S,T]	These users are not loyal to the system and do not have access to a car. They use transit during the week, are not motivated by cost savings, but are slightly motivated by the convenience of transit. [S]	These users are not loyal to the system and do not have access to a car. They are not motivated by cost savings or convenience, tend to be older, have higher incomes. [S,T]
Young riders		These users tend to be younger and have lower incomes. They are loyal, use transit regularly, and are not motivated by cost savings. They are somewhat satisfied with services. [S,T]	These users tend to be younger and have lower incomes. They are loyal, use transit regularly, and are not motivated by cost savings. They do not have access to cars and are somewhat satisfied with services. [S,T]
Carless riders	These users do not have access to a car, do not have high incomes, and tend to be loyal to transit. They are older, travel during the week, and are somewhat satisfied with services. [S,T]	These users do not have access to a car, do not have high incomes, and are regular users who travel during the week. They are not motivated by cost or convenience, and only somewhat satisfied with services. [T]	These users do not have access to a car, do not have high incomes, and tend to be loyal to transit. They are regular users who are not motivated by cost savings or convenience. [S]

3.6 DISCUSSION

Based on the findings from the cluster analyses presented in Figure 5 and Figure 6, we are able to update Krizek and El-Geneidy's (2007) Transit Market Segmentation Model to account for the different types of transit users that have been identified in the present study. Figure 7, accordingly, demonstrates that choice and captive users are not always separate entities, but instead overlap showing that some individuals in fact chose to be captive.
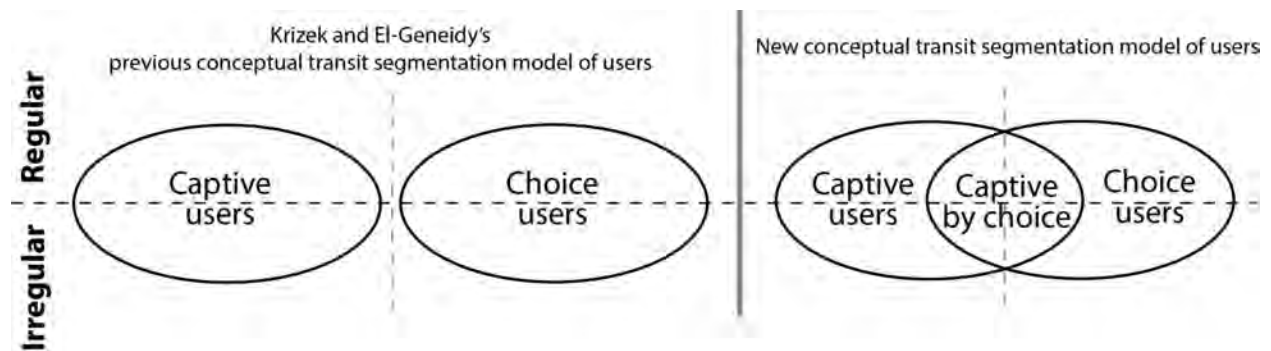
Figure 7: Krizek and El-Geneidy's and the new conceptual transit segmentation model of users

The group that is *captive by choice* may have the financial ability to access another mode, but might have chosen to give up their cars because they prefer the experience of taking transit over that of driving. However, it is important to recognize that because information on household structure is not available to include in the analysis, individuals living in larger households have a higher chance of being financially constrained compared to those in the same income bracket living with fewer family members. Therefore, some captive by choice users who have many members in their household may be more financially constrained compared to captive by choice users who are financially responsible for fewer household members. In other words, car ownership may not be equally financially viable for all captive by choice users. Similarly, not all choice riders will have the same transportation options available to them, and some, regardless of

choice, may be more restricted to using public transit than others. Nevertheless, Figure 7 demonstrates that given these findings, the conceptual model makes clear that different groups of people can be accounted for within the broader categories of captive, choice, and captive by choice.

3.6.1 A new conceptual transit segmentation model

The new model presented in Figure 8 could serve as a tool for transit agencies wishing to develop marketing strategies to increase satisfaction and loyalty among many users. More specifically, this broader segmentation strategy can be used as a framework to better understand the urgency of developing policy interventions geared at the different groups using transit. Figure 8 further extends the new transit market segmentation model by demonstrating the predictability of future usage of the different groups:
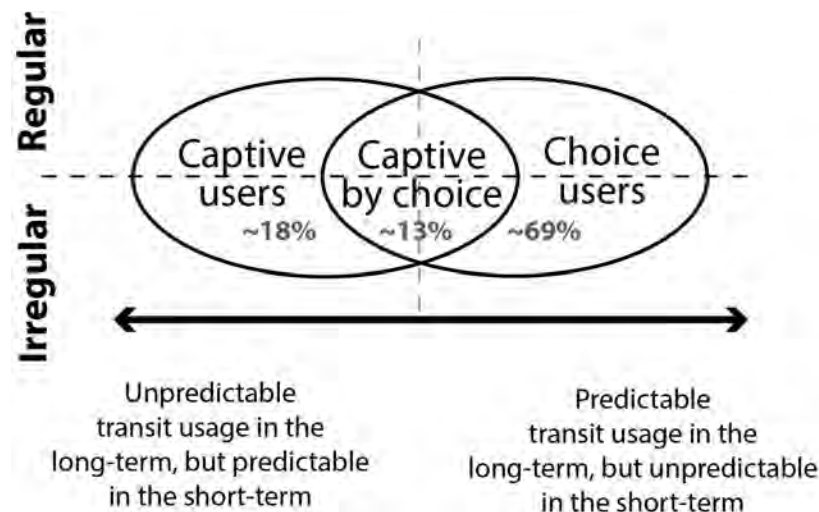
Figure 8: Predictability of transit usage by group

Figure 8 demonstrates that while choice users are likely to continue using transit in the long-term, they may not choose to use it for all trips in the short-term as they have alternative modes available to them. Captive users, however, do not have access to alternative modes, and therefore

76

in the short-term are predicted to use transit, but in the long-term might gain access to a car or increase their income and consequently become captive by choice or choice users. Therefore, while at any given point it is likely that there will always be captive users, choice users, and captive by choice users, individuals will likely move between categories throughout the course of their lives. The goal of transit agencies should be to maximize the number of choice riders in a city, while also working to better serve captive and captive by choice riders who have fewer modal options, and therefore may also have more limited access to opportunities. The following section provides specific policy interventions aimed at inspiring users in different categories to continue using transit as they go through different life phases.

3.6.2 Choice users (~69%)

In Vancouver and Montreal, choice users make up the majority of the transit market, and therefore it is important to motivate these users to continue using transit in the future. *Service driven riders* represent the largest group, and therefore their needs should be prioritized. *Economizing riders*, however, represent another large group of transit users, and policies should be carefully developed to encourage this group to continue using transit. However, the needs and desires of *weekend riders* and *occasional riders* should not be overlooked, as service improvements geared specifically at this group may result in increased usage.

Service driven riders often use transit because they are satisfied with the services and with the characteristics associated with their trips. To motivate these users to continue using transit, agencies should focus on maintaining the cleanliness and the safety of services (Weinstein 2000, de Oña, de Oña et al. 2013), develop service improvements such as real-time travel information,

and communicate transit investment and plans for service improvements (Tyrinopoulos and Antoniou 2008, dell'Olio, Ibeas et al. 2011).

Economizing riders often use transit because they benefit from the associated cost savings. Providing a low-cost transit service is associated with ridership (Hodge, Orrell III et al. 1994, D'Alessandro and Des 2008), and to positively impact individuals' perception of service, and ultimately motivate their loyalty, transit agencies should communicate the cost saving benefits associated with using transit compared to other modes (Lai and Chen 2011). Agencies would also benefit from developing policies that encourage ridership through financial motivation (such as reduced fares), and increases in fares will likely have a negative influence on this group's transit ridership, and therefore must be carefully planned. Finally, cities can help motivate this group to continue using transit by developing policies which increase the price of driving and parking cars.

Weekend riders and occasional riders are grouped together as they represent irregular users. Transit agencies should ensure that these users develop a positive perception of the system with regard to efficiency, travel time and reliability (de Oña, de Oña et al. 2013, Carreira, Patrício et al. 2014, Chou, Lu et al. 2014). In the long-term transit agencies should focus on improving the common negative cultural image that is often attributed to transit (Schweitzer 2014). Transit's cultural stigma can be changed by the implementation of policies that promote the service as being more comfortable and more efficient than using a private motorized vehicle (Chou and Kim 2009, Lee, Jin et al. 2009, Chou, Lu et al. 2014). Individuals' attitudes and preconceived ideas about public transit can be improved through policies that promote the aspects of transit

that are unique to the service such as the ability for commuters to save time by working, reading, using the internet, or relaxing while they travel (Cain, Flynn et al. 2009).

Although not all **Frustrated riders** are choice riders, the majority fit into this overarching category. They are regular users who are not motivated by cost savings and are not satisfied with the services provided by public transit agencies. To satisfy these users, transit agencies should ensure that the system is clean, safe and reliable (Weinstein 2000, Burkhardt 2003, de Oña, de Oña et al. 2013, Susilo and Cats 2014). Additionally, *frustrated riders* would benefit from the implementation of an advanced information system to better communicate waiting times (Politis, Papaioannou et al. 2010), route information, and connections to alternative modes such as bicycle share to increase the ease of usage of the entire transit system. Finally, it is important to note that although these riders have been categorized as choice riders, they may not have as many options as other choice riders, and therefore, although not low income, and having access to a car, could be restricted to using public transit. This is an area of research that should be explored in the future.

3.6.3 Captive users (~18%)

Captive users are often *carless riders* and *young riders* and transit agencies should take special care to cater to the needs of these groups in order to increase rider satisfaction in the present, as not to lose these riders in the future. Life-cycle changes (e.g., student to employment, renting to home-ownership, changes in family size and structure, etc.) often result in travel behaviour changes (Evans 2004, Perk, Flynn et al. 2008, Grimsrud and El-Geneidy 2014). Therefore, if

captive users are not satisfied with the services provided by the transit agency they may consider switching their mode when they increase their income due to a change in employment.

Carless riders use transit because they do not have access to a vehicle and do not have high incomes. Transit agencies must assess the needs and desires of this group and engage in equitable planning that recognizes that this group is strongly reliant on public transit (Stanley and Lucas 2008). In addition, transit agencies should provide the safest services possible for this group as they do not have alternative options, and depending on the context, safety provisions may include the installation of platform screen doors, additional lighting or surveillance cameras, and even security guards.

Although not all ***Young riders*** are captives, this group tends to take transit because of their low incomes. Transit agencies should aim to improve how young transit users experience transit by developing technologically up to date online customer feedback tools such as social media, web-based forums, and customer information mobile applications that will likely provide useful information for riders (Ferris, Watkins et al. 2010). Furthermore, in the long-term agencies should be prepared to accommodate these uses as they go through lifestyle changes. This may include increasing convenience by increasing spatial and temporal coverage density.

3.6.4 Captive by choice users (~13%)

The identification of the captive by choice segment provides an important conceptual step from the car-as-norm paradigm that is often dominating transport research and policy. This newly identified group appears to view public transit neither as a last resort when no options are

available, nor a mere complement to other transport modes. Alternatively, the existence of this group suggests that these users view transit as a viable transportation alternative on its own and in Vancouver and Montreal includes *convenience riders* and *disloyal riders*. Because these groups are likely to have the financial accessibility to switch modes, it is in the best interest of transit agencies to develop a transit system that takes into account the needs and desires of these users. For example, for *captive by choice* users, public transit is likely to be in direct competition with car-share programs such as Car2Go and ride-share services and Transportation Network Companies such as Uber, and the lower-cost UberX (Rayle, Shaheen et al. 2014, Car2Go 2015, Uber 2015).

Convenience riders generally take transit because they benefit from the convenience of this mode compared to other modes. Well-integrated services provided at and around transit stations are likely to attract these users. For example, in many regions free Wi-Fi is now offered on trains and buses as well as stations to provide an additional service which appeals to the younger generations. Such improvements are likely to increase overall levels of satisfaction for all users and attract irregular commuters to begin enjoying commuting by transit regularly. Furthermore, transit users tend to have a biased, distorted perception regarding transit travel time and waiting time, and they often report travel and waiting times that are longer than reality (Diab and El-Geneidy 2014). Correcting this distortion by using polices that improve the awareness of transit service qualities, as well as by implementing technologies such as next arrival services, may help in increasing transit use (Rose and Ampt 2001, Garvill, Marell et al. 2003, Kenyon and Lyons 2003, Mishalani, McCord et al. 2006).

To increase loyalty among ***Disloyal riders***, transit agencies should communicate the benefits of using transit to these groups and focus on maintaining a safe, clean, and convenient system (Minser and Webb 2010, Figler, Sriraj et al. 2011, Lai and Chen 2011). However, transit agencies should also invest in better understanding the specific needs and desires of this group as it is not clearly understood why these users are strongly disloyal.

3.7 CONCLUSION

This cluster analysis of two Canadian transit agencies links customers' points of view to transit performance in order to bridge an existing gap in public transit segmentation research. The analysis has made clear that although different segments exist within each modal category, the overarching categories of captive, choice, and captive by choice are helpful to develop policy recommendations that are further reaching than policies directed at a single cluster. Because the findings have been consistent in both the geographically distinct settings of Montreal and Vancouver, this research is expected to be replicable and applicable in other cities. However, future research would benefit from applying and testing a similar segmentation analysis in other cities, especially in the United States where transit mode shares tend to be lower, and the percentage of captive riders tends to be higher. Furthermore, although choice, captive, and captive by choice users are expected to be present in all transit markets, the percentage of users per group is expected to vary depending on the context. System improvements that are targeted at a specific segment could improve the experience of other groups as well; thereby motivate ridership among different users.

While the research presented in this chapter placed transit users into single market segments, in the future it would be useful to quantitatively consider the likelihood of how each variable affects the probability of a transit rider belonging to captive, choice, and captive-by-

choice segments and the make-up of each individual. Such a latent class approach would probabilistically assign transit users to different segments based on personal and travel behaviour characteristics similar to the models used to explore mode choice (Bhat 1997, Srinivasan, Naidu et al. 2009). For transit market analysis, this method would provide a more flexible approach to identifying and predicting market segments.

Finally, in addition to the findings of the analysis, this chapter has also demonstrated how existing data from transit agencies can be productively used to inform public transit research, policy, and managerial practice. In the future, to further help in the development of policies that aim to retain and/or increase transit ridership, research should include in-depth analyses focused on understanding the needs and desires of the different market segments and set out to better understand how to motivate non-users to use public transit.

4 CHAPTER FOUR: ENJOYING LOYALTY: THE RELATIONSHIP BETWEEN SERVICE QUALITY, CUSTOMER SATISFACTION, AND BEHAVIOURAL INTENTIONS IN PUBLIC TRANSIT

4.1 OVERVIEW OF CHAPTER

The relationship between customer satisfaction and loyalty has recently received international attention as transit agencies aim to identify ways to increase ridership. Improvements in perceived service quality increase the attractiveness of transit, and therefore lead to growing patronage. Chapter 4 builds directly on the results presented in the previous chapter and examines how transit users' perceptions of service quality and user satisfaction influence loyalty. Using information from five years of customer satisfaction questionnaires collected by two Canadian transit providers, this study attempts to better understand the complexities of several factors influencing passenger satisfaction and behavioural intentions. It uses a Structural Equation Modelling approach in order to assess the causal relationships between service quality, satisfaction, and loyalty. Accordingly, this chapter presents a series of causal models that reflect the different transit user groups that were identified in Chapter 3; captive riders (users who are dependent on transit), choice riders (car owners who choose to take transit), and captive-by-choice riders (users who are dependent on transit but could own a car) are accounted for. The findings from this study are used to define areas where transit agencies can develop specific strategies in order to benchmark user satisfaction with the aim of growing patronage among the different groups. Insight into the perceptions of passengers provides useful information that can help transit agencies understand what inspires customers' perceptions of satisfaction and loyalty in general.

This chapter is in press at the journal of *Research in Transportation Economics* as:

van Lierop, D. and A. El-Geneidy (2016). "Enjoying loyalty: The relationship between service
quality, customer satisfaction, and behavioral intentions in public transit." Research in
Transportation Economics.

4.2 INTRODUCTION

The relationship between transit users' levels of satisfaction and future behavioural intentions
has recently received much attention as transit agencies aim to identify ways to increase ridership
and cities develop policies aimed at decreasing auto-dependency. Improvements to passengers'
satisfaction with service attributes are believed to increase the attractiveness of transit overall,
and grow patronage by increasing ridership frequency and motivating long-term continued
usage. Understanding what affects transit users' levels of satisfaction is vital because it can be
used to determine a person's intention to continue using a service, to increase spending, or to
promote the service through word of mouth (Dixon, Freeman et al. 2010). More specifically, as
customer satisfaction increases, so does customer loyalty, meaning that satisfied customers are
more likely to continue using a service, and also recommend the service to others. Therefore, it is
in the best interest of transit agencies to have satisfied and loyal customers as these are the users
who are likely to positively affect the growth and profitability of the agency (Loveman 1998,
Rigby and Ledingham 2004, Heskett, Jones et al. 2008). While several studies have attempted to
understand the determinants of satisfaction and loyalty for particular transit agencies or
geographic regions, to our knowledge, no study has attempted to develop a more generalizable
framework that is broadly applicable to transit market research. To fill this gap in the literature,
this chapter sets out to examine the relationship between satisfaction and loyalty in the two

geographically distinct Canadian cities of Montreal, Quebec, and Vancouver, British Columbia with the goal of developing a generalizable framework. The chapter begins with a discussion of the theoretical background that is based on a review of the relevant literature. Next, nine hypotheses about the relationships between satisfaction with information, cleanliness, safety, reliability, frequency, overall modal satisfaction and loyalty are presented and followed by a discussion of the data and methods used. Then, the hypotheses are tested and the results are discussed. Finally, based on the discussion of the results, this study defines areas where transit agencies can focus their attention in order to increase user loyalty with the aim of growing patronage among different groups of transit users.

4.3 THEORETICAL BACKGROUND

In recent years, transit market researchers have begun to focus on understanding how to positively influence transit users' behavioural intentions for the future, and thereby influence users' loyalty (Wen, Lan et al. 2005, Tyrinopoulos and Antoniou 2008, Shiftan, Barlach et al. 2015). Oliver (1999) defines loyalty as *"a deeply held commitment to rebuy or repatronize a preferred product/service consistently in the future"* (p. 34). Transit researchers are focusing on increasing their understanding of loyalty as, ultimately, the goal for transit agencies is to increase mode share through rider-retention, an objective that is more likely to be met if passenger loyalty increases. Lai and Chen (2011) reiterate the importance of understanding loyalty in the context of transportation and state that, *"by better understanding the passenger behavior marketers and managers of transit systems will be better equipped to develop more appropriate marketing strategies and tailor their products and services to attract new passengers, as well as retain existing ones"* (p. 319).

The Transportation Research Board's (TRB) Transit Cooperative Research Program (TCRP) report on customer satisfaction suggests that transit agencies should analyze satisfaction and loyalty as a way to understand what makes a secure customer. To do this, the report suggests a method for defining who is a secure customer that includes combining individuals' scores based on their levels of satisfaction, likeliness to repeat, and likeliness to recommend (Transportation Research Board 1999). However, since this report's publication date, few papers to our knowledge have assessed loyalty based on a construct that combines both satisfaction and loyalty as was suggested in the report (Conlon, Foote et al. 2001). Instead, the majority of studies focus specifically on understanding the causes of satisfaction in transit users. The limited research on this topic is likely due to the fact that the relationship between (perceived) service quality, customer satisfaction and loyalty can be complex in transportation research (Merkert and Pearson 2015).

4.3.1 Satisfaction

An early example of determining the causes of satisfaction in transit users was a study of the New York Subway system by Stuart, Mednick et al. (2000) who applied structural equation modelling (SEM) techniques to demonstrate how different service attributes directly and indirectly influence customer satisfaction. These authors called for more detailed SEM analyses in the future, claiming that this method offers a more realistic assessment of customer satisfaction compared to more traditional methods. More recently, Eboli and Mazzulla (2014) analyzed how passengers of regional rail lines in Northern Italy perceive satisfaction with service quality. These authors similarly demonstrated that improving service characteristics such as reliability, frequency, and cleanliness would likely improve overall perception of service quality, thus leading to increased customer satisfaction. These results are echoed by the findings from a

study in Granada, Spain, which was based on a large scale survey as well as passengers' statements about their satisfaction with the quality of service (de Oña, de Oña et al. 2013). These authors also analyzed how different service attributes influenced overall perceptions of service and found that service performance, comfort while traveling, and the behaviour of the staff were the main factors explaining satisfaction with overall service quality. Other researchers have also examined trip satisfaction across modes, and found that personal characteristics and trip attributes influence overall satisfaction (St-Louis, Manaugh et al. 2014).

4.3.2 Loyalty

According to TCRP report 49, *"customer loyalty is reflected by a combination of attitudes and behaviors. It usually is driven by customer satisfaction, yet also involves a commitment on the part of the customer to make a sustained investment in an ongoing relationship with transit service (p. 18)"* (Transportation Research Board 1999).

Recent research that analyzes customer loyalty does not have a standardized or even common way, to assess loyalty. For example, in a cross-country comparison study, Chou and Kim (2009) used SEM to measure the impact of service quality, corporate image, satisfaction, and customer complaints on loyalty. They assess loyalty through repeat business, willingness to recommend, and price tolerance. In another study, Minser and Webb (2010) used SEM to assess the factors influencing loyalty among customers of the Chicago Transit Authority. These authors defined loyalty based on likeliness to continue to use the service and willingness to recommend, and found that service quality, service value, customer satisfaction directly, as well as problems and agency image indirectly influenced their definition of loyalty. Alternatively, in a recent study assessing loyalty among bus and rail passengers in Israel, Shiftan, Barlach et al. (2015) found that loyalty towards a mode was affected by how passengers felt about the mode. These authors

had a unique definition of loyalty, including satisfaction with service characteristics, but did not include a variable to demonstrate intended use in the future or willingness to recommend. In our study we use a combined measure to define loyalty based on the TCRP report 49 definition above. This framework has also been used by other researchers to understand the impact of improvement strategies on user perception and loyalty (Conlon, Foote et al. 2001). Yet, as was discussed in Chapter 2, there is no consensus about how loyalty should be measured; while some researchers define loyalty specifically based on users' likeliness to recommend the service to others and intended future usage (Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014), others, as mentioned above, additionally include overall satisfaction with the agency (Transportation Research Board 1999, Figler, Sriraj et al. 2011), as well as other variables (Carreira, Patrício et al. 2014, Shiftan, Barlach et al. 2015) when developing loyalty constructs. For the purposes of this study, a loyal customer is defined based on his or her overall satisfaction with the service, likeliness to continue using the service in the future and, when available, the likeliness to recommend it to others.

4.3.3 The groups using transit

While this brief review of the literature has revealed how satisfaction and loyalty have been assessed in previous studies, much of the research using SEM assumes that transit users are a homogenous group and researchers often ignore the reality that different groups exist within the larger transit market. In previous segmentation research, transit riders have been categorized into two distinct groups: captive and choice riders. Captive riders are commonly defined as individuals who do not have an alternative transportation choice, while choice riders are those who choose to use transit even though another mode, usually a car, is available to them (Wilson, Stevens et al. 1984, Beimborn, Greenwald et al. 2003, Krizek and El-Geneidy 2007, Jacques,

Manaugh et al. 2013). More recently, van Lierop and El-Geneidy (2017) identified an additional group which they coined "captive by choice," based on the fact that this group does not have access to an additional mode, but financially, is not limited to transit.

Acknowledging that there are different groups who use transit is important as the relationships between satisfaction and loyalty may not be consistent among all user types. This idea has been pointed out by dell'Olio, Ibeas et al. (2010) who found that service quality was perceived differently by various types of users. Understanding the existence of different groups is essential since it illustrates the benefit of segmenting transit markets before attempting to understand the causes of satisfaction and loyalty.

4.4 HYPOTHESES

Based on a review of the relevant literature, the basic conceptual relationships between different aspects of customer satisfaction and loyalty are presented in Figure 9. These relationships are illustrated in their most rudimentary form and the hypotheses that are tested in this study are listed below. The factors included in the figure are based on the data discussed below and include satisfaction with information, safety, cleanliness, service quality and loyalty for users of both bus and rail. The dashed grey boxes around "satisfaction with quality of information," "satisfaction with safety," and "satisfaction with sense of cleanliness" demonstrate that due to data availability only two of the three are modelled for each transit agency that will be discussed in the following section. The hypotheses for each group using transit are:

H1: Transit users' satisfaction with the quality of information have a positive effect on their satisfaction with the service quality of the bus.

H2: Transit users' satisfaction with the quality of information have a positive effect on their satisfaction with the service quality of rail.

H3: Transit users' satisfaction with the sense of safety have a positive effect on their satisfaction with the service quality of the bus.

H4: Transit users' satisfaction with the sense of safety have a positive effect on their satisfaction with the service quality of the rail.

H5: Transit users' satisfaction with cleanliness have a positive effect on their satisfaction with the service quality of the bus.

H6: Transit users' satisfaction with cleanliness have a positive effect on their satisfaction with the service quality of rail.

H7: Transit users' satisfaction with the service quality of bus has a positive effect on their loyalty to transit overall.

H8: Transit users' satisfaction with the service quality of rail has a positive effect on their loyalty to transit overall.

H9: The strength of the relationships between factors will vary between captive, choice, and captive by choice users (not included in figure 9).
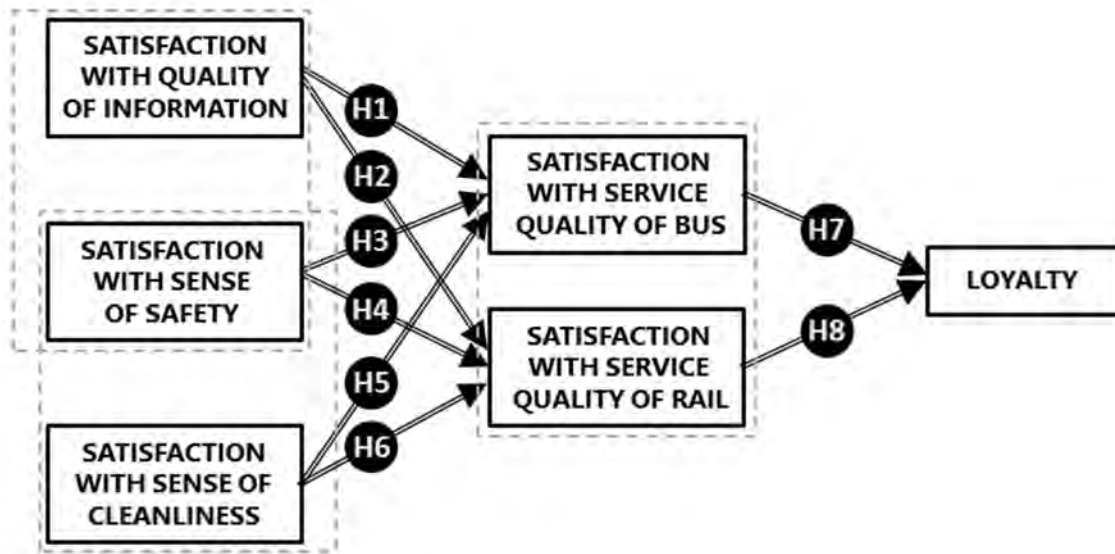
Figure 9: General model presenting the conceptual framework of the factors influencing loyalty

4.5 DATA

The data used for this study is obtained from two large public transit agencies in Canada: Montreal's Société de transport de Montréal (STM) and Vancouver's TransLink under a data sharing agreement to be used in academic research. In 2011, the population of the Montreal census metropolitan area (CMA) was 3,824,221 with a transit mode share of 22.2 percent for work trips. In Vancouver the CMA was 2,313,328 with 19.7 percent using transit for work trips (Statistics Canada 2014). The transit agencies in both cities provided the results of ten years of customer satisfaction questionnaires that were conducted three or four times a year using telephone interviews. Because participation was voluntary, non-response bias may be present. In both regions these questionnaires are intended to evaluate how residents perceive the quality of the transit service provided by the transit agencies. They are used by the transit agencies to better understand perception of service quality and also as insight into where changes and/or improvements to service attributes can be accomplished to increase customer satisfaction and, accordingly, increase ridership. To assess customer satisfaction with the transit service, the STM asks survey participants to report their experience with transit in general over the last 30 days. TransLink, however, takes a different approach by asking participants to specifically report their experience of their last and second to last trip. Although both strategies are appropriate for collecting information concerning customer satisfaction, the STM's approach of asking about individuals' experiences in general may lack detail, whereas TransLink's method of asking about the previous trip could result in some individuals reporting irregular travel behaviour, which can provide a better picture of the usage of the overall system. The two questionnaires asked similar questions, included several identical ones, and the sample sizes were large, thus the differences

in the method of the data collection are not problematic for this study as we only include data that is consistent between the two cities and analyze each region separately.

The STM and TransLink provided data for surveys conducted between the five years of September 2009 and December 2013. Not all questions were asked every year, and therefore inconsistent questions were removed from the database and not included in the analysis. In addition, only individuals who used two transit modes (bus + metro/SkyTrain) in combination are included in the analysis, to ensure that all users experience at least one transfer. The data is not weighted as it would require the sample to have auxiliary information for all transit users in the regions and also did not contain geographic information such as origin and destination points. However, the data is a representative random sample of transit users only, and, according to the STM and TransLink, are representative of the greater population.

Additional data cleaning was required to remove entries that were missing relevant information as well as apparent mistakes in the data such as entries that were too high for the scale provided (e.g. satisfaction 11/10). The surveys asked information including, but not limited to, transit users' socioeconomic status, personal preferences, perception of satisfaction and travel habits. After data preparations were completed, a total of 2,568 observations were found suitable for the STM analysis and 9,370 for TransLink.

To avoid analyzing all transit users as equal, this chapter segments the transit markets based on the categories identified in previous research and recognizes transit users as choice, captive, or captive by choice:

Choice users: Car access
Captive users: No car access, low income
Captive by choice users: No car access, do not have low income (TransLink >$65,000; STM>$60,000)

This threshold captures the closest survey income categories to Montreal ($69,150) and Vancouver's ($68,970) median total household incomes in 2011, the year that was chosen because the surveys were administered between 2009-2013 (Statistics Canada 2012). There were 1,063 (41%) captive users, 1,297 (51%) choice users, and 208 (8%) captive-by-choice users for the STM, and 2,228 (24%), 6,055 (65%), and 1,047 (11%) for TransLink respectively. Table 10 presents summary statistics for the sample populations.

Table 10: Summary Statistics

	TRANSLINK *N*=9370				STM *N*=2568			
	All users	Captive (24%)	Choice (65%)	Captive by choice (11%)	All users	Captive (41%)	Choice (51%)	Captive by choice (8%)
AGE								
16-24	17%	19%	15%	27%	12%	12%	10%	16%
25-34	13%	15%	12%	17%	21%	19%	23%	17%
35-44	19%	15%	20%	21%	17%	14%	20%	18%
45-54	21%	18%	22%	20%	20%	18%	21%	22%
55-64	17%	17%	19%	10%	17%	18%	16%	19%
65 and over	13%	17%	13%	5%	14%	18%	11%	7%
STATUS								
Student	12%	14%	10%	17%	22%	22%	22%	21%
Employed	66%	54%	69%	72%	68%	59%	74%	77%
Other	22%	32%	21%	11%	10%	18%	5%	2%
INCOME								
Under $25,000	14%	37%	9%	0%	18%	33%	10%	0%
$25,000-$45,000	18%	34%	15%	0%	28%	40%	23%	0%
$45,000-$65,000	19%	29%	19%	0%	23%	27%	23%	0%
$65,000-$85,000	16%	0%	18%	40%	12%	0%	16%	49%
More than $85,000	32%	0%	39%	60%	18%	0%	28%	51%
SURVEY YEAR								
2009	19%	22%	18%	16%	9%	10%	8%	8%
2010	22%	22%	21%	22%	22%	23%	21%	24%
2011	19%	19%	19%	18%	24%	26%	22%	25%
2012	20%	20%	20%	21%	27%	25%	30%	27%
2013	21%	18%	21%	23%	18%	17%	19%	16%

4.6 METHODS AND RESULTS

Structural Equation Modelling (SEM) is a common approach to assess satisfaction and loyalty in public transit research (Minser and Webb 2010, Eboli and Mazzulla 2012, de Oña, de Oña et al.

2013, Shiftan, Barlach et al. 2015). This modelling technique can use latent variables to capture individuals' underlying perceptions and can provide descriptive information about the relationships within a theoretical causal model (Peter and Olson 1999, Weinstein 2004). SEM techniques begin with a Confirmatory Factor Analysis (CFA) to determine the measurement model, and are followed by a structural model. While the CFA confirms the existence of variable groups, it does not describe the relationship between variables. It is the structural model that, based on a theoretical framework, determines the significance of the relationship between variables.

Although many studies use SEM to implement on an entire transit population, we combine this technique with a different strategy to improve our understanding of loyalty. More specifically, we combine SEM with a market segmentation analysis to allow for a more in-depth analysis of the different groups existing within the studied transit markets. Such an approach provides insight into the relationship between attributes among the different groups. Even though this combination of SEM and market segment analysis approach is likely to provide transit agencies with information necessary to better understand the needs and desires of different groups within a transit market (Demby 1994, Peter and Olson 1999, Weinstein 2004), this type of analysis remains rare. The segments used in this study are based on car access and income, and have been previously described in the data section of this chapter.

4.6.1 Exploratory Factor Analysis

The first phase of the analysis involved an exploratory factor analysis (EFA) of the captive, choice, and captive by choice users present in the TransLink and STM markets. Table 11 and Table 12 show the results of the factor analysis before segmentation was applied to each agency. The factors are based on eigenvalues that are greater than one, and the same analysis was applied

to every group using transit. Only the results for the homogenous transit markets, or unsegmented datasets, are shown here. However, identical factors with varying factor loadings were uncovered for every group. For TransLink, the EFA explained 70.8 percent of the data, and for the STM it was 67.4 percent.

All of the variables included in the analysis are based on questions that were asked using a 10 point Likert scale. The majority of the questions asked specifically about transit users' satisfaction with particular aspects of a trip, but in the STM data several questions were answered by stating agreement instead of satisfaction. To be more specific, instead of asking about satisfaction with reliability, the STM asked *"What is your level of agreement with the following statement: In the last month, the métro service on the lines that I used was reliable."* This slight difference in wording was not considered problematic for the analysis as the scale remained the same.

Table 11: Results from the Exploratory Factor Analysis for TransLink

TRANSLINK FACTORS	CODE	FACTOR LOADINGS			
Satisfaction with service quality of bus:					
How would you rate your last/second last bus trip in terms of providing on-time reliable service?	BUSRELIAB	.845			
How would you rate your last/second last bus trip for service overall?	BUSOVERAL	.805			
How would you rate your last/second last bus trip in terms of frequency of service?	BUSFREQ	.792			
How would you rate your last/second last bus trip in terms of trip duration from the time you boarded to the time you got off the bus?	BUSTRIPDUR	.515			
Satisfaction with sense of safety:					
How would you rate your last/second last SkyTrain trip in terms of feeling safe from crime inside the SkyTrain station?	SKYSAFESTP		.814		
How would you rate your last/second last SkyTrain trip in terms of feeling safe from crime onboard the SkyTrain?	SKYSAFEON		.805		
How would you rate your last/second last bus trip in terms of feeling safe from crime at the bus stop where you boarded or at the transit exchange?	BUSSAFSTP		.650		
How would you rate your last/second last bus trip in terms of feeling safe from crime onboard the bus?	BUSSAFON		.586		
Satisfaction with quality of information:					
How would you rate the transit system for providing adequate information on-board transit vehicles, starting with bus?	BUSONBORDINFO			.922	
How would you rate the transit system for providing adequate information on-board transit vehicles, starting with SkyTrain?	SKYONBORDINFO			.723	
Thinking of the transit system in Greater Vancouver, how would you rate it for providing adequate transit information at stops and stations?	INFOSTO			.660	
Satisfaction with quality of SkyTrain:					
How would you rate your last/second last SkyTrain trip in terms of providing on-time reliable service?	SKYRELIAB				.801
How would you rate your last/second last SkyTrain trip in terms of frequency of service?	SKYFREQ				.801
How would you rate your last/second last trip by SkyTrain in terms of service overall?	SKYOVERAL				.673
Cronbach's Alpha		.842	.826	.820	.825

Table 12: Results from the Exploratory Factor Analysis for the STM

STM FACTORS	CODE	FACTOR LOADINGS			
Satisfaction with sense of safety:					
What is your level of agreement with the following statement: "I feel that the driver drives carefully while respecting traffic regulations."	DRIVCARE	.945			
What is your level of satisfaction with the way in which drivers start, drive and stop their buses on the STM bus routes that you use?	SATDRIV	.753			
What was your level of security at any time you were on the bus?	SAFIB	.603			
What is your level of satisfaction with the courtesy of the drivers during your exchanges with them?	SATSERVB	.452			
Satisfaction with service quality of bus:					
What is your level of general satisfaction with all aspects of the service when you travelled aboard an STM bus in the last month?	SATBUS		.808		
What is your level of satisfaction with the frequency or the number of buses on the routes you use?	SATPOPAVB		.783		
What is your level of satisfaction with the punctuality of the buses that you take?	SATPUNCB		.703		
Satisfaction with cleanliness:					
What is your level of satisfaction with the cleanliness inside the metro cars?	SATCLNCM			.902	
What is your level of satisfaction with the cleanliness inside the stations that you use most often?	SATCLNSM			.768	
What is your level of satisfaction with the cleanliness inside STM buses that you have taken?	SATCLNCB			.423	
Satisfaction with quality of metro:					
What is your level of general satisfaction with all aspects of the service when you travelled by metro in the past month?	SATMET				.758
What is your level of agreement with the following statement: "In the last month, the metro service on the lines that I used was reliable."	RELIABM				.705
What is your level of satisfaction with the frequency or the number of trains?	SATPOPAVM				.549
Cronbach's Alpha		.801	.804	.758	.730

4.6.2 The Measurement Models (Confirmatory Factor Analyses)

Using AMOS 22.0.0, the results of the EFA were confirmed through a Confirmatory Factor Analysis (CFA). Accordingly, the factors in Table 11 and Table 12 were used to construct the latent variables present in the measurement models and identified four latent variables for each transit agencies' data. For TransLink these were "satisfaction with quality of information", "satisfaction with sense of safety", "satisfaction with service quality of bus", and "satisfaction with quality of SkyTrain." Similarly, for the STM they included "satisfaction with cleanliness", "satisfaction with sense of safety", "satisfaction with service quality of bus", and "satisfaction with quality of metro." While the service quality factors are similar for both transit agencies, variation exists in the safety variables. In addition, the results reveal that TransLink's "satisfaction with quality of information" variable and the STM's "satisfaction with cleanliness" variable are unique to each agency. This is an important finding for SEM research in the field of transport planning as it demonstrates the significance of the input data. For example, in the TransLink survey there were more questions about safety from crime compared to the STM which included a wider set of questions concerning a variety of aspects related to safety. In addition, while the TransLink survey asked several questions relating to information, similar questions were not included in the STM's survey, and therefore could not be included in the analysis. The reverse is true of questions regarding cleanliness. What these differences demonstrate is that while many recent SEM studies in this field have made claims about which aspects of transit service should be improved based on SEM techniques, this finding should remind researchers that the quality and quantity of survey questions, which are often a reflection of a transit agency's priorities, will likely lead to different results. Therefore while the findings of the studies mentioned in the literature review are different with regard to which aspects of

service quality they suggest to increase loyalty, these results may be context specific, and therefore may not be transferrable to other cities.

The measurement models for each transit agency were assessed through a CFA and deemed to be good fit based on their goodness-of-fit index (GFI: TransLink (T)= .938 & STM (S)= .968), adjusted goodness-of-fit (AGFI: T=.908 & S=.951), comparative fit index (CFI: T=.940 & S=.959), Normed Fit Index (NFI: T=.939 & S=.954) standardized root mean square residual (SRMR: T=.0481 & S=.0502), and the root mean square error of approximation (RMSEA: T=.075 & S=.058) (Hoyle and Panter 1995, MacCallum, Browne et al. 1996, Kline 1998, Hu and Bentler 1999).

Item reliability is considered acceptable when all loadings are greater than 0.5 (Hair, Black et al. 2010). This criterion is met for all models. In addition, construct reliability meets the criteria to be greater than 0.6 for all models and the average variance extracted is found to have satisfactory values. In addition, all constructs showed values of Cronbach's Alpha greater than the cut off value of 0.7 (Iacobucci and Duhachek 2003).

4.6.3 The loyalty variables

To generate the loyalty variable on which the latent variables are tested a loyalty score was computed using variables that were not previously included in the analysis. The previously mentioned "secure customer" framework was used to generate the loyalty variable as suggested by the TCRP report on customer satisfaction (Transportation Research Board 1999). For TransLink this included the questions: *(1) "Based on your own experience in the past [seven/thirty] days, on a scale of one to ten, where '10' means 'excellent' and 'one' means 'very poor,' how would you rate the overall service provided by the transit system in Metro Vancouver?"* and *(2) "On a scale from 1 – 5 with one being 'definitely not continue as often'*

and 5 being 'definitely continue as often as am now,' how likely are you to continue to take transit as often as you do now in the foreseeable future?" And for the STM: *(1) "Generally speaking, thinking about your experience with the STM public transit services in the 30 days, what is your level of satisfaction, out of 10, with all aspects of the STM services?"*, *(2) "For how long are you planning to keep using STM public transit network? A few weeks, a few months, a few years, or many years?"*, and *(3) "On a scale from one to ten, would you recommend STM services to your friends or your co-workers?"*

As is evident, while using the STM allowed for the generation of the loyalty score as recommended by the TCRP report, the fact that TransLink did not ask a question about recommending the service to a friend or co-worker resulted in the use of loyalty score that only included information about overall satisfaction with the service as well as intention to use the service in the future. In each case, we first adjusted the scale of each item to be out of ten, and then we generated an overall loyalty score comprised of the abovementioned questions, and again adjusted it by taking the average to ensure that this variable would also be on a ten point scale.

4.6.4 Structural models

After assessing the results of the CFA, four structural models for each transit agency were built. This resulted in a total of eight models. For each transit agency one general model was developed using the entire sample of transit users for each transit agency. Then, each agency's sample was divided into three groups: captive users, choice users, and captive by choice users. Each model tested the hypothetical paths on the sample data and used the maximum likelihood method of estimation to analyze the data (Chen 2008). The models demonstrate the relationships between the latent variables and the loyalty score. For TransLink, the models test how

satisfaction with information and safety influence continued future use via satisfaction with the service quality of each mode. Because of the results of the factor analysis presented in Table 12, the STM model tests cleanliness instead of information.

The structural models presented in Figure 10 and Figure 11 show good model fit. The findings for the general models are presented above, and those for the captive, choice, and captive by choice models are shown in the tables below. All values exceed the recommended levels and are higher than those used by many in the field (Chen 2008, Githui, Okamura et al. 2010, de Oña, de Oña et al. 2013, Eboli and Mazzulla 2014).

TRANSLINK	CAPTIVE		CHOICE		CAPTIVE BY CHOICE	
	Estimate (p<0.001)	Goodness-of-fit	Estimate (p<0.001)	Goodness-of-fit	Estimate (p<0.001)	Goodness-of-fit
Info->Bus	0.28		0.35		0.31	
Info->SkyTrain	0.16	GFI: .941	0.22	GFI: .934	0.20	GFI: .933
Safety->Bus	0.44	AGFI: .916	0.38	AGFI: .905	0.31	AGFI: .904
Safety->SkyTrain	0.67	CFI: .948	0.58	CFI: .935	0.58	CFI: .928
Bus->Loyalty	0.31	SRMR: .0472	0.31	SRMR: .0471	0.29	SRMR: .0527
SkyTrain->Loyalty	0.34	RMSEA: .069	0.38	RMSEA: .074	0.33	RMSEA: .072

Figure 10: Structural model for TransLink
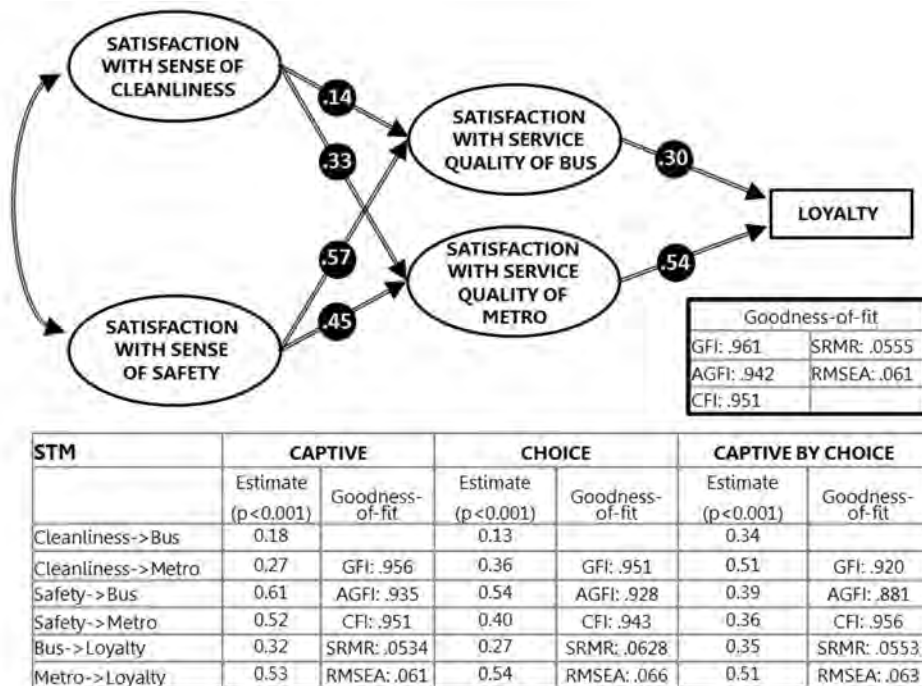
Figure 11: Structural model for the STM

The findings presented in Table 13 and Table 14 demonstrate that the nine hypotheses presented in Figure 9 are positive and significant for all models. The findings exhibit that transit users' satisfaction with the quality of service relating to safety, information, and cleanliness have a positive effect on their satisfaction with mode specific characteristics which, in turn, have a significant positive effect on loyalty. Safety appears to be the most important, and these findings are similar to previous research (Minser and Webb 2010, Figler, Sriraj et al. 2011, Lai and Chen 2011, Zhao, Webb et al. 2014). In addition, cleanliness, information and other service characteristics such as punctuality and frequency have similarly been cited to influence satisfaction and loyalty (Weinstein 2000, Tyrinopoulos and Antoniou 2008, de Oña, de Oña et al. 2013, Carreira, Patrício et al. 2014, Mouwen 2015).

Table 13: Model results: TransLink

TRANSLINK			ALL USERS			CAPTIVE			CHOICE			CAPTIVE BY CHOICE		
			Estimate	S.E.	P	Estimate	S.E.	P	Estimate	S.E.	P	Estimate	S.E.	P
Among constructs	BUS	<--- INFO	0.332	0.012	***	0.278	0.024	***	0.346	0.015	***	0.315	0.04	***
	SKYTRAIN	<--- INFO	0.203	0.009	***	0.165	0.017	***	0.217	0.012	***	0.197	0.026	***
	BUS	<--- SAFETY	0.381	0.016	***	0.437	0.032	***	0.381	0.02	***	0.308	0.049	***
	SKYTRAIN	<--- SAFETY	0.603	0.014	***	0.666	0.026	***	0.58	0.017	***	0.58	0.037	***
	LOYALTY	<--- BUS	0.308	0.01	***	0.308	0.019	***	0.308	0.012	***	0.285	0.027	***
	LOYALTY	<--- SKYTRAIN	0.365	0.012	***	0.339	0.026	***	0.383	0.015	***	0.326	0.042	***
Among items and constructs	BUSOVERAL	<--- BUS	0.82	---	---	0.814	---	---	0.819	---	---	0.837	---	---
	BUSTRIPDUR	<--- BUS	0.635	0.011	***	0.634	0.022	***	0.648	0.014	***	0.561	0.034	***
	BUSFREQ	<--- BUS	0.772	0.014	***	0.798	0.027	***	0.765	0.017	***	0.753	0.042	***
	BUSRELIAB	<--- BUS	0.807	0.013	***	0.827	0.026	***	0.799	0.016	***	0.811	0.041	***
	SKYOVERAL	<--- SKYTRAIN	0.775	---	---	0.77	---	---	0.785	---	---	0.727	---	---
	SKYFREQ	<--- SKYTRAIN	0.77	0.014	***	0.799	0.029	***	0.761	0.016	***	0.756	0.051	***
	SKYRELIAB	<--- SKYTRAIN	0.801	0.013	***	0.821	0.028	***	0.795	0.015	***	0.796	0.049	***
	SKYSAFEON	<--- SAFETY	0.766	---	---	0.778	---	---	0.759	---	---	0.771	---	---
	BUSSAFSTP	<--- SAFETY	0.729	0.014	***	0.732	0.026	***	0.739	0.017	***	0.677	0.044	***
	BUSSAFON	<--- SAFETY	0.713	0.012	***	0.73	0.024	***	0.711	0.015	***	0.694	0.039	***
	SKYSAFESTP	<--- SAFETY	0.741	0.014	***	0.75	0.028	***	0.738	0.018	***	0.726	0.046	***
	BUSONBOARDINFO	<--- INFO	0.841	---	---	0.87	---	---	0.834	---	---	0.814	---	---
	INFOSTO	<--- INFO	0.73	0.012	***	0.736	0.022	***	0.739	0.015	***	0.654	0.041	***
	SKYONBOARDINFO	<--- INFO	0.766	0.012	***	0.792	0.022	***	0.759	0.014	***	0.759	0.041	***

Table 14: Model results: STM

STM			ALL USERS			CAPTIVE			CHOICE			CAPTIVE BY CHOICE		
			Esti mate	S.E.	P	Esti mate	S.E.	P	Esti mate	S.E.	P	Esti mate	S.E.	P
Among constructs	BUS	<---	CLEANLINESS	0.138	0.026	***	0.129	0.04	***	0.129	0.036	***	0.338	0.105	***
	METRO	<---	CLEANLINESS	0.334	0.023	***	0.272	0.034	***	0.362	0.032	***	0.512	0.089	***
	BUS	<---	SAFETY	0.566	0.03	***	0.607	0.049	***	0.54	0.04	***	0.393	0.122	***
	METRO	<---	SAFETY	0.445	0.025	***	0.52	0.039	***	0.396	0.033	***	0.362	0.098	***
	LOYALTY	<---	BUS	0.297	0.014	***	0.324	0.023	***	0.267	0.02	***	0.349	0.051	***
	LOYALTY	<---	METRO	0.537	0.02	***	0.529	0.034	***	0.544	0.026	***	0.507	0.062	***
Among items and constructs	SATBUS	<---	BUS	0.817	---	---	0.816	---	---	0.813	---	---	0.865	---	---
	SATPOPAVB	<---	BUS	0.756	0.027	***	0.763	0.042	***	0.76	0.039	***	0.697	0.09	***
	SATPUNCB	<---	BUS	0.714	0.028	***	0.712	0.042	***	0.71	0.041	***	0.739	0.093	***
	SATMET	<---	METRO	0.755	---	---	0.725	---	---	0.767	---	---	0.799	---	---
	SATPOPAVM	<---	METRO	0.627	0.028	***	0.595	0.045	***	0.655	0.039	***	0.59	0.087	***
	RELIABM	<---	METRO	0.684	0.034	***	0.664	0.056	***	0.685	0.046	***	0.771	0.114	***
	SATDRIV	<---	SAFETY	0.773	---	---	0.759	---	---	0.792	---	---	0.748	---	---
	SAFIB	<---	SAFETY	0.663	0.021	***	0.685	0.034	***	0.634	0.027	***	0.725	0.071	***
	DRIVCARE	<---	SAFETY	0.798	0.024	***	0.799	0.038	***	0.812	0.032	***	0.717	0.089	***
	SATSERVB	<---	SAFETY	0.633	0.027	***	0.613	0.045	***	0.641	0.035	***	0.706	0.107	***
	SATCLNCM	<---	CLEANLINESS	0.801	---	---	0.785	---	---	0.819	---	---	0.791	---	---
	SATCLNCB	<---	CLEANLINESS	0.557	0.024	***	0.551	0.041	***	0.546	0.033	***	0.663	0.077	***
	SATCLNSM	<---	CLEANLINESS	0.813	0.029	***	0.811	0.048	***	0.808	0.039	***	0.838	0.089	***

4.7 DISCUSSION AND POLICY RECOMMENDATIONS

4.7.1 General models

The results demonstrate that transit users' satisfaction with sense of safety is positively associated with their satisfaction with the service quality of bus and SkyTrain/metro in both the general models for the STM and TransLink. However, for TransLink, the impact is higher for safety on SkyTrain than it is on bus, whereas for the STM it is the opposite. This difference is no surprise considering the variation in the items included in the safety latent constructs for each agency. For TransLink's general model, satisfaction with the quality of information has a

stronger effect on satisfaction with the service quality of bus than SkyTrain. This finding makes sense considering that bus systems generally are more complex and difficult to navigate compared to rail systems due to their size and inherent flexibility. In both the general TransLink and STM models, satisfaction with the service quality of both modes is significantly and positively associated with loyalty. Most importantly, however, both models show that the impact of being satisfied with rail (SkyTrain or metro) is stronger than bus. This means that for transit users who take both modes, the quality of their experience using the SkyTrain or metro has a greater influence on their loyalty to the system compared to their experience using the bus. This may be due to the fact that for many of these trips, the rail component is the line-haul part of the trip, whereas the bus segment may be the feeder part. Therefore, it is important to ensure a high level of service quality for the rail segment, but this finding also suggests that service improvements are needed to increase users' satisfaction with bus services.

4.7.2 Comparing models: Captive, choice, and captive by choice

It is important for transit agencies to recognize that different factors influence loyalty among captive, choice, and captive by choice users. Based on a comparison of the results for the different groups, the TransLink models revealed that captive users' satisfaction with mode specific services is influenced less by the quality of information than choice and captive by choice users. In contrast, captive users' satisfaction with mode-specific services is influenced more by safety than are the other groups. This finding is expected as captive users rely on the transit system and are likely to be familiar with it and value safety as they do not have the opportunity to switch to using an alternative mode. Another important difference between the models is that while for all groups loyalty is more closely related to the service quality of the SkyTrain and the bus, this is less so for captive users. This might be because captive users in

Vancouver live farther from the SkyTrain due to lower housing costs (Foth 2010) and, therefore, may be more dependent on the bus network.

The findings for the STM are similar to those of TransLink. Firstly, the importance of safety is the highest for captive users. More specifically, satisfaction with mode specific services is influenced less by cleanliness than safety. This finding demonstrates that safety is an important issue for passengers of both transit agencies, a finding that is similar to other studies (Githui, Okamura et al. 2010). Specific strategies have been suggested by Yavuz and Welch (2010) who claim that transit users' perception of safety can be improved by increasing the presence of police, installing surveillance video cameras and by making the service more reliable. In addition, Carreira, Patrício et al. (2014) find that users' trust in bus drivers' skills influence their perception of transit. Furthermore, the results of the present study demonstrate that captive by choice users are the least influenced by safety and while satisfaction with cleanliness has a greater impact on satisfaction with the service quality of the metro than the bus, the difference is most strongly observed for choice users. As in the TransLink sample, the STM's sample also shows that satisfaction with the service quality of the metro is more strongly associated with future use than satisfaction with the service quality of the bus. Again, this effect is not as strong for captive users who compared to choice and captive by choice riders, are the least influenced by the service quality of the metro, showing that the service quality of bus services is also important for them.

These results demonstrate that system improvement strategies which focus on a particular aspect of service quality will influence the loyalty of the groups in different ways. In addition, system improvements that are targeted at choice and captive by choice users are important not only to benefit these groups, but also to improve the experience of using transit for captive users.

In other words, a service improvement targeted at a specific group could motivate ridership among others as well.

4.7.3 Improvement strategies

Based on the results of both the general and group specific models, several areas can be identified as being essential to increase loyalty among transit users. In this section we will discuss the strategies that can be adopted by transit agencies to increase user satisfaction and loyalty. Increasing loyalty is expected to increase patronage among the different groups. Table 15 provides a summary of the effectiveness of implementing strategies for the different groups using transit.

4.7.3.1 Service quality of bus
As the models indicate (Table 13 and Table 14), service quality with rail (SkyTrain/metro) is more influential than service quality with bus services when it comes to influencing future use and gaining loyal transit customers. However, because of the significant cost savings associated with developing comprehensive bus networks compared to rail, transit agencies should work to develop more enjoyable bus services by attempting to integrate rail-like features. In other words, bus systems should be built to enhance travellers' experiences over time by implementing service improvements gradually (Diab and El-Geneidy 2015), and strategies should be developed to assess how satisfied transit users are with bus services in detail.

4.7.3.2 Reliability
With regard to improving other aspects of service quality, the results of this study show that for both TransLink and the STM metro/SkyTrain reliability is more influential than frequency in predicting users' overall satisfaction with the service quality of the metro. For TransLink, this is also true for all bus users. Unfortunately, since the STM assesses transit users' satisfaction with

punctuality rather than reliability, this information is unknown. However, because of the consistencies for all groups in TransLink and metro users in the STM, we assume that in general a reliable service is more important for increasing satisfaction with the service quality of a mode than is the frequency of the service. Recent research has highlighted the importance of service reliability, demonstrating that transit agencies wishing to increase their customers' levels of satisfaction should focus on developing a consistently reliable service (Chakrabarti and Giuliano 2015).

4.7.3.3 Safety

The findings on safety demonstrate that transit agencies should ensure that users' perceptions of safety should be increased in order to positively influence overall mode satisfaction and loyalty. As previously discussed in this chapter, the results of this study demonstrate that satisfaction with safety is more important than satisfaction with either cleanliness or information. More specifically, for the STM the way that the driver operates the bus is the most influential aspect characterizing safety. This means that bus users tend to value drivers who operate vehicles carefully while respecting traffic regulations, as well those who skillfully start, drive, and stop their buses. This is especially true for choice riders compared to the other groups using transit. Although for captive and captive by choice riders, the drivers' way of operating a vehicle is also important in defining safety, compared to choice riders these groups are more influenced by the level of security inside the bus as well as the level of satisfaction with the courtesy of the driver during personal exchanges. TransLink's customer satisfaction survey asked participants less detailed information about safety. However, the results of the analysis show that safety on the SkyTrain is most representative of the overall sense of safety of all groups. Regardless, the factor loadings associated with all aspects of safety are higher for captive users than they are for choice users, which in turn tend to be higher than those for captive by choice users. Possible

interventions to increase users' satisfaction with safety include the implementation of services such as the STM's in between stops services for women travelling alone in the evenings and at night, the application of safety features such as automatic platform gates at rail stations, the development of dedicated lanes for safe and smooth driving conditions, as well as those previously mentioned by Yavuz and Welch (2010) that include improved surveillance measures.

4.7.3.4 Information

Transit agencies should be aware that on board information, rather than information at transit stops, contributes more to the overall satisfaction with the quality of information. The results also demonstrate that information about transit services is not as relevant for captive users compared to other groups. Transit agencies wishing to ensure that customers feel comfortable with the system should ensure that information is both accessible and accurate for all users regardless of socioeconomic background, languages spoken, or physical and mental ability.

4.7.3.5 Cleanliness

Transit users' perceptions of satisfaction with the sense of cleanliness are strongly influenced by their satisfaction with the cleanliness inside the metro stations. In contrast, satisfaction with the cleanliness inside buses is not as representative and for choice users, satisfaction with the cleanliness inside the metro cars is not as strongly related as the cleanliness around the stations. Accordingly, transit agencies should increase the levels of cleanliness in buses and maintain the cleanliness of rail services.

Table 15: Summary of effectiveness of strategies

Strategies	Captive	Choice	Captive by choice
Service quality of bus	⬆ (black)	⬆ (white)	⬆ (white)
Service quality of rail	⬆ (white)	⬆ (black)	⬆ (white)
Reliability	⬆ (black)	⬆ (white)	⬆ (black)
Safety	⬆ (black)	⬆ (white)	⬆ (white)
Information	⬆ (white)	⬆ (black)	⬆ (black)
Cleanliness	⬆ (white)	⬆ (white)	⬆ (black)
		Black arrow = strong association	
		White arrow = medium association	

4.8 STUDY LIMITATIONS AND FUTURE RESEARCH

While there are five areas of focus listed above, a limitation of this study is that comfort, accessibility, and affordability were poorly measured in the surveys and therefore did not show up in the analysis. Therefore, the results are fairly general and future research should attempt to assess these and other possible service attributes to further develop the understanding of the relationship between satisfaction and loyalty in order to more specifically inform public transit marketing managers. In addition, no information was collected about how the value of transit is perceived compared to other modes, which may be a factor in mode choice decision making. Finally, future research should assess whether the relationships between variables have changed over time. Regardless of its limitations, the addition of this study to the literature is that it demonstrates that the abovementioned areas where strategies need to be developed are generalizable among transit agencies and clarifies that the path to increasing loyalty amongst transit users differs among captive, choice, and captive by choice riders.

While planners often consider that every city is embedded in its own cultural, geographic, and economic context, the results of this study show that the causes of satisfaction and loyalty are similar in two geographically and culturally distinct Canadian cities. Furthermore, even

though transportation plans should come as a result of context specific studies, planners need to recognize that transit users are more likely to be loyal to a system that is reliable, frequent, safe, clean, and provides accurate and accessible information.

5 CHAPTER FIVE: PERCEIVED REALITY: UNDERSTANDING THE RELATIONSHIP BETWEEN CUSTOMER PERCEPTIONS AND OPERATIONAL CHARACTERISTICS

5.1 OVERVIEW OF CHAPTER

The previous chapters have discussed that it is important to ensure that customers are satisfied with public transit, as satisfied customers are likely to demonstrate loyalty by continuing to use the service over time. Ensuring that customers are satisfied with public transit is important, and traditionally transit agencies have assessed customer satisfaction using questionnaires designed to collect information about users' personal characteristics and perceptions of service. However, these questionnaires only assess individuals' perceptions of transit services, without accounting for the service that users actually experienced. With this in mind, the purpose of this chapter is to analyze the drivers of public transit satisfaction among users based on an analysis of customer satisfaction questionnaires, as well as operations data obtained from automatic vehicle location (AVL) and automatic passenger counter (APC) systems for an express bus route in Vancouver, Canada. We seek to understand what are the main factors influencing customer satisfaction in this context, and question whether using operations data in parallel with passengers' perception data is useful to understand customer satisfaction. Using a series of logit models we find that both actual crowding and users' reported satisfaction with crowding are associated with how transit users perceive overall satisfaction with the bus service. Furthermore, the models reveal that car access, age, past use, and users' perceptions of frequency, on-board safety, and cleanliness are also positively associated with overall satisfaction. This study could be useful for public transit planners as it provides new insight into how data derived from customer satisfaction surveys and bus operations can be used to identify which modifiable components of the service can be prioritized in order to effectively increase riders' overall satisfaction.

This chapter has been accepted for presentation at the 96th Annual Meeting of the Transportation Research Board, which will be held in Washington, D.C. from January 8th-12th 2017.

5.2 INTRODUCTION

As cities around the world plan for sustainable transport options, public transit agencies are becoming increasingly customer-oriented in order to retain current users and attract new ones. Accordingly, many transit agencies are currently focusing on understanding the policies that are needed to increase customer satisfaction among users (dell'Olio, Ibeas et al. 2011, de Oña, de Oña et al. 2013). Ensuring that customers are satisfied with public transit is important, as satisfied customers are more likely to demonstrate loyalty by continuing to use the service over time (Imaz, Habib et al. 2015) and recommend it to others (Diab, van Lierop et al. 2017). Traditionally, transit agencies have assessed customer satisfaction and priorities using questionnaires designed to collect information about users' personal characteristics and perceptions of service. However, these questionnaires only assess individuals' perceptions of transit services, without accounting for the service users actually received. Previous research has revealed that there is a disconnect between the level of satisfaction that users experience in comparison to the improvements in service quality that are introduced by a transit agency (El-Geneidy and Surprenant-Legault 2010, Diab, Badami et al. 2015). Therefore, while findings from customer satisfaction questionnaires are useful to assess how transit users' experience different aspects of a transit service, customer satisfaction studies alone tend to provide an incomplete picture of actual service performance. With this in mind, the purpose of this chapter is to analyze the drivers of public transit satisfaction among users of an express bus route in Vancouver, Canada based on an analysis of data derived from both customer satisfaction

questionnaires, and operations data obtained from automatic vehicle location (AVL) and automatic passenger counter (APC) systems. We seek to answer two research questions: the first asks whether users' perceptions of customer satisfaction along a high-frequency express route in Vancouver, Canada match the reality that is reported on the ground; and, the second questions whether using both data coming from customer satisfaction surveys and operations data can be useful to better understand overall customer satisfaction. To our knowledge, no previous research has combined perception and personal characteristic variables obtained from customer satisfaction questionnaires together with operations data to evaluate users' overall satisfaction with a transit service.

We start this chapter with a review of the literature focusing on the service factors which are associated with customer satisfaction. Second, we discuss the data sources and methods used in the analyses. Third, we present our results of the logistic regressions, where we develop three models to better understand how various elements of travel and personal characteristics are associated with overall customer satisfaction; the first two models include information derived from operations data, whereas the third includes variables that account for users' levels of satisfaction with specific service attributes. This is followed by a discussion of whether it is beneficial to use both AVL/APC and customer satisfaction data in statistical analyses that aim to better understand overall customer satisfaction. Finally, we discuss the findings of the analysis and potential policy implications.

5.3 LITERATURE REVIEW

5.3.1 Overall customer satisfaction

Research on perceived rider satisfaction is important for the economic well-being of transit agencies, and many studies have shown that a customers' level of satisfaction with a service influences their behavioural intentions (Fornell, Johnson et al. 1996, Abou-Zeid, Witter et al. 2012). Understanding what will make a customer satisfied in transit is complex and depends on many different factors (Transportation Research Board 1999, Weinstein 2000, Eboli and Mazzulla 2012). Previous research has suggested that perceptions of service quality are positively related to satisfaction (Jen and Hu 2003, Petrick 2004, Chen 2008), and that satisfaction influences customer loyalty which includes continuous usage and recommending transit to others (Olsen 2007, van Lierop and El-Geneidy 2016). Furthermore, while satisfaction with specific trip attributes is important for assessing overall trip satisfaction, passengers' individual experiences with transit and socio-demographic characteristics are also important to better understand users' perceptions of service quality (Habib, Kattan et al. 2011).

Researchers have made attempts to understand overall satisfaction with transit service quality by evaluating passengers' satisfaction with different service attributes (Ory and Mokhtarian 2005, Tyrinopoulos and Antoniou 2008, Eboli and Mazzulla 2009, Eboli and Mazzulla 2010, Páez and Whalen 2010, Chen and Chao 2011). For example, an early study of customer satisfaction of users of the New York City subway found that station cleanliness and reliability both directly and indirectly influenced overall satisfaction (Stuart, Mednick et al. 2000). In another study, Weinstein (2000) analysed customer satisfaction in the San Francisco Bay Area and found that on-time performance and service information were particularly important factors explaining service quality. In addition, Tyrinopoulos and Antoniou (2008) used

factor analysis and ordered logit modeling to assess customer satisfaction in Athens and Thessaloniki, Greece, and found that satisfaction with transit service coordination, service frequency, accessibility, waiting time and vehicle cleanliness were especially important aspects in explaining overall satisfaction. In a separate study, dell'Olio, Ibeas et al. (2011) used focus groups and stated preference surveys to assess the quality of service desired by bus users in Santander, Spain and found that waiting time, cleanliness and comfort were the most important service factors. In another Spanish study, de Oña, de Oña et al. (2013) used Structural Equation Modelling to assess the drivers of overall satisfaction amongst bus users in Granada and highlighted the importance of satisfaction with service quality, comfort, and safety. More recently, Mouwen (2015) found that public transit users in the Netherlands particularly value on-time performance, travel speed, and service frequency. All of these studies have demonstrated that users perceptions' of and satisfaction with specific service attributes are associated with how individuals perceive their overall transit experiences.

5.3.2 Satisfaction with on-board experience

While the discussion above has made clear that there are many factors influencing users' overall satisfaction with transit services, on-board experiences specifically, are considered to be important for affecting overall satisfaction. On-board experiences are related to many aspects and range from the physical aspects such as vehicle quality (Weinstein 2000, Tyrinopoulos and Antoniou 2008, Lai and Chen 2011, Carreira, Patrício et al. 2014), to interpersonal interactions such as those with drivers and other personnel (Burkhardt 2003, Krizek and El-Geneidy 2007, Figler, Sriraj et al. 2011, Lai and Chen 2011). For example, they can include users' perceptions of the comfort of the seats inside the vehicles (Lee, Jin et al. 2009), and cleanliness (Weinstein 2000). Other factors that influence passengers' on-board experiences include in-vehicle

temperature (Chou and Kim 2009, de Oña, de Oña et al. 2013), the quality and physical accessibility of a vehicle (dell'Olio, Ibeas et al. 2011, Lai and Chen 2011, Carreira, Patrício et al. 2014, Hussein and Hapsari 2015), safety from traffic and crime (Smith and Clarke 2000, Peden, Scurfield et al. 2004), and service information (Weinstein 2000).

Also, in-vehicle crowding is repeatedly cited as being one of the most important factors influencing on-board experience in transit (dell'Olio, Ibeas et al. 2011, Carreira, Patrício et al. 2014, Imaz, Habib et al. 2015). Crowded vehicles can be perceived as an encroachment on personal space, and even a personal safety concern (Cox, Houdmont et al. 2006). A similar measure to crowding is the seating capacity of the vehicle, which has been found to be strongly associated with satisfaction, as users tend to be more satisfied when they are able to sit down (Mouwen and Rietveld 2013, Nwachukwu 2014).

5.4 METHODOLOGY

5.4.1 Context

This study analyzes customer satisfaction among users of TransLink's 99 B-Line, which is an express bus service that runs east-west in Vancouver, Canada. TransLink is the transit authority responsible for Metro Vancouver's regional transportation network, and Figure 12 shows the 99 B-Line, which connects to all of Vancouver's SkyTrain lines (automated rapid transit rail service). This bus service is used as a connection to and from several of Vancouver's busiest employment hubs including the city's Central Business District, the University of British Columbia (UBC) in the west, Vancouver General Hospital at Willow and Cambie Streets, as well as several elementary schools and high schools.
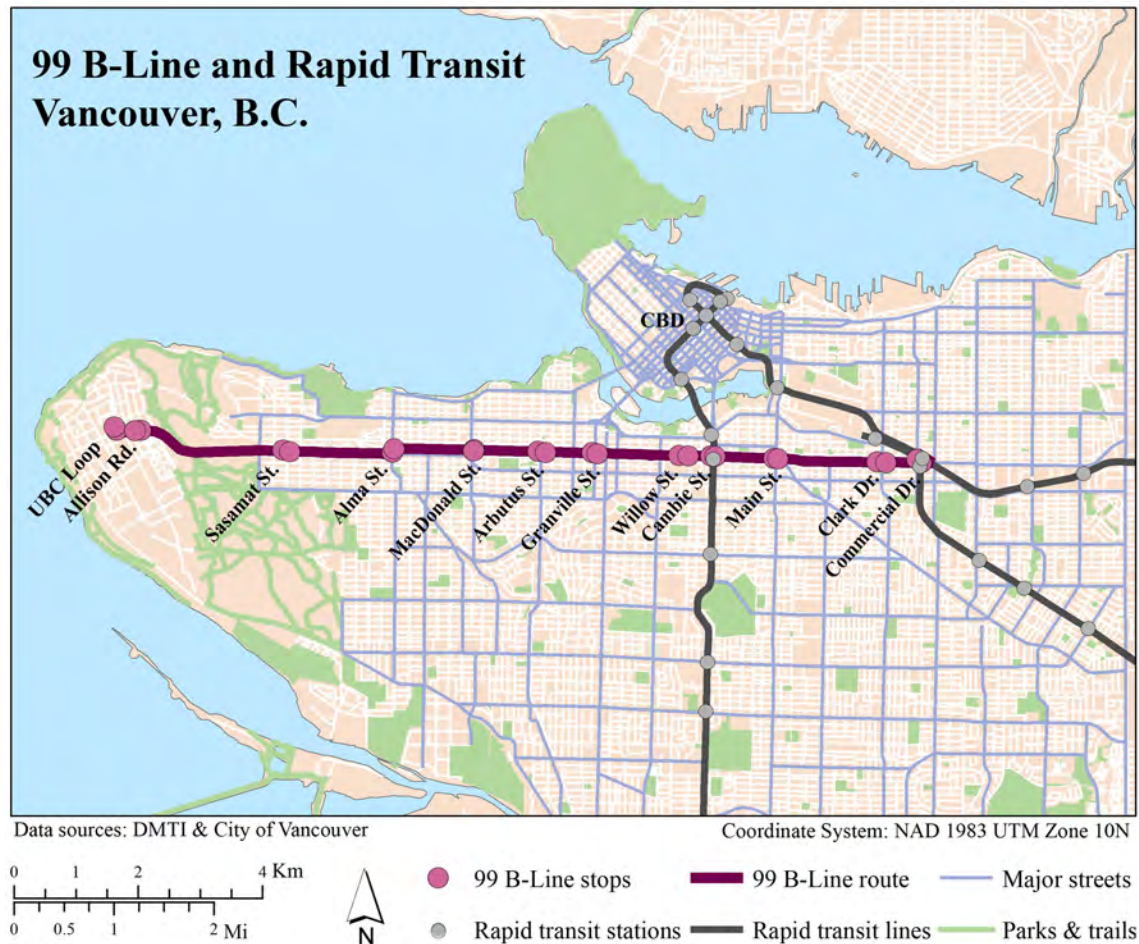
Figure 12: Context map for 99 B-Line in Vancouver, B.C.

Since it opened in 1996, the number of users has increased annually, and in 2013 it ran an average of 16 buses per hour, and was ranked the most crowded bus in the Greater Vancouver Regional District with a daily ridership of 55,000 on weekdays (TransLink 2014). This route is serviced exclusively by 18-meter low-floor articulated vehicles that have 54 seats and a maximum capacity of 85 passengers (TransLink 2014). The travel time of this route is scheduled to be approximately 42 minutes, and buses run every three minutes during the AM and PM peaks, and every four-five minutes during the day-time off-peak period.

5.4.2 Data

The data used for this study was obtained from TransLink under a data sharing agreement to be used in academic research. In 2011, the population of the Vancouver census metropolitan area (CMA) was 2,313,328 with 19.7 percent of the commuters using transit for work trips (Statistics Canada 2014).

Figure 13 illustrates the data types that are used in this study. The first data source is derived from TransLink's customer satisfaction surveys, and users of the 99 B-Line were extracted for the purpose of this study. These surveys include information about users' reported levels of satisfaction with various service attributes as well as overall customer satisfaction, and also contain information about users' personal characteristics. TransLink provided the results of five years of customer satisfaction questionnaires that were conducted throughout the year from Spring 2010 to Spring 2015.[1] Only trips operating after the Vancouver Winter Olympic Games which occurred in February 2010 are included in this study. The second data source is operations data which is derived through AVL/APC systems and includes information about the performance of the bus and the number of passengers boarding and alighting at every stop for the same study period. It is important to note that each data source that is bounded in a box has been collected and analyzed separately in the past, with the customer satisfaction surveys being the responsibility of the marketing department and the operations data that of the operations or planning department. The goal of our study is to break the boundary between these two boxes and combine operations data with customer satisfaction surveys to develop a better understanding of system performance and customer satisfaction.

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[1] The data used for the purpose of this study was obtained after the data used in Chapters three and four of this dissertation.

Figure 13: Data sources used to assess customer satisfaction

5.4.2.1 Customer satisfaction surveys

The customer satisfaction surveys were conducted by telephone, and because participation was voluntary, non-response bias may be present. The questionnaire is intended to evaluate how residents perceive the quality of the transit service provided by the transit agency. It is used by TransLink to better understand users' perceptions of service quality and also as insight into where changes and/or improvements to service attributes can be accomplished to increase customer satisfaction and accordingly increase ridership. To assess customer satisfaction with the transit service, TransLink, asks participants to specifically report their experience of their last or second to last trip. The data is a representative random sample of transit users only, and, according to TransLink it is representative of the greater population (Ipsos Reid 2013).

Responses from users of the 99 B-Line were extracted from the larger customer satisfaction survey, and data cleaning was required to remove entries that were missing relevant information as well as apparent mistakes in the data such as entries that were too high for the scale provided (e.g. satisfaction 11/10). The surveys were designed to collect information including, but not limited to, socioeconomic status, personal preferences related to transit use, satisfaction with service attributes and travel habits.

5.4.3.2 AVL/APC data

TransLink also provided us with access to the AVL/APC operations data for the 99 B-Line for the same period of analysis. Since one of the goals of this chapter is to merge the AVL/APC data with results from the customer satisfaction surveys, it was necessary to aggregate the stop-level operations data so that it could be matched. The data from the customer satisfaction surveys includes information about whether a user's reported trip was conducted from Monday to Friday during the AM peak from 5:00-9:30AM, during the off-peak from 9:30AM-3:00PM, the PM peak from 3:00-6:30PM, the evening or night after 6:30PM, or during the weekend or on a holiday. Operations data was therefore aggregated to match these broad timeframes, and for the purposes of this study, we analyzed only trips taken Monday to Friday on non-holidays between 5:00AM and 6:30PM. We chose to analyze only weekday AM peak, day-time off-peak, and PM peak, as the sample sizes of customer satisfaction surveys completed during other times were not large enough to be representative. In addition, TransLink's customer satisfaction surveys do not collect information regarding where passengers board or alight, or in which direction trips occur, so the operations data was aggregated for both directions.

To clarify the process of generating operations variables to be matched with the customer satisfaction questionnaires, we use crowding as an example. First, to generate a crowding variable based on the AVL/APC data, we calculated the percentage of trips that had a passenger load larger than 85, which is the maximum capacity of a bus serving the route (TransLink 2014). This variable is used to represent extreme crowding. Next, for every time period on every day that a customer satisfaction survey was completed, we calculated the average percentage of extremely crowded buses over the past 30 days, for the specific time period. For example, for a 99 B-Line user who was surveyed on June 15th 2013 and reported that he or she had used the service within the last thirty days and that their trip had occurred during the morning, the

associated crowding variable was based on the level of crowding along the entire route during the AM peak from May 15th to June 15th 2013. In other words, the customer satisfaction surveys and the aggregated and rolling 30-day average AVL/APC data were matched based on (1) the reported trip time slot, and (2) the day the customer satisfaction survey was administered. This method makes the assumption that for a given time of day the single trips described by the respondents of the customer satisfaction survey provide a representation of the service characteristics on the route for the past 30 days. By doing so, the method ensures that, in this example, every customer satisfaction survey could be linked to a unique crowding variable based not only on a specific day, but the average level of crowding over thirty days prior to participating in the survey at a specific time of day. While the date the survey was administered was recorded, the date on which survey participants took their last trip was not, although all survey participants were required to have used transit within thirty days of participating in the survey. Using this method we generated variables measuring travel time, variation in travel time, passenger activity, on-time performance, variation in on-time performance, and usage of the bicycle rack and ramp.

After generating the various variables, we joined them to the data derived from the customer satisfaction surveys in order to better understand the context within which the surveyed users had experienced the transit system with regard to bus operations. This yielded a total sample size of 737, with 208 users travelling at the AM peak, 292 during the day-time off-peak, and 237 during the PM peak.

As mentioned before, a limitation that we encountered during this process was that the customer satisfaction questionnaires did not ask participants about the travel direction or location of stops that passengers boarded and alighted from, so trip direction could not be distinguished.

However, although the operations data revealed that eastbound usage during the study period was higher during the PM, and westbound was higher during the AM, this bus service connects many employment hubs and schools and is heavily used to access both directions at all times of the days. Therefore, because the route is heavily used throughout the day in both directions, we calculated an average crowding score for all buses operating at a particular time of day. Figure 14 demonstrates the average load after each stop, and reveals that the route consistently has a higher load in the east part of the route, than it does in the west, regardless of the direction.
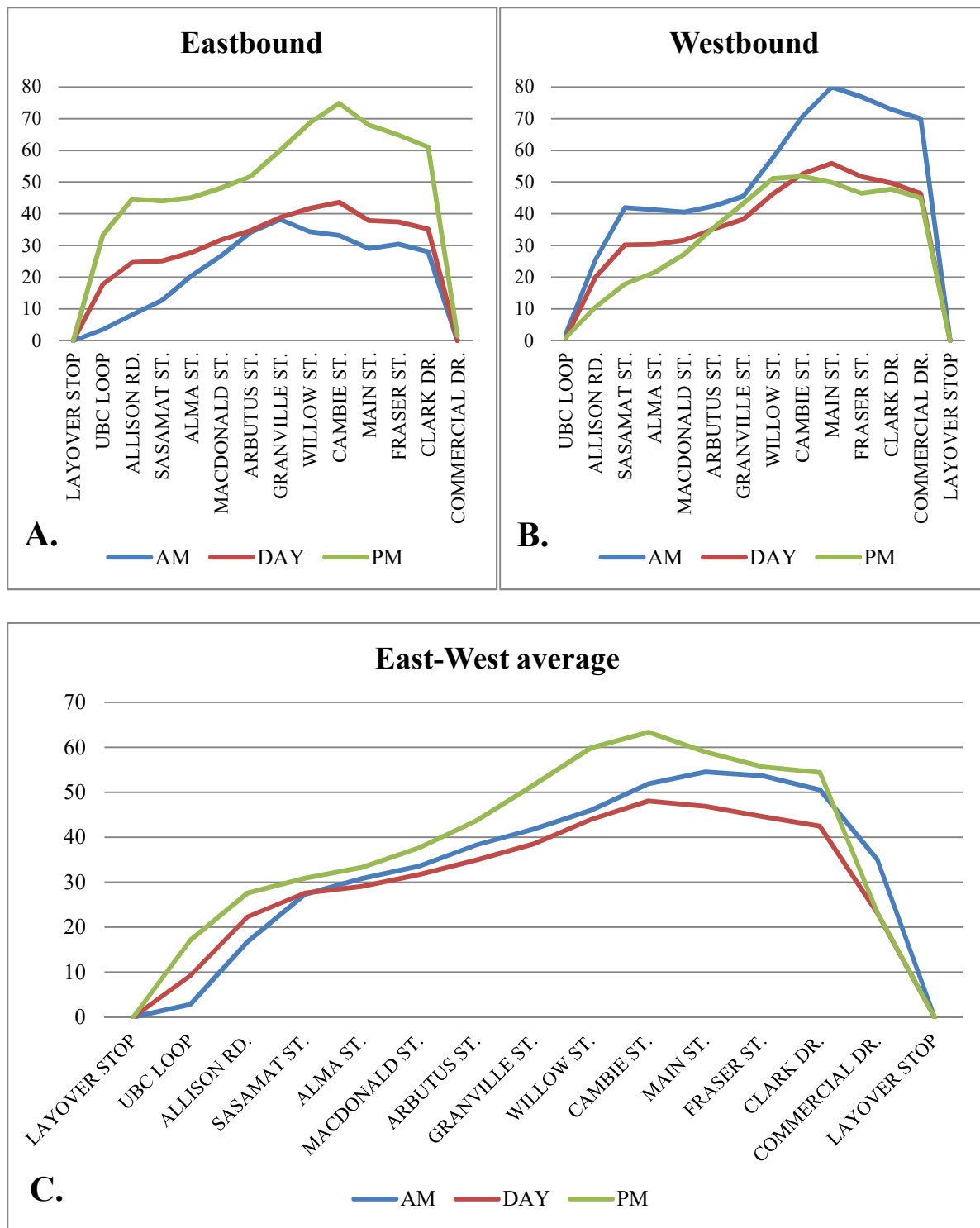
Figure 14: A. Eastbound average leave load per stop, B. Westbound average leave load per stop, and C. Average for both eastbound and westbound trips

5.4.3 Methods

Using a binary logistic modelling technique we determined how different factors impact the odds that a 99 B-Line bus user will be satisfied or not. The dependent variable of interest was derived from the question on overall satisfaction with the bus trip: "*Thinking about the trip you made on the 99 B-Line bus, on a scale of one to ten, where "ten" means "excellent" and "one" means "very poor", how would you rate it for service overall?*" To convert these ratings into discrete binary variables, we classified ratings of seven and below as dissatisfied and eight and above as satisfied. This cut-off was chosen as TransLink considers ratings of eight to ten as good to excellent, and focuses specifically on analyzing this group (Ipsos Reid 2013). We kept other satisfaction ratings of the various service components as continuous variables, but coded the variables related to personal information as dummy variables for inclusion in the model. Table 16 provides the summary statistics for individuals' socio-economic information and personal characteristics that were derived from the customer satisfaction questionnaires.

Table 16: Summary statistics for users' socio-economic information and personal characteristics

INCOME		CAR ACCESS	
under $15,000	7%	Yes	63%
$15,000-$25,000	7%	No	37%
$25,000-$35,000	8%		
$35,000-$45,000	7%		
$45,000-$55,000	7%	**PREVIOUS USAGE**	
$55,000-$65,000	12%	Less than a year	6%
$65,000-$75,000	7%	2-5 years	26%
$75,000-$85,000	7%	6-10 years	20%
$85,000-$95,000	6%	More than 12 years	49%
$95,000 +	32%		
AGE		**FUTURE USE**	
16-24 years old	11%	Definitely not continue as often	1%
25-34 years old	12%	Probably not continue as often	2%
35-44 years old	19%	Might or might now continue as often	3%
45-54 years old	20%	Probably continue as often as I do now	26%
55-64 years old	19%	Definitely continue as often	67%
65+ years old	19%		
EMPLOYMENT		**INTENTION TO USE**	
Full time	48%	More regularly	15%
Part time	15%	Less regularly	8%
Student	11%	The same	76%
Non job	25%		
EDUCATION		**TRIP TIME**	
Some high school	4%	AM peak	28%
Graduated high school	10%	Day time	40%
College	16%	PM peak	32%
Some university	13%		
Graduated university	57%		

In addition, Table 17 provides summary statistics of the satisfaction questions included in the customer satisfaction surveys as well as the route information derived from the AVL/APC data. The percentage of users who are very satisfied with a particular service factor, indicate ratings of 8-10 on a 10-point Likert scale.

Table 17: Summary statistics for customer satisfaction questions and route information

OVERALL SATISFACTION		SATISFACTION WITH RELIABILITY	
Average overall satisfaction	7.5	Average satisfaction with reliability	7.9
% of users very satisfied with overall service	60%	% of users very satisfied with reliability	70%
SATISFACTION WITH THE 99 B-LINE		**SATISFACTION WITH CLEANLINESS**	
Average satisfaction with the previous trip on the 99 B-Line	7.6	Average satisfaction with cleanliness	7.9
% of users very satisfied with previous trip on the 99 B-Line	61%	% of users very satisfied with cleanliness	64%
SATISFACTION WITH ON BOARD SAFETY		**SATISFACTION WITH DIRECTNESS**	
Average satisfaction with on board safety	8.4	Average satisfaction with trip directness	8.9
% of users very satisfied with on board safety	79%	% of users very satisfied trip directness	88%
SATISFACTION WITH SAFETY AT STOP		**SATISFACTION WITH DURATION**	
Average satisfaction with safety at the stop	8.4	Average satisfaction with trip duration	8.4
% of users very satisfied with safety at the stop	78%	% of users very satisfied trip duration	80%
SATISFACTION WITH CROWDING		**SATISFACTION WITH FREQUENCY**	
Average satisfaction with crowding	5.2	Average satisfaction with trip frequency	8.2
% of users very satisfied with crowding	25%	% of users very satisfied trip frequency	76%
AVL/APC DATA			
Average trip time	35.2mins		
Average delay	-1.7mins		
Average arrive load	37.2		

5.6 RESULTS

5.6.1 Model selection

Table 18 demonstrates the results of the logistic models used to uncover important qualities that are associated with overall satisfaction. The dependent variable determines whether a user is satisfied with the 99 B-Line or not, and the results in the table are presented with the odds ratios and 95% confidence intervals for all models, and include only the significant variables.

To generate these models, we used R statistical program and ran an exhaustive model selection processes to understand which variables should be used to best understand the causes of satisfaction. Models were compared and selected based on AIC and BIC scores. In addition, in

order to assess the predictive ability of our models, we calculated the error rate based on maximizing sensitivity and specificity on the receiver operating characteristics (ROC) curve for each model as a Goodness-of-Fit statistic.

Surprisingly, the only variable derived from the AVL/APC data that showed statistical significance in these models measuring overall satisfaction was crowding. Although we tested variables measuring travel time, variation in travel time, passenger activity, on-time performance, variation in on-time performance, and usage of the bicycle rack and ramp, none of these variables showed statistical significance. The lack of significance in AVL/APC variables other than crowding is likely due to the high frequency nature of route 99 B-Line, which will be further discussed in the discussion section of this chapter. In addition, lack of significance may also be due to the absence of directional information of the data, which was explained earlier in the chapter. Accordingly, we report only variables that showed a statistically significant relationship with overall satisfaction.

Another important finding that was revealed during the model selection process was that including data based on users' reported levels of satisfaction with service attributes together in the same statistical model with operations data was not useful for better understanding what influences overall satisfaction. This is because, as expected, satisfaction with various service attributes closely predicted overall satisfaction with the route, and the influence of personal characteristics and the crowding variable were weakened, meaning that these variables' effects on overall satisfaction could not be observed.

With this in mind, the first model presented in Table 18 assesses only the effect that actual crowding has on satisfaction with the route. The second model builds on the first model by adding variables that control for users' personal characteristics. Lastly, model 3 describes how

personal perceptions of specific service attributes affect trip satisfaction while controlling for bus users' personal characteristics.

Table 18: Logistic modelling results

Satisfaction with bus service	MODEL 1			MODEL 2			MODEL 3		
DEPENDENT VARIABLE									
Overall satisfaction: where 1-7 = not satisfied, and 8-10 = satisfied									
	OPERATIONS			OPERATIONS +PERSONAL			PERCEPTION + PERSONAL		
	OR	2.5 %	97.5 %	OR	2.5 %	97.5 %	OR	2.5 %	97.5 %
(Intercept)	2.348 ***	1.711	3.246	1.218	0.658	2.242	0.00007***	0.00001	0.0004
REALITY VARIABLES									
Crowding Extreme crowding	0.166***	0.046	0.594	0.236**	0.062	0.895	---	---	---
PERSONAL CHARACTERISTICS									
Vehicle access No car access	---	---	---	1.395**	1.014	1.926	1.512**	1.011	2.275
Age 16-34 yrs old	---	---	---	0.765	0.507	1.158	1.035	0.623	1.726
35-54 yrs old	---	---	---	0.559***	0.391	0.797	0.859	0.549	1.346
55+ yrs old	---	---	---	NA	NA	NA	NA	NA	NA
Past use More regularly	---	---	---	2.408***	1.273	4.615	1.944	0.860	4.455
The same	---	---	---	2.270***	1.320	3.923	1.873 *	0.940	3.785
PERCEPTION VARIABLES									
Satisfaction Crowded	---	---	---	---	---	---	1.403***	1.294	1.526
Frequency	---	---	---	---	---	---	1.682***	1.445	1.975
On-board safety	---	---	---	---	---	---	1.280***	1.097	1.502
Cleanliness	---	---	---	---	---	---	1.199**	1.034	1.393
Goodness-of-Fit measures	*N=737* AIC: 979.9 BIC: 989.1 Error rate: .13†			*N=737* AIC: 964.2 BIC: 996.4 Error rate: .13†			*N=737* AIC: 666.6 BIC: 712.6 Error rate: .14†		
*Signif. codes: 0.001 '***' 0.01 '**' 0.05 '*'* *--- = Not in model, NA = Reference Category* *†Thresholds for error rates are based on maximizing sensitivity and specificity as indicated by ROC curves.*									

5.6.2 Perception and reality

The purpose of model 1 is to assess whether the crowding variable has an effect on bus users' trip satisfaction. As expected, we find that as users experience more crowding, their satisfaction decreases. Next, in model 2, we include users' personal characteristics and we observe the same

relationship between actual crowding and overall satisfaction. Once we control for vehicle access, age, and past usage, we find that for every unit increase in crowding, the odds of being satisfied decrease by 76% (OR=0.236, 1-OR=0.764, which represents a decrease of 76% for ease of interpretation). The results of model 2 also demonstrate that the odds of being satisfied for users who do not have access to car is 40% higher than those that do have a car, when other variables are controlled for. This is in line with previous research that suggested that captive users who do not have access to a car and have a low income tend to be more satisfied with bus services compared to choice users (van Lierop and El-Geneidy 2016). Also, age is shown to have a significant effect on users' satisfaction. The odds of being satisfied for users aged 35-54 is 44% lower than for older users (55+). This finding is unsurprising, as this age group tends to be employed full-time and often has many life responsibilities that include travel such as taking care of both younger and older family members. Furthermore, users' previous behaviour is especially important for describing satisfaction as those who use the service more regularly or the same amount compared to six months ago tend to be more satisfied than those who use it less. Income was not included in the model as it is confounded with age. Being a student was also not included because the category "student" was not representative of employment status. The number of months that a user had been taking the bus is strongly related to age and therefore was not included. In addition, users' level of education and future usage did not show statistical significance in the model and therefore were also not included. As was mentioned earlier we also tested several operational variables including travel time, variation in travel time, passenger activity, on-time performance, variation in on-time performance, and usage of the bicycle rack and ramp, but none showed statistical significance.

Model 3 shows users' overall satisfaction as a function of satisfaction with specific service attributes and personal characteristics. We included specific service attributes in model 3 to better understand which service attributes most strongly describe overall satisfaction. The results demonstrate the likeliness of being satisfied with the 99 B-Line increase as users' satisfaction with frequency, crowding, on board safety, and cleanliness increases. Satisfaction with the frequency of the trip is strongly related to overall satisfaction and for every unit increase in satisfaction with frequency (Likert scale 1-10) that a user experiences, the odds that a user is satisfied with the route increases by 68%. This finding is similar for other service attributes where a one unit increase in satisfaction with crowding, on-board safety, and cleanliness is associated with 40%, 28%, 20% increases in the odds of being satisfied overall respectively. Interestingly, although crowding and frequency were not highly correlated (0.4), on the supply side these service attributes are very much theoretically related as increases in frequency decrease passenger load per bus. Yet, on the demand-side, these two attributes may have a different meaning for passengers as, conceptually, frequency may be more significantly linked to passengers' perceptions of waiting time. Reported satisfaction with safety and crowding are also not statistically correlated, but previous studies have suggested that crowding may influence users to feel unsafe (Cox, Houdmont et al. 2006). Furthermore, safety, comfort, and cleanliness have repeatedly been found in the literature to be strongly associated with user satisfaction (Tyrinopoulos and Antoniou 2008, Lai and Chen 2011, Eboli and Mazzulla 2012).

As was discussed earlier in the section on summary statistics and shown in Table 17, the customer satisfaction survey also collected information about users' satisfaction with bus reliability, trip duration, the directness of the route, and off-board safety. The variable measuring reliability was not included in the model as it was highly correlated with frequency (0.75). In

addition, while frequency is a somewhat simple term for users to understand and assess, evaluating reliability is a comparatively more complex issue as it involves knowledge of the full public transport schedule over time (Chakrabarti and Giuliano 2015). Furthermore, off-board safety was correlated with on-board safety (0.67), and since we were assessing on-board trip satisfaction, we chose this variable accordingly. In addition, both satisfaction with the duration and directness of the route were not found to be significant, and were therefore not included in the model. The results of model 3 therefore demonstrate the service attributes that are most important for increasing users' overall satisfaction with the 99 B-Line are frequency of service, crowding, on-board safety, and cleanliness.

In addition, the personal characteristics in model 3 revealed that with regard to overall satisfaction, users who do not have access to a car have an increased odds of 51% compared to those who do have access to a car. Note that the actual crowding variable is not used in model 3 as it is strongly related to users' satisfaction with crowding. However, while most of the users' personal characteristics are not significant in model 3, these variables are essential to include as control variables. Overall, models 1 and 2 have revealed that actual crowding is associated with overall satisfaction, and model 3 has confirmed that users' satisfaction with crowding is also important for predicting users' perceptions of overall satisfaction with the route.

The results of models 1-3 demonstrate how various factors are associated with users' overall satisfaction with the route. The Goodness-of-Fit measures revealed that statistically model 3 is better at predicting satisfaction compared to models 1 and 2. This is due to the fact that the service quality variables that are included in model 3 are derived from the same data source as the dependent variable - the customer satisfaction survey. As expected, a strong association between the components of satisfaction (frequency of service, crowding, on-board

safety, and cleanliness) and overall satisfaction is revealed. Therefore, because models 1 and 2 do not model the effects of the components of satisfaction on overall satisfaction, the relationship between the operations variable and overall customer satisfaction can be observed. This is an important finding, as it demonstrates the benefit of combining data derived from both operations and customer satisfaction questionnaires.

5.7 DISCUSSION

Overall, the results of models 1-3 help us better understand the determinants of satisfaction for users of the 99 B-Line in Vancouver, and provide additional insight into the research questions that we set out to explore which asked (1) whether users' perceptions match the reality that is reported on the ground, and (2) and how data derived from customer satisfaction surveys and AVL/APC systems can be used to better understand overall customer satisfaction.

5.7.1 Perceived and actual crowding

Reflecting on our first research question, we have found that in the case of Vancouver's 99 B-Line, perception does appear to be highly associated with what is happening on the ground. Due to the high frequency nature of the route, the relationship between perception and reality could only be tested for crowding (the variable that greatly varies throughout the day). Accordingly, the results of models 1-3 demonstrate that both actual crowding and users' satisfaction with crowding are strongly associated with users' overall satisfaction with their experience on-board the 99 B-Line when controlling for personal characteristics.

Because the variables describing actual crowding and perceived satisfaction of crowding could not be included in the same model, we use summary statistics to further investigate this particular relationship. Figure 15 demonstrates the existing variation in satisfaction and the

variation in actual crowdedness during different times of the day. It should be noted that in models 1-3 we did not include a variable describing the time of day, as crowding is strongly associated with time of day, and therefore only one of these two variables could be included in the models. Yet, a detailed analysis of crowding and time reveals that while actual crowding is much higher during the peak periods compared to the off-peak period, satisfaction does not vary as much. In other words, Figure 15 demonstrates that while 30% of buses are extremely crowded at peak periods, compared to only 9% at the off-peak, overall satisfaction only fluctuates between 7.4 and 7.9, and satisfaction with crowding between 4.8 and 5.6 out of 10 respectively. While it is expected that overall satisfaction and satisfaction with crowding would increase as actual crowding decreases, it is unexpected that there is no significant change in the satisfaction variables between the peak and the off-peak travel times.
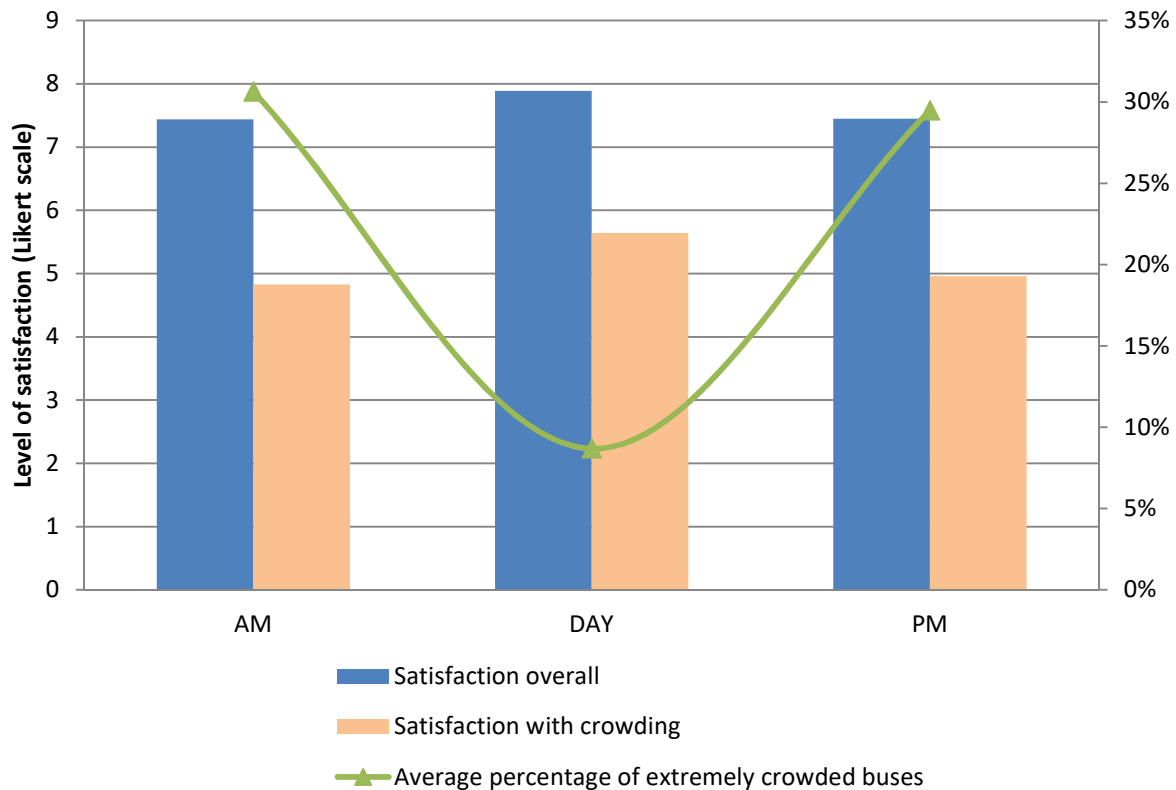
Figure 15: Variation in satisfaction vs. variation in actual crowdedness

Figure 15 demonstrates that the variation in actual crowding changes much more than that of perceived overall satisfaction and with crowding over different time periods. This observation raises an important question as to why users' levels of perceived satisfaction with crowding and the trip overall do not reflect actual crowding. Although user satisfaction does increase when there is less crowding, the relative changes in satisfaction over the day do not reflect the extreme differences in actual levels of crowding between time periods. One possible explanation for why users on average remain highly satisfied with the trip overall when there is a high level of extreme crowding, could be because their expectations about crowding change over the day. For example, it might be possible that during the peak periods it is enough for users to board the bus without waiting in line, whereas during the off-peak satisfaction depends more on

whether or not there is a seat available once they board. Another explanation could be that different populations are using the bus during the peak and off-peak periods. Therefore, to understand whether it is individuals' expectations or differences in their personal characteristics that influence how users experience satisfaction over the day, we used a series of t-tests to compare the characteristics of satisfied users ($\geq 8/10$) travelling at the AM peak and PM peak compared to all users travelling during the day-time off-peak. While we did observe some differences between specific employment, age, and income categories, overall, few statistically significant differences were observed between time periods. Furthermore, we found that in general, the populations travelling during the three time periods were mostly homogeneous.

The lack of differences between the groups travelling during different time periods could suggest that the expectations of users may be changing depending on when they use the service. This is an important hypothesis for transit agencies to consider as it means that developing thresholds of what users consider acceptable levels of crowding may change over the time of the day. Moreover, these thresholds can be used to set crowding standards and are useful for indicating when transit agencies must dispatch an additional bus in order to maintain customers' expectations with regard to crowding. Flexible thresholds for service variables may therefore be important for transit agencies to consider when analysing customer satisfaction surveys, and future research is needed to better understand this hypothesis.

5.7.2 Combining data sources

With regard to our second research question concerning data sources, Figure 16 demonstrates how data derived from customer satisfaction surveys and operations systems can be used together to effectively assess user satisfaction with a bus service. The figure demonstrates that perception variables such as satisfaction with crowding and cleanliness are derived solely from

customer satisfaction questionnaires, and can be collected and analyzed together with data describing personal characteristics such as age and income. On the other hand, non-perception variables include personal characteristics and operations data that measure actual crowding and, for example, on-time performance. These non-perception variables can be analyzed in the same model and customer satisfaction analyses that use these three types of data are more likely to accurately depict what influences users to be satisfied with a particular route, compared to analyses that are based primarily on users' perceptions of service quality.
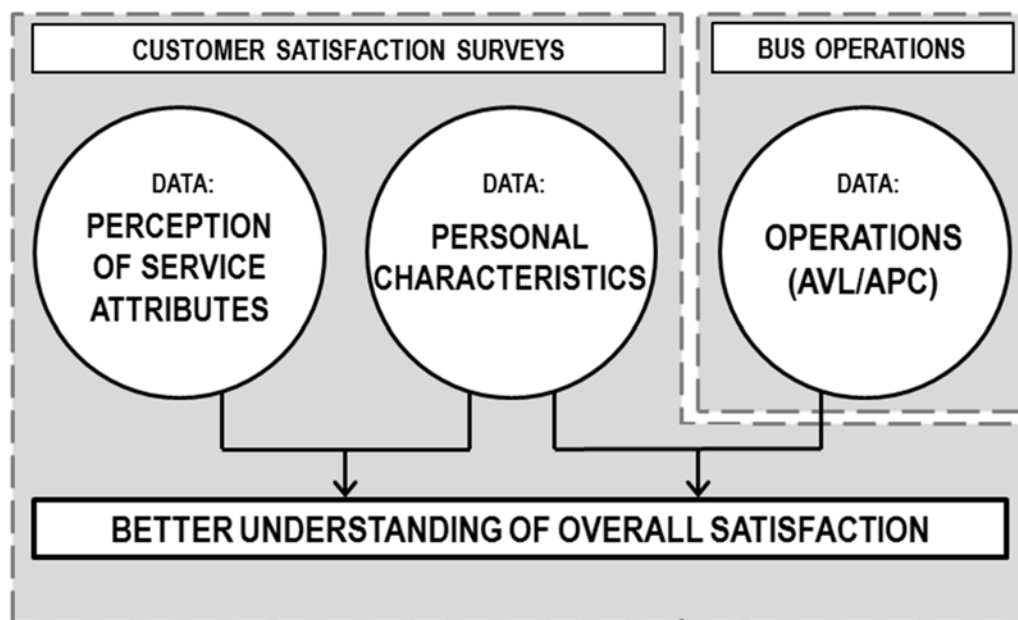
Figure 16: How to assess customer satisfaction

5.8 CONCLUSION

This chapter has provided insight on how to use data obtained from customer satisfaction surveys as well as operations data in order to better understand the drivers of overall customer satisfaction. The findings suggest that variables measuring users' perception about service quality are most useful if they are analyzed separately from variables that are not subjective and

138

not based on users' perceptions. The findings from this study suggest that satisfaction with crowding, service frequency, on-board safety, and cleanliness are particularly important for increasing overall satisfaction. In addition, actual crowding is associated with overall satisfaction, as is car access, age, and past use. Finally, based on testing the differences between the populations using transit at different times of the day, the results suggest that users' expectations of crowding may change over the time of the day. It is important for transit agencies to understand which service attributes most strongly affect satisfaction on particular routes as increases in satisfaction have been found to increase overall loyalty (Minser and Webb 2010, Lai and Chen 2011, van Lierop and El-Geneidy 2016). Furthermore, one of the findings is that users who are between the ages of 35-54 tend to be less satisfied than other users. This is important for transit agencies to consider, as it suggests that users in this age group are somehow being disappointed by the service, which is a problem because unsatisfied users tend to defect. Thus, increasing the satisfaction of this group could be important to motivate continued ridership as transit usage tends to decrease with age and lifestyle changes (Grimsrud and El-Geneidy 2014).

5.8.1 Limitations and future research

In the future, studies should assess multiple routes with more variation to be able to test the variety of data that can be derived from AVL/APC data. For example, if researchers wish to better understand the relationship between users' satisfaction between actual on-time arrival and users' satisfaction with on-time arrival it would be necessary to match customer satisfaction surveys and operations data from multiple, and less homogenous, bus routes rather than a single high frequency route. Additionally, this study converted the satisfaction variable from a Likert scale into a binary scale, and in future research it may be interesting to employ ordered logit models for similar analyses. However, in this study we converted these ratings into discrete

binary variables because the transit agency that we worked with (TransLink) considers ratings of eight to ten as good to excellent, and focuses specifically on analyzing this group. Therefore, in order to increase the policy relevance of our research, we followed the binary approach set by the transit agency. Furthermore, the method used in this study makes the assumption that for a given time of day the single trips described by the respondents of the customer satisfaction survey provide a representation of the service characteristics on the route for the past 30 days. In order to improve data matching, future studies would benefit from using fare card data to better map individuals to specific trips and thereby further assess the relationship between customer satisfaction and operations data. However, when it is not possible to match exact customer satisfaction survey data to operations data for the same trip, then this method has been shown to be useful. Furthermore, to our knowledge, this study is a first attempt to combine customer satisfaction data with AVL/APC data, and in order to improve these kinds of analyses in the future, transit agencies should collect information about where and when passengers board and alight in the customer satisfaction questionnaires. With the appropriate data, studies could be more accurate and recommendations could be developed to assess specific areas along individual routes.

Overall, the results of this study demonstrate the complex relationship between users' perceptions of transit with what is actually happening on the ground. These findings suggest that users' expectations of transit may be changing over the day, and results could be used to assist transit agencies to identify which modifiable components of the service should be prioritized in order to effectively increase overall rider satisfaction through service improvements.

6 CHAPTER SIX: PUBLIC IMAGE: DETERMINING THE EFFECTS OF USERS' IMAGE OF PUBLIC TRANSIT ON LOYALTY

6.1 OVERVIEW OF CHAPTER

As has been discussed in earlier chapters, many cities and transit agencies are currently focusing on increasing passenger satisfaction and loyalty in response to regional policies aimed at decreasing auto-usage and increasing the use of more sustainable modes. Accordingly, in recent years researchers have begun to explore how users' views and opinions about public transit influence user satisfaction and future behavioural intentions. This chapter departs from using data provided by transit agencies, and instead, uses primary survey data collected by the author along a bus route in Montreal, Canada, to assess whether users' image of public transit is associated with their satisfaction and intention to continue using public transit in the future. Two binary logit models are developed and the results reveal that having a positive image of transit increases users' odds of being satisfied and of intending to continue using transit in the future. Results also suggest that previous transit usage is a good indicator of intended future usage. Furthermore, this chapter explores whether users' image of transit should be considered when assessing loyalty. Based on our findings, we suggest that loyalty constructs in public transit research should be composed of users' image of public transit, their overall satisfaction with a particular service, and, passengers' intentions to continue using the service in the future. Overall, this study is useful for researchers and transit agencies aiming to better understand and increase loyalty among current and future public transit users.

This chapter has been accepted for presentation at the 96th Annual Meeting of the Transportation Research Board, which will be held in Washington, D.C. from January 8th-12th 2017.

6.2 INTRODUCTION

In many cities, transit agencies are focusing on increasing passenger satisfaction and loyalty in response to regional policies aimed at decreasing auto-usage and increasing the use of more sustainable modes. Accordingly, in recent years researchers have begun to explore how users' views and opinions about public transit influence user satisfaction and future behavioural intentions (Beirão and Cabral 2007, Lai and Chen 2011, Abou-Zeid, Witter et al. 2012). Furthermore, researchers have found that passengers who are satisfied with transit services tend to be loyal (Minser and Webb 2010, Chou, Lu et al. 2014, Zhao, Webb et al. 2014, Shiftan, Barlach et al. 2015, van Lierop and El-Geneidy 2016). Many of these satisfaction studies focus specifically on understanding the relationship between users' overall satisfaction with transit services and their opinions of specific service quality attributes. While these studies are useful for determining which components of a transit service agencies should address in order to increase users' overall satisfaction, they rarely account for transit users' attitudes towards transit. More specifically, only few studies have accounted for the relationship between users' image of transit when assessing loyalty and discussing ridership retention. Furthermore, the relationships between having a positive or negative image of public transit, being satisfied with transit overall, and having the intention to use transit in the future remain unclear. With this in mind, the purpose of this study is to better understand whether users' image of public transit is associated with their (1) satisfaction, and (2) intentions to continue using the service in the future. The research aims to understand the relationship between transit users' opinions about the image they have of public transit and their satisfaction with the service, and whether passengers' image of public transit is a determinant of loyalty. This study also aims to assess whether users' image of transit should be considered when assessing loyalty.

To better understand how to increase overall transit ridership retention, we focus specifically on users' satisfaction and intended future usage as these are two important components of loyalty. For example, according to the Transit Cooperative Research Program's (TCRP) Report 49, satisfaction and the intention to continue using transit in the future are two important elements of loyalty (Transportation Research Board 1999). Therefore, for transit agencies it is important to increase customers' satisfaction and intended future use as a way to motivate increased user loyalty. However, the concept of loyalty is not simple to define, especially for a public service such as transit where competition often lies across modes, rather than among different service providers. In addition, loyalty is also difficult to define considering that for some users public transit is the only mode that is a viable option. Therefore, as transit agencies and researchers have begun to concentrate on increasing their understanding of passenger loyalty (Wen, Lan et al. 2005, Tyrinopoulos and Antoniou 2008, Shiftan, Barlach et al. 2015), the definition of loyalty has become a point of debate. For example, several authors have suggested that behavioural and emotional loyalty towards transit results from users' overall satisfaction, their intention of continuing to use public transit, and their willingness to recommend the service (Transportation Research Board 1999, Allen and Allen 2004). Others have suggested that loyalty should be based on whether users consider the service provided by the transit agency to be their first choice to travel from an origin to a destination (Carreira, Patrício et al. 2014). Although there are different definitions of loyalty, most authors agree that it should include passengers' intentions to continue using the service which is often considered a proxy for actual future usage (Lai and Chen 2011).

With this in mind, the following section of this chapter briefly reviews the relevant literature on transit users' satisfaction and intended future usage. The review of the literature also

elaborates on the importance of understanding the image that users have of public transit in general. Next, the study context and data used in this study are described. This is followed by a section presenting the summary statistics that are used to explore passengers' satisfaction and intended future usage in the context of this study. Summary statistics are also used to explore users' image of public transit. To further explore two important components of loyalty, we develop two models using logistic regressions in order to understand whether the image that users have of public transit is associated with satisfaction (model 1), and the intention to continue using the service in the future (model 2). Finally, based on the findings from the statistical models, the chapter concludes by proposing an improved approach to assessing customer loyalty.

6.3 LITERATURE REVIEW

6.3.1 Satisfaction and future usage

Research on transit users' satisfaction has suggested that as customer satisfaction increases, so does the tendency for users to have the intention of continuing to use the service (Minser and Webb 2010, Chou, Lu et al. 2014, Zhao, Webb et al. 2014, Shiftan, Barlach et al. 2015, van Lierop and El-Geneidy 2016). Therefore, it is in the best interest of transit agencies to increase satisfaction among customers, as it is a way to retain current users. In addition, increasing overall customer satisfaction is also a way to attract new customers, as satisfied users often promote the service to others (Diab, van Lierop et al. 2017). For these reasons, an increase in customer satisfaction can be beneficial for transit agencies as satisfied customers often have a positive impact on growth and profitability (Loveman 1998, Rigby and Ledingham 2004, Heskett, Jones et al. 2008). Furthermore, satisfying transit users can be beneficial to cities as an increase in loyal transit users may increase the frequency at which they use transit, thereby decreasing auto-based trips in urban areas.

The majority of customer satisfaction research related to transit is focused on understanding what influences users to be satisfied with transit services in general. The most common way that researchers have addressed this question is by investigating which components of a trip have the greatest impact on overall trip satisfaction. For example, Stuart, Mednick et al. (2000) applied structural equation modelling techniques to demonstrate how different service attributes directly and indirectly influence customers to be satisfied with the subway system in New York. These authors found that, for example, speed, security, and service frequency, are some of the specific trip attributes influencing overall satisfaction. Other researchers have also attempted to identify the specific attributes that influence overall passenger satisfaction, such as Tyrinopoulos and Antoniou (2008) who used factor analysis and ordered logit modelling to analyse data about bus and rail services from two regions in Greece, and found that a well-coordinated transportation system with a service that is accessible, frequent, and clean would lead to increases in passenger satisfaction. In the context of Northern Italy, Eboli and Mazzulla (2014) analyzed the drivers of satisfaction among passengers of regional rail lines and found that making improvements to service factors such as reliability, frequency, and cleanliness would likely increase overall satisfaction. Similarly, in a study based on a large scale survey as well as passengers' statements about their satisfaction with the quality of bus service in Granada, Spain, de Oña, de Oña et al. (2013), found that service performance was the main factor explaining satisfaction with overall service quality and that comfort while travelling, and the behaviour of the staff had less of an influence.

The main benefit of the majority of these transit satisfaction studies is that they identify which service attributes should be the focus of service or even policy changes for specific transit agencies or regions. However, while most transit satisfaction research focuses on identifying the

service attributes that are associated with overall satisfaction, these studies often do not to reveal how users' personal opinions, involvement, or image of transit is related to their reported satisfaction. Additionally, users' image of transit has typically not been used to assess intended future usage. However, in recent years, researchers have become increasingly interested in understanding how to determine transit users' intended future usage in order to be able to determine the factors that lead to increased loyalty. Stemming from the satisfaction literature, research on intended future usage has started to assess whether satisfaction with specific service factors influences loyalty (Minser and Webb 2010, Lai and Chen 2011, Carreira, Patrício et al. 2014, Zhao, Webb et al. 2014, Shiftan, Barlach et al. 2015, van Lierop and El-Geneidy 2016). Furthermore, several studies have also found that intended future usage is an important element of loyalty, and a recent study by Zhao, Webb et al. (2014) suggested that transit loyalty is not only related to a person's continuous behaviour to purchase or use a product or service, but also has to do with a transit user's attitudes and emotions towards the service on an ongoing basis.

6.3.2 Transit Image

In recent years, researchers have begun to explore how users' views and opinions about public transit influence their satisfaction and loyalty. For example, Minser and Webb (2010) revealed that users who have a positive image of public transit tend to be more satisfied. Furthermore, other researchers have found that having a positive image of public transit is also strongly associated with passenger loyalty (Tri-County Metropolitan Transportation District of Portland Oregon 1995, Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014, Şimşekoğlu, Nordfjærn et al. 2015). Moreover, other researchers have suggested that passengers emotional feelings towards a mode are associated with their mode choice (Shiftan, Barlach et al. 2015). Therefore, passengers' positive attitudes towards public transit can be used as a proxy for

passengers' intentions to continue using the service in the future, and also for their loyalty (Lai and Chen 2011, Zhao, Webb et al. 2014, Şimşekoğlu, Nordfjærn et al. 2015). With this in mind, Lai and Chen (2011) suggested that it is important for public transit agencies to focus on developing strategies that aim to motivate passengers to strongly identify with public transit. Outside the realm of public transit research, the association between customers' positive emotions with products or services has also been observed, and researchers have suggested that loyalty can be positively influenced through the development of schemes that influence potential customers to have an emotional association with a product or service (Zaichkowsky 1994, Mahajan and Wind 2002). For example, in the automobile industry, promotional strategies often play into the needs and desires of potential customers (Sheller 2004). While such strategies are not often used to promote public transit, there exists a potential for transportation agencies to increase ridership through such measures as users who are emotionally connected to the mode are more likely to be loyal (Lai and Chen 2011).

Although public transit agencies and transportation researchers are often interested in better understanding and increasing transit users' satisfaction and loyalty, questions regarding passengers' perception of, and emotions related to, public transit are rarely included in customer satisfaction questionnaires. Furthermore, customer satisfaction questionnaires seldom ask respondents whether using public transit constitutes a part of their personal identity. In addition, researchers working in this area have not agreed on how to define users' image of public transit, nor have they settled on whether the term "image," "involvement," "attitude," or a different term completely best describes how a passenger views public transit and how engaged he or she is with the service. Nevertheless, even though there is no standardized term, researchers who have assessed passengers' image or involvement with public transit have found that these concepts are

important to increase loyalty among public transit users (Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014, Şimşekoğlu, Nordfjærn et al. 2015), and have suggested that transit agencies should aim to increase ridership retention by improving passengers' overall image of the mode (Tri-County Metropolitan Transportation District of Portland Oregon 1995). Yet, one aspect that remains unclear is whether satisfaction creates a strong image, or vice versa. However, the majority of the research suggests that image, perception, and attitudes influence satisfaction and loyalty (Minser and Webb 2010, Zhao, Webb et al. 2014, Şimşekoğlu, Nordfjærn et al. 2015), and few studies suggest that satisfaction influences involvement (Lai and Chen 2011). Therefore, because attitudes have been found to be strongly associated with future mode use (Şimşekoğlu, Nordfjærn et al. 2015), and satisfaction and future use are two important components of loyalty, this chapter focuses specifically on understanding the effect that a users' image of transit has on these two elements of loyalty.

6.4 DATA AND METHODS

6.4.1 Context

To assess whether having a positive image of public transit is associated with users' overall satisfaction and intended future use, this study analyzes customer satisfaction surveys that were administered along route 121 Sauvé, a major east-west route along Côte-Vertu Boulevard and Sauvé Street, in Montreal, Canada. This bus route is operated by Montreal's primary bus operator, the Société de transport de Montréal (STM). It is a non-express, regular bus service, with stops spaced every few city blocks, and an average one-way trip duration of 50.5 minutes. Furthermore, the route has a high frequency of service, and is one of the busiest in the STM's network, with approximately 34,000 individuals using it on weekdays. The route is

approximately 11 kilometers long, and it connects with two metro stations (Côte-Vertu and Sauvé) and two commuter rail stations (Montpellier and Sauvé).

The route was selected for the purposes of this study due to its high usage, connection to the metro network, and the fact that it passes through neighbourhoods with varied ethnic populations. For example, according to the Canadian Census, at the west of the route, visible minorities make up approximately 40% of residents, with the ethnic composition being primarily Arab, Chinese, South Asian, and Black. The census tracts on the eastern side of the route have a slightly lower presence of visual minorities at approximately 35%, with the majority being Black, Arab, and Latin American. The neighbourhood at the east of the route also has a large and active Italian community (Statistics Canada 2011). Furthermore, the route passes along a busy commercial area in the west, and a calmer, greener, and more residential section to the east. Figure 17 shows the Route 121 Sauvé, and demonstrates where it connects with the orange line of the metro.
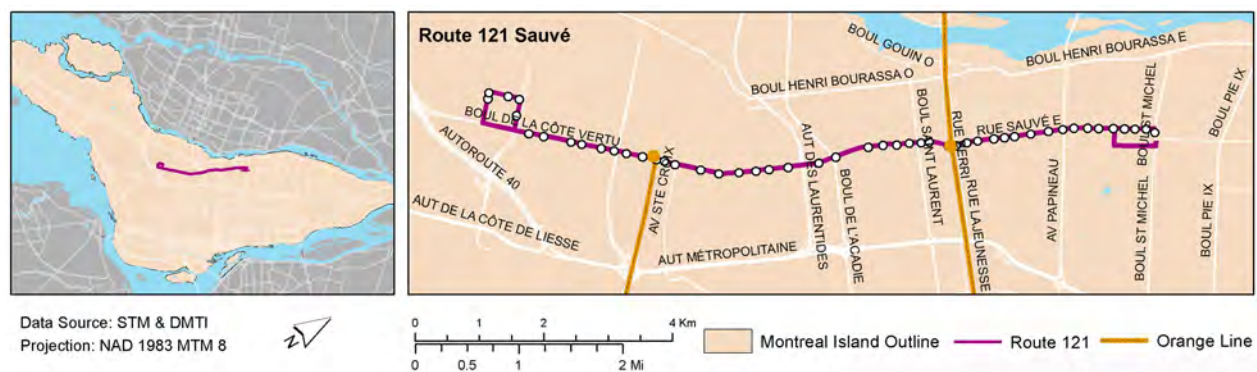

Figure 17: Context map of Route 121 Sauvé

6.4.2 Data collection

The in-person customer satisfaction surveys[2] were administered along route 121 between 6:30 AM and 6:30 PM on a Tuesday, Wednesday, and Thursday early in the summer of 2016. Weather conditions were warm and dry and no events impeded ordinary operations of the bus route. Data collection times were chosen in order to collect an equal distribution of data between peak and off-peak hours. The survey was one page long, was available in both English and French, and took three minutes to complete on average. Surveyors worked in groups of two or three and data collection occurred at both east and westbound stops. In order to avoid respondent selection bias, the surveys were administered in the order in which passengers arrived at the bus stop. If passengers agreed to participate, the surveyors would provide participants with a paper version of the survey and a pen, if passengers were not willing, then surveyors moved on to the next person in line.

Although surveys were administered along the entire bus route, bus stops with high passenger activity were prioritized by surveyors in order to obtain a representative sample size. This resulted in an over sampling of passengers boarding at stops that intersected with metro stations. In addition, due to the high frequency nature of the route, many respondents were not able to complete the survey due to the arrival of the bus, as has similarly been reported in several other bus surveys (Hess, Brown et al. 2004, Mishalani, McCord et al. 2006, Psarros, Kepaptsoglou et al. 2011, Diab and El-Geneidy 2014).

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[2] A copy of the questionnaire can be found in Appendix I.

6.4.3 The survey

The survey was composed of 13 different questions regarding their satisfaction with route 121, characteristics of their trip, and personal characteristics. Table 19 shows a summary of the results of several of these questions.

Because this analysis focuses on better understanding the drivers of satisfaction and loyalty, we were particularly interested in the questions that focused on these issues. More specifically, the question assessing customer satisfaction used a Likert scale from 1 ('very unsatisfied') to 5 ('very satisfied') to assess passengers overall satisfaction with Route 121. In addition, we asked passengers whether in a year from now, they plan to use transit more, less, or at the same frequency, and—on a scale on a scale of 1 ('disagree') to 5 ('agree')—whether they have a positive image of public transit and whether they believe that public transit is an important public service.

In total, 642 surveys were administered of which 192 were incomplete, leaving 450 fully completed surveys. Additional surveys were omitted if the survey respondent indicated they were under the age of 16 or if answers were illogical given the questions asked. In total, 395 surveys are included in the analysis, and this number exceeds the 380 surveys necessary for a representative sample, based on the daily passenger activity aboard the route with a confidence interval of +/-5% at the 95% confidence level.

Table 19: Summary statistics

SUMMARY STATISTICS				
Gender:			**For how long have you been using this route?**	
Female	58%		Less than a year	26%
Male	42%		1-5 years	45%
			More than 5 years	29%
Age categories:			**On a scale from 1-5, indicate how satisfied you currently are with the 121:**	
16-35 years old	56%		Average overall satisfaction	3.93
36-55 years old	33%		Average satisfaction with on-time arrival	3.74
56-76 years old	11%		Average satisfaction with travel time	3.88
Do you have access to a car?			**What is the purpose of this trip?**	
Car access: Yes	44%		Going to work	68%
			Going to school	29%
Direction the passenger was travelling:			Going for shopping	13%
East	48%			
			In one year from now, do you plan to be using public transit:	
Language:			Less than you do now	14%
English	36%		The same	76%
French	64%		More than you do now	10%

6.5 RESULTS

Figure 18 demonstrates that many of the surveyed bus users reported that they were satisfied or very satisfied with the service overall. In addition, the figure shows that 14% reported that they plan to use the service less than they currently use it. Furthermore, the lower part of Figure 18 demonstrates that satisfaction is not always associated with loyalty; however, among users of all levels of satisfaction, most intend to continue using the service the same amount as they currently do. Additionally, in nearly every category of satisfaction there are users who both want to use transit more and less than they currently do. However, the percentage of users who intend to use transit less than they currently do increases as overall satisfaction decreases.
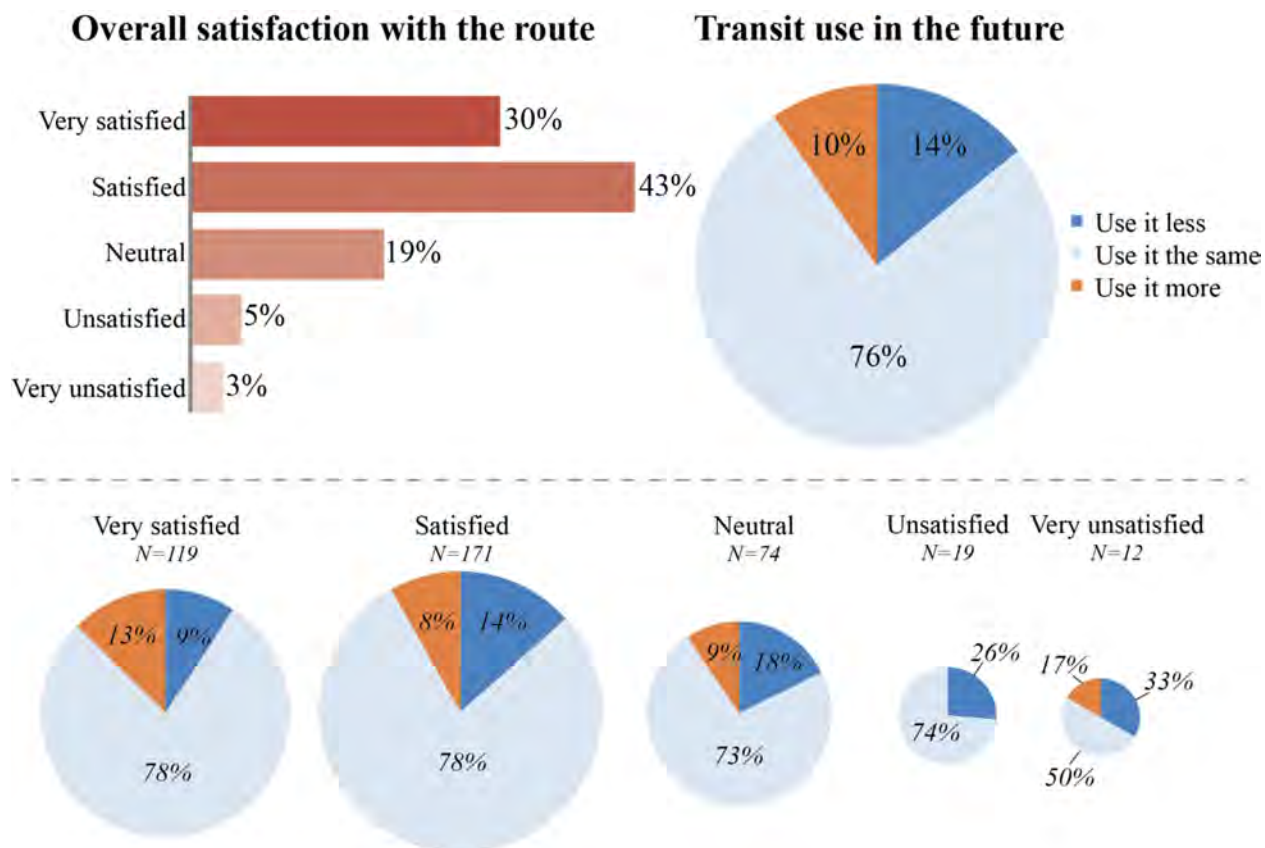
Figure 18: Satisfaction and future usage

Figure 19 illustrates users' agreement with the statements "*I have a positive image of transit*", and "*public transit is an important public service*". While nearly all users agree that transit is an important public service, the results relating to having a positive image of transit are more mixed. The figure reveals that there is space for improvement when it comes to promoting users to have a positive image of public transit. On the other hand, the figure also shows that, although variation does exist, the majority of the sample already agrees that transit is an important public service.
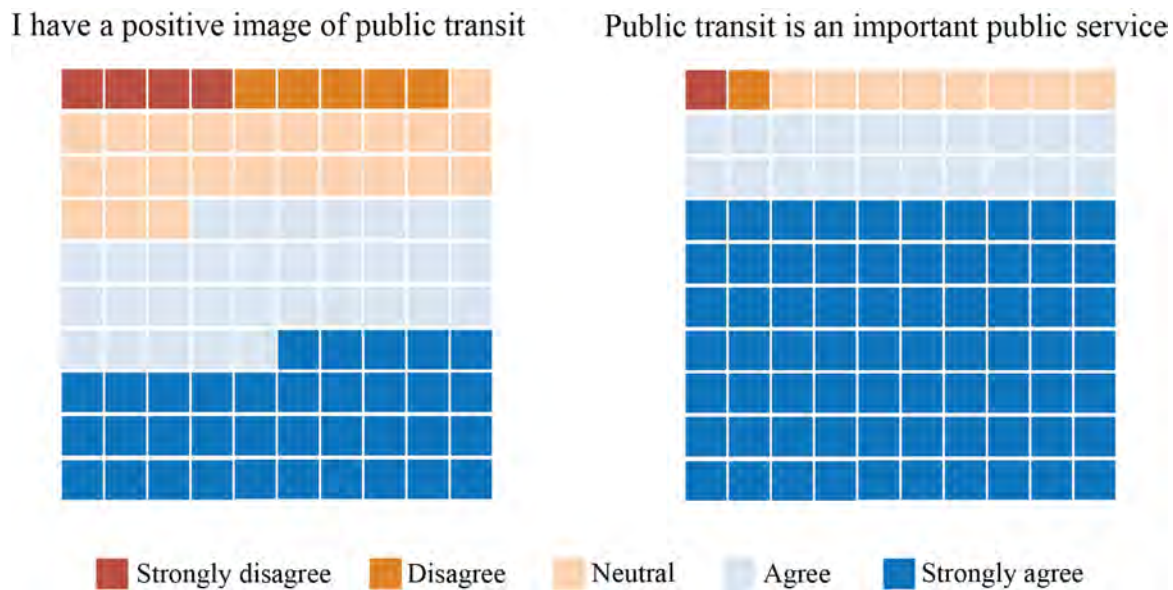
Figure 19: Image of public transit

While the survey questions illustrated in Figure 18 are used as the dependent variables for the logistic models discussed in the following section of the manuscript, those in Figure 19 are used as independent, predictor variables. Accordingly, the following section presents statistical models based on two key components of loyalty: overall satisfaction, and the intention to continue using the service in the future. Overall satisfaction and users' intentions to continue using transit in the future are two aspects that previous researchers have linked to loyalty (Transportation Research Board 1999, van Lierop and El-Geneidy 2016). Therefore, rather than assessing the direction of influence between variables, this research seeks to assess the effect of users' image of transit on satisfaction and future use, and not the reverse.

6.5.1 Model selection

Table 20 demonstrates the results of the first model used to understand the relationship between having a positive image on overall satisfaction while controlling for age. In addition, Table 21 shows the results of the model used to better understand the relationship between having a

positive image and an individuals' intention to continue using transit in the future while controlling for previous usage. In model 1 the dependent variable determines whether a user is satisfied with the bus service or not, with 'satisfied' and 'very satisfied' users coded as 1, and 'neutral', 'unsatisfied', and 'very unsatisfied' users having been coded as 0. In model 2 the dependent variable reflects users' intentions to continue using transit. Users who stated that they plan to continue using the service 'the same' or 'more' than they currently do were coded as 1, and those who stated that they plan to use it 'less; were coded as 0. Users' satisfaction and intentions to continue using the service are analysed as they are two important components of user loyalty. The results are presented in Table 20 and Table 21 with the odds ratios and 95% confidence intervals for both models, and include only significant variables.

We used R statistical program to generate the models and ran exhaustive model selection processes in order to understand which variables should be included in each of the models. Model selection was based on AIC and BIC scores, and in order to assess the predictive ability of the models we calculated error rates based on maximizing specificity and sensitivity on the receiver operating characteristics (ROC) curves for each model as a Goodness-of-Fit (GoF) statistic. Finally, as an additional GoF statistic we measured the area under the curve (AUC), which in both cases was greater than .5, meaning that the models are useful for assessing overall satisfaction and future usage.

Table 20: Model 1 – Overall satisfaction

OVERALL SATISFACTION: Level of satisfaction with the bus service	MODEL 1		
	OR	2.5 %	97.5 %
(Intercept)	6.689 ***	2.037	23.888
Personal Characteristics			
Age group: 16-35	0.429 *	0.157	1.027
Age group: 36-55	0.374 **	0.134	0.926
Age group: 56-76	NA	NA	NA
I have a positive image of public transit:			
Low agreement (1-2/5)	0.138 ***	0.057	0.325
Medium agreement (3-4/5)	0.461 ***	0.255	0.810
High agreement (5/5)	NA	NA	NA
Public transit is an important public service:			
Agreement (4-5/5)	2.003 *	0.969	4.125
Signif. codes: 0.001 '***' 0.01 '**' 0.05 '*' --- = Not in model, NA = Reference Category †*Thresholds for error rates are based on maximizing* *sensitivity and specificity as indicated by ROC curves.*	*N=395* AIC: 433 BIC: 457 Error rate: 0.058† AUC: 0.673		

The purpose of model 1 was to assess whether having a positive image of public transit is associated with users' overall satisfaction. The model reveals that having a positive image increases users' odds of being satisfied. More specifically, when controlling for other variables, the odds of being satisfied are 86% lower for users who do not have a positive image of transportation compared to those with a high agreement. The odds increase for those with a medium agreement, and are 54% lower compared to those with a high agreement. Furthermore, the odds for users who agree that public transit is an important public service is two times higher compared to users who do not agree with this statement. With regard to age, the odds of being satisfied are 63% lower for middle aged users (36-55) and 57% lower for young users (16-35) compared to older users.

Table 21: Model 2 – Future usage

FUTURE USAGE: Intention to continue to use	MODEL 2		
	OR	2.5 %	97.5 %
(Intercept)	11.409***	2.620	56.752
Personal Characteristics			
Have used transit for less than a year	0.432 *	0.181	0.991
Have used transit for 1-5 years	0.443 **	0.196	0.937
Have used transit for more than 5 years	NA	NA	NA
I have a positive image of public transit:			
Low agreement (1-2/5)	0.152 ***	0.048	0.464
Medium agreement (3-4/5)	0.266 ***	0.105	0.584
High agreement (5/5)	NA	NA	NA
Satisfaction			
Overall level of satisfaction with public transit (1-5)	1.325 *	0.976	1.789
Signif. codes: 0.001 '***' 0.01 '**' 0.05 '*' --- = Not in model, NA = Reference Category †*Thresholds for error rates are based on maximizing sensitivity and specificity as indicated by ROC curves.*	*N=395* AIC: 308 BIC: 332 Error rate: 0.035† AUC: 0.843		

Model 2 assesses whether having a positive image of public transit is associated with users' intention to continue using transit in the future. Similar to model 1, the results of model 2 reveal that having a positive image of transit increases users' odds of continuing to use transit in the future. When controlling for other variables, the odds of intending to use transit in the future are 85% lower for users who do not have a positive image of transportation compared to those with a high agreement. The odds increase for those with a medium agreement, and are 73% lower compared to those with a high agreement. Furthermore, for every increase in satisfaction on a scale from 1-5 the odds of intending to use transit in the future increase by 33%. Satisfaction is included in the model to control for the findings of previous studies that have demonstrated that satisfaction influences behavioural intentions (Lai and Chen 2011, van Lierop and El-Geneidy 2016). Correlation between the satisfaction and image variables were tested (0.35), and collinearity was not present. On the other hand, the variable measuring users' agreement with

public transit being an important public service is not included as we had no theoretical basis for including it. Furthermore, as a control variable, model 2 includes the amount of time that a transit user has been taking transit and found that the longer that a user has been taking transit, the greater their odds of continuing to use transit in the future. Compared to users who have been taking transit for more than five years, the odds of intending to use transit in the future are 57% lower for users who have been using transit for less than a year and 56% lower for users who have been using it for 1-5 years. We used the amount of time that an individual had been taking transit rather than a user's age, as these two variables are strongly related, and previous research has found that individuals' previous behaviours can be used to predict future behaviour (Aarts, Verplanken et al. 1998). The results of model 2 confirm that individuals who have been using transit for more than five years have a higher odds of intending to continue using the service. Finally, a variable describing car access was also tested, but unlike the results of the previous chapters of this dissertation, the variable was not found to be associated with the intention to continue using transit in the future.

6.6 DISCUSSION

6.6.1 Defining loyalty

Overall, models 1 and 2 have confirmed that as individuals' image of public transit improves, the odds of being satisfied and of intending to use transit in the future increase. This means that having a positive image of transit influences two important components of loyalty: satisfaction and intended future usage.

In the introduction of this manuscript we discussed that researchers have adopted different definitions of loyalty, explained that in transportation research the relationship between customer satisfaction and loyalty can be complex (Merkert and Pearson 2015), and that therefore

defining the characteristics of a loyal transit user is not a straightforward task. However, many researchers agree that two of the most commonly used components of loyalty are satisfaction and future usage (Transportation Research Board 1999, Allen and Allen 2004, van Lierop and El-Geneidy 2016) – the dependent variables used in models 1 and 2. Furthermore, while several authors include users' intention to continue taking public transit as one of the elements in their loyalty construct (Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014), it remains rare to define loyalty by including users' attitudes and image of transit in the conceptualization of loyalty.

However, the results of this study have revealed that users' image of public transit is strongly associated with their intentions to continue using transit. These results are consistent with previous research (Minser and Webb 2010, Lai and Chen 2011, Zhao, Webb et al. 2014), and accordingly, based on the review of the literature and results of the analysis presented in this study, we suggest that loyalty constructs in transportation research should be composed of three essential elements: (1) users' image of public transit, (2) their overall satisfaction with a particular service, and (3), passengers' intentions to continue using the service in the future. Figure 4 demonstrates the relationships between these components of satisfaction.

While past research has demonstrated that satisfaction influences future usage (Lai and Chen 2011, Carreira, Patrício et al. 2014, van Lierop and El-Geneidy 2016), and the present study has revealed relationships between image and satisfaction as well as image and future usage, these relationships may not be linear. Future research should therefore assess the linearity and cyclicality of the relationships presented in Figure 20.

Figure 20: The key to loyal customers

6.6.2 Improving the image of public transit

Improving the image of public transit is an essential and difficult task that many cities and public transit agencies face today. There is often a negative connotation associated with the use of public transit that is not present with other modes. For example, in a qualitative study of attitudes towards private cars and public transportation, Beirão and Cabral (2007) found that several barriers towards taking public transit included "*[n]egative feeling towards public transport*" and that users "*[d]o not know what to expect.*" These negative sentiments towards the mode demonstrate that it is important for cities and transit agencies to work together to promote public transit and educate users about what should be expected when using a transit service. Changing the opinions of both transit users and non-users towards transit is essential for the de-stigmatization of transit use that is present in many regions. In a study focusing on public transit and stigma, Schweitzer (2014) found that on social media, there are often more negative comments being made compared to other public services. Accordingly, as a strategy to overcome the negative stigmas associated with public transit usage, Schweitzer (2014) suggests that transit agencies take an active part in changing these negative perceptions by using social media to respond directly to the questions, comments, and concerns of social media users. Interestingly,

the study found that transit agencies who did engage in such practices received "*more positive statements about all aspects of services and fewer slurs directed at patrons, independent of actual service quality.*" The results of Schweitzer's (2014) study reveal that it is possible for transit agencies to actively participate in changing the dialogue associated with users' (preconceived) perceptions of public transit. This is important for both transit agencies and cities to consider, given that the findings of the present study demonstrate that there is a strong relationship between users' image of transportation and their satisfaction and intention to continue to use it in the future.

6.7 LIMITATIONS AND FUTURE RESEARCH

While the present study included only responses from transit users, future research should focus on non-users, especially car drivers. Furthermore, future studies should be conducted in regions that are more auto-centric than Montreal, Canada, such as the in the United States of America where there is often a stigma associated with transit usage (Schweitzer 2014). Furthermore, it is also essential for future research to understand what are the factors influencing users to have a positive image of public transit and the relationships between transit users image, satisfaction, and future usage should be further explored as they may not be linear. More specifically, it is conceivable that certain transit users who have favourable views of public transit do so because it constitutes an integral part of their lifestyle, and therefore they may be more likely to report more positively in customer satisfaction surveys. The cyclical relationship between service attributes, overall satisfaction, and loyalty should be further explored. In addition, the data used in this study is a result of collecting primary data specifically for the purpose of this study. However, questions about transit users' image of public transit are usually not included in public agencies' customer satisfaction surveys. In the future, transit agencies would benefit from including image

questions in their large-scale customer satisfaction surveys – especially if individuals' image about transit can be compared to their image of other modes. The results of this study add to the existing literature on transit user loyalty by investigating the association between the image that users have of public transit and their overall satisfaction and intentions to continue using the mode. The findings are also useful for researchers and transit agencies aiming to better understand and increase loyalty among current and future public transit users.

7 CHAPTER SEVEN: CONCLUSION

7.1 SUMMARY OF CHAPTERS

This dissertation consists of seven interrelated chapters addressing fundamental questions about how transit agencies can encourage passenger loyalty by increasing satisfaction among different populations of riders. Using a multifaceted approach, this dissertation has asked fundamental questions about the drivers of customer satisfaction and loyalty among existing transit users. The five studies included have provided insight into how transit agencies and cities can motivate and increase overall satisfaction, loyalty, and ridership retention.

The first chapter framed the research presented in this dissertation in the context of urban public transit research more generally, and discussed how this research can be useful for improving current and future public transit systems. The second chapter systematically analysed the relevant literature regarding the causes of satisfaction and loyalty in public transit, and the findings suggested that the service factors most influencing overall satisfaction are on-board cleanliness and comfort, courteous and helpful behaviour from public transport agencies' personnel, safety, as well as punctuality and frequency of service. In addition, the results of the literature review chapter identified that loyalty is often reported as being associated with users' perceptions of value for money, on-board safety and cleanliness, interactions with personnel and the image and commitment to public transport that a user feels. Furthermore, this review of the literature provided a discussion about the variation in how researchers define loyalty, and identified gaps in the literature that the empirical studies that are included in this dissertation set out to address.

Next, using data from two Canadian transit agencies (Montreal's Société de transport de Montréal and Vancouver's TransLink), Chapter 3 set out to better understand the factors

influencing satisfaction and loyalty among the different groups using transit in Vancouver, British Columbia, and Montreal, Quebec. Building on the results of the literature review presented in Chapter 2, this chapter used secondary data to assess satisfaction and loyalty within a Canadian context. The analysis revealed that nine market segments are present across different modes in both transit agencies. Moreover, the results showed that three overarching groups of transit users are likely to be present in any transit market based on income and vehicle access: choice users, captive users, and captive by choice users. Next, the results of Chapter 3 were used in Chapter 4 to examine how transit users' perceptions of service quality and user satisfaction influence loyalty among different groups of transit users. The findings of Chapter 4 revealed that different service factors are important for motivating loyalty among choice users, captive users, and captive by choice users.

Chapter 5 departed from basing analyses solely on data coming from transit agencies' customer satisfaction questionnaires. Instead, Chapter 5 analyzed the drivers of public transit satisfaction among users based on both customer satisfaction questionnaires, as well as operations data obtained from automatic vehicle location (AVL) and automatic passenger counter (APC) systems for an express bus route in Vancouver, Canada. It provided a framework to identify the main factors influencing customer satisfaction, and questioned whether using operations data in parallel with passengers' perception data is useful to understand customer satisfaction. The findings of this chapter revealed that both actual crowding and users' perception of crowding are related to how transit users perceive overall satisfaction with bus services, and demonstrated the benefit of using both customers' perceptions as well as information coming from bus operations to identify which modifiable components of a service can be prioritized in order to effectively increase riders' overall satisfaction.

164

While chapters three, four and five relied on data provided by public transit agencies, the sixth chapter used primary data collected by the author in order to explore how users' views and opinions about public transit are associated with users' trip satisfaction and future behavioural intentions. Information about the image that users have of public transit was not included in the transit agencies' customer satisfaction questionnaires that were used for the analysis of the earlier chapters; therefore, it was necessary for the author to collect primary data in order to assess whether users' image of public transit is related to passengers' satisfaction and intention to continue using public transit in the future. The results revealed that having a positive image of transit increases users' odds of being satisfied and of intending to continue using transit in the future and suggest that loyalty constructs in public transit research should account for users' image of public transit, their overall satisfaction with a particular service, and, passengers' intentions to continue using the service in the future.

Overall, the results of the research presented in this dissertation can be helpful for transit agencies aiming to develop specific strategies in order to benchmark user satisfaction and loyalty with the aim of growing patronage among different groups. Insight into how passengers perceive transit services can be useful for helping transit agencies understand what inspires customers to be satisfied and loyal in order to motivate ridership retention.

7.2 THEORETICAL, METHODOLOGICAL, AND POLICY CONTRIBUTIONS

This research addresses the challenge of prescribing policies and interventions to increase satisfaction and loyalty among transit users. It focusses specifically on ways in which transportation agencies and cities can motivate the continued use of public transit among current transit users. Overall, this dissertation offers a multifaceted approach to better dissect and

understand the drivers of customer satisfaction and loyalty among existing transit users, and contributes to expanding knowledge in the field of public transit research by:

- Deepening the understanding of how improvements to particular service factors and users' image of public transit influence satisfaction and loyalty among different groups of transit users, in order to develop targeted strategies that maximize overall ridership retention. (Chapters two, three, four, five, and six)

- Comprehensively reviewing and clearly redefining the concept 'loyalty' in public transit in order to allow transit agencies and researchers to measure loyalty in a more valid and reproducible manner, i.e., the re-operationalization of the concept of 'loyalty.' (Chapters two and six)

- Developing a methodology for assessing, contrasting and integrating customer satisfaction surveys (i.e., user's perception of service) with operations data (i.e., actual service), which is reproducible and implementable in many regions. (Chapter five)

7.2.1 Identifying important service factors

The concepts of satisfaction and loyalty are at the core of this dissertation. Chapter 2 illustrated that researchers around the world have identified that both different and similar service attributes are associated with satisfaction and loyalty depending on the geographic and cultural setting. While previous researchers identified the service factors most influencing satisfaction and loyalty in specific case studies (Stuart, Mednick et al. 2000, Weinstein 2000, Githui, Okamura et al. 2010, Minser and Webb 2010, Figler, Sriraj et al. 2011, de Oña, de Oña et al. 2013, Mouwen 2015), this dissertation has added to the literature by highlighting common threads and identifying which service factors are strongly associated with overall satisfaction and loyalty. Accordingly, Figure 21 illustrates which service factors are most frequently associated with

satisfaction and loyalty by pictorially representing the relative importance of service attributes that, based on the literature reviewed and presented in Chapter 2, contribute the most to increasing overall satisfaction and loyalty among public transit users. The larger the font size of a word, the more frequently it occurs in the literature, meaning that the larger words appear in a higher number of papers.

Satisfaction:

Loyalty:

Figure 21: The service factors most influencing satisfaction and loyalty

In addition to identifying important service factors according to the literature, this dissertation also identified which service factors most strongly influence customer loyalty among different groups of transit users in two Canadian cities. In Chapter 3, a fine-grained analysis of the transit markets in two Canadian cities revealed the presence of specific market segments such as *economizing riders*, *convenience riders* and *young riders*. The *young riders* are likely to share some of the characteristics of the millennial generation, which has been documented to have high transit mode share and lower rates of auto and driver's license ownership (Dutzik and Baxandall 2013, Brown, Blumenber et al. 2016). In the future, further analysis of transit markets would be helpful to develop policies for other specific groups that are known to be more likely to have a higher propensity to use transit during certain life phases. For example, in addition to millennial populations, immigrant populations who come from places where transit is the dominant mode, may be more inclined to use transit in the short-term (Heisz and Schellenberg 2004). Developing specific policies to retain younger or newer users by making service improvements geared specifically to their needs and desires is likely to result in increased loyalty over time and greater overall transit user retention. Overall, Chapter 3 demonstrated how segment-specific policies can be useful for motivating satisfaction among specific populations. However, Chapter 3 also presented the more generalizable and overarching categories of captive, choice, and captive by choice which are likely to exist in any transit market.

While traditionally 'captivity' was most commonly based on car access (Krizek and El-Geneidy 2007), the results of this dissertation suggest the presence of an additional segment which we have named 'captive by choice,' to reflect the fact that there exists a group of transit users who are captive to transit because they do not have access to a car, but likely have chosen

this situation as they appear not to have as much of an income barrier compared to other lower-income transit users:

- Choice users: Car access

- Captive users: No car access, low income

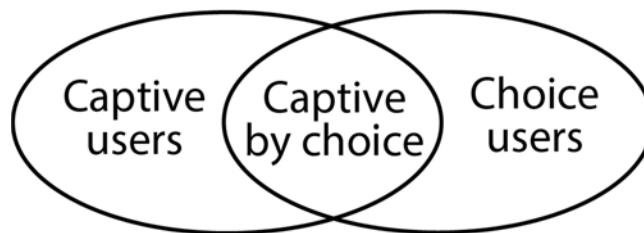- Captive by choice users: No car access, do not have low income

Figure 22: The overarching groups using transit

With these three overarching transit user segments in mind, this dissertation recognizes that improvements to different service factors will impact transit market segments in different ways. Figure 23 demonstrates how the same seven service factors are related to different market segments. These results come from the findings of Chapter 4, and similarly to Figure 21 (above), the larger the font size of the word, the more likely that service improvements to the service factor in question will increase overall loyalty for each of the groups using transit.

Figure 23: Service changes will impact transit user segments differently

Furthermore, the research on market analysis presented in this dissertation placed transit users into single market segments in order to identify which service factors were most strongly associated with the different groups using transit. As mentioned in Chapter 3, in future research it would be useful to quantitatively consider the likelihood of how each variable affects the probability of a transit rider belonging to captive, choice, and captive-by-choice segments and the make-up of each individual. Such a latent class approach would probabilistically assign transit users to different segments based on personal and travel behavioural characteristics similarly to the models used to explore mode choice (Bhat 1997, Srinivasan, Naidu et al. 2009). For transit market analysis, this method would provide a more flexible approach to identifying and predicting market segments.

7.2.2 Redefining loyalty

Previous research has based loyalty on transit users' levels of satisfaction, likeliness to repeat using the service in the future, and likeliness to recommend it others (Transportation Research Board 1999), and attributed it to being related to a person's continuous behaviour to purchase or use of a product or service, as well as attitudes and emotions towards a service on an ongoing basis (Zhao, Webb et al. 2014). This dissertation contributes to the academic literature on loyalty by suggesting that the image that a user has of public transit should also be considered. Accordingly, based on the results of analysing loyalty in chapters 2, 4, and 6, Figure 24 builds on Figure 1 which was presented in the introduction of this dissertation, by demonstrating that a loyal customer is someone who altogether is (1) satisfied with the service, (2) willing to recommend transit to a friend or colleague, (3) planning to use transit in the future, and (4) has a positive image of transit. In Figure 24, the box containing the word "image" is a darker shade of gray representing that it is a new element that should be considered in the definition of loyalty.

With this in mind, in the future, transit agencies would benefit from adding questions about users' image of transit to their customer satisfaction questionnaires in order to more accurately identify who are their loyal customers, in order to develop strategies to increase overall loyalty among the different groups using transit.
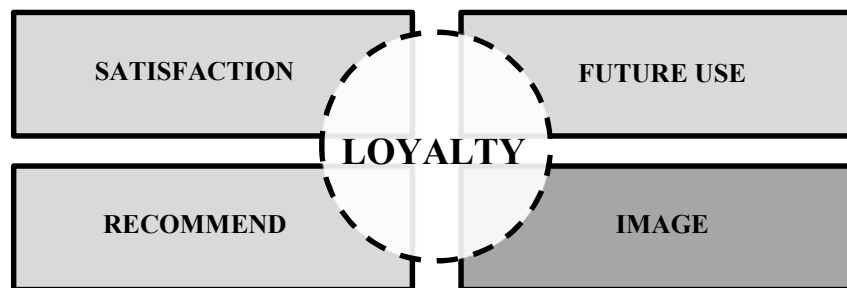

Figure 24: The elements of loyalty

7.2.3 A new methodology

This dissertation has presented a new methodology for assessing, contrasting and integrating customer satisfaction surveys with operations data. While it is common practice to base analyses of transit users' satisfaction solely on data derived from customer satisfaction surveys (Stuart, Mednick et al. 2000, Weinstein 2000, Tyrinopoulos and Antoniou 2008, Minser and Webb 2010, Figler, Sriraj et al. 2011, Kim and Ulfarsson 2012, de Oña, de Oña et al. 2013, Zhao, Webb et al. 2014), Chapter 5 of this dissertation contributes to the literature by presenting a methodology for analysing both users' perceptions of service and actual service, which can be useful for transit agencies and researchers to assess complex relationships between users' perceptions of transit with what is actually happening on the ground. For example, the results demonstrated that acceptable levels of crowding may change over the time of the day for transit users, and that thresholds can be used by transit agencies to set crowding standards and can also be useful for indicating when transit agencies must dispatch an additional bus in order to

maintain customers' expectations with regard to crowding. Furthermore, because this methodology used in Chapter 5 is not attached to a specific geographic context, it is reproducible and implementable in many regions. Figure 25, which was first presented in Chapter 5, summarizes how data derived from customer satisfaction surveys and operations systems can be used together to effectively assess user satisfaction with a bus service.
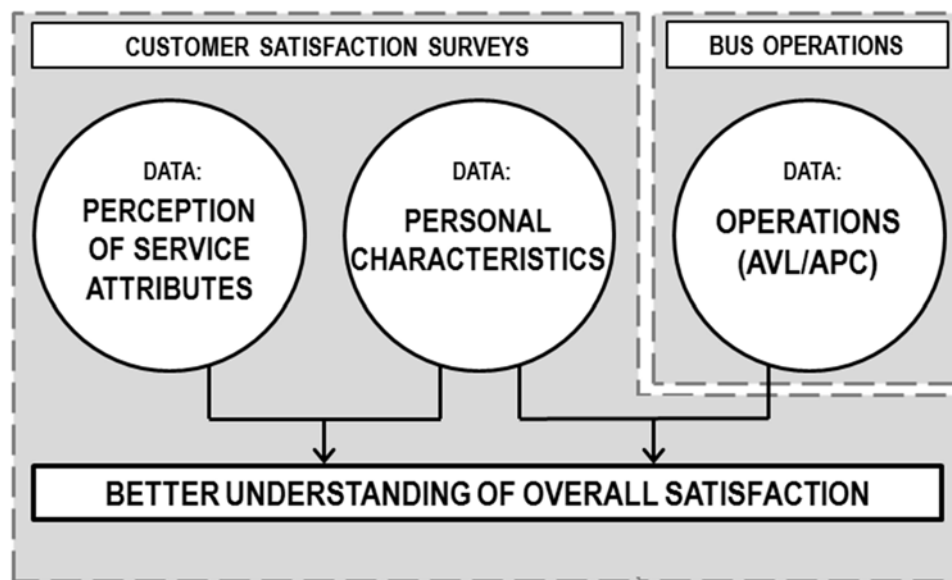

Figure 25: How to assess customer satisfaction

7.3 CONCLUDING REMARKS

Overall, by identifying different segments of public transit users, important service factors which are associated with satisfaction and loyalty, as well as a new approach to analysing operations and customer satisfaction data in a combined manner, the findings presented in this dissertation can be productively used to inform public transit research, policy, and managerial practice. More specifically, the results of the research can be helpful for developing strategies to attract people to taking public transit. The timing of this research is appropriate as in the near future, city planners, policy makers, and transportation professionals are expected to begin planning for

multi-modal cities that safely and efficiently integrate public transit, AVs, and other modes. Accordingly, the results of this research can be used to develop strategies that attract people to use public transit even when AVs become a mainstream travel option. For example, because this dissertation provides a framework to understand how transit users' personal opinions and perceived levels of satisfaction with transit are related to passengers' future mode choice, the results can be used to develop transit systems that are built based on loyalty rather than necessity. This approach will be helpful in creating better policies that can promote transit as a preferred mode across the socio-economic spectrum in cities both today, and in the future.

In order to plan attractive and competitive public transit that is well integrated into the urban fabric of the future, cities and public transit agencies must prepare for the needs and desires of future transit users. Furthermore, satisfaction and loyalty research should be developed in order to increase ridership retention among different populations and motivate transit usage in the long term. Whereas this dissertation focused specifically on segmenting and analysing adult populations, in my future research I plan to apply the framework presented in this dissertation to child and youth populations as they constitute both current and future users of transit. In order to motivate multi-modal travel behaviour in the future that includes the use of public transit, it is essential to focus on the needs and desires of children and youth populations as it has been found that increased usage of public transit at a younger age is a strong predictor of continued use in the long-term (Grimsrud and El-Geneidy 2014). Furthermore, the results of Chapter 6 revealed that transit riders' image of transit is strongly related to their loyalty. While increasing satisfaction and loyalty among adult populations is useful for promoting their current and continued use of public transit, assessing the travel needs and desires of children and youth, and promoting a positive image of the mode, could encourage younger riders to request that their

adult escorts take them by transit, and to continue using this sustainable mode as they move through different stages in their lives, inspiring them to view it as a normative, rather than alternative, mode.

Research on transit satisfaction should also be applied to aging populations, especially because as this group grows and their ability to drive decreases, there will be higher demands on public transit systems (Newbold, Scott et al. 2005). However, if public transit is not developed and imagined by these users as an attractive and viable mode, they might become more inclined to use modes such as present-day ride share services or taxis, and in the future switch to using AVs, thereby decreasing their likeliness benefit from walking to transit (Jacobson, King et al. 2011, Wasfi, Ross et al. 2013), and also adding to congestion by increasing the total amount of vehicles on the road (Fagnant and Kockelman 2015). Therefore, to further help in the development of policies that aim to increase transit ridership among users of all ages, in my future research I plan to engage in in-depth analyses focused on understanding the needs and desires of individuals who currently do not use public transit. Furthermore, because service interruptions such as strikes and breakdowns have been related to mode shifts away from transit (Van Exel and Rietveld 2009, Pnevmatikou, Karlaftis et al. 2015), future research should assess how service disruptions shape different segments of transit users' attitudes and perceptions of transit. Finally, because in the future public transit must be planned to be integrated with the use of AVs, in my future research I will aim to develop stated preference surveys to be used in combination with the results of this dissertation in order to accurately study who will be the early adopters of AV technology, and how these users will expect AVs to be integrated with public transit systems.

Overall, this dissertation is an example of combining community engagement with academic research. The results of analysing customers' points of view about transit performance by using data provided by Montreal's STM and Vancouver's TransLink, as well as primary data collected by the author, helped bridge important gaps in public transit customer satisfaction and loyalty research, while assisting local public transit agencies by identifying ways to increase ridership retention. Moreover, the research included in this dissertation recognizes that as the world's urban population continues to rise, the volume of intra-urban transportation increases, and new technologies such as the wide-spread introduction of AVs become integrated into urban environments, transit agencies and governments will need to understand what motivates individuals to choose environmentally and socially sustainable forms of transportation such as public transit over personal motorized vehicles. Therefore, this dissertation has contributed towards finding knowledge and solutions that promote sustainable and accessible forms of transportation and motivate transit usage regardless of age, gender, race, or socio-economic status. Overall, this dissertation has contributed to both research and practice by giving academic attention to real-world, everyday urban issues with the goal of influencing public policy in order to develop more socially, environmentally, and economically sustainable communities.

8 REFERENCES

(2016). Loyal. <u>Merriam-Webster</u>, An Encyclopædia Britannica Company.

(2016). Satisfaction. <u>Merriam-Webster</u>, An Encyclopædia Britannica Company.

Aarts, H., B. Verplanken and A. Knippenberg (1998). "Predicting behavior from actions in the past: Repeated decision making or a matter of habit?" <u>Journal of Applied Social Psychology</u> **28**(15): 1355-1374.

Abou-Zeid, M., R. Witter, M. Bierlaire, V. Kaufmann and M. Ben-Akiva (2012). "Happiness and travel mode switching: findings from a Swiss public transportation experiment." <u>Transport Policy</u> **19**(1): 93-104.

Allen, D. and D. Allen (2004). <u>Customer satisfaction research management: A comprehensive guide to integrating customer loyalty and satisfaction metrics in the management of complex organizations</u>, Asq Press.

Anable, J. (2005). "'Complacent car addicts' or 'aspiring environmentalists'? Identifying travel behaviour segments using attitude theory." <u>Transport Policy</u> **12**(1): 65-78.

Anderson, J., K. Nidhi, K. Stanley, P. Sorensen, C. Samaras and O. Oluwatola (2014). <u>Autonomous vehicle technology: A guide for policymakers</u>, Rand Corporation.

Barlow, S. and H. Clark (2006). Findings of customer surveys conducted for Sacramento Regional Transit.

Beimborn, E., M. Greenwald and X. Jin (2003). "Accessibility, connectivity, and captivity: Impacts on transit choice." <u>Transportation Research Record: Journal of the Transportation Research Board</u> **1835**(1): 1-9.

Beirão, G. and J. Cabral (2007). "Understanding attitudes towards public transport and private car: A qualitative study." <u>Transport policy</u> **14**(6): 478-489.

Beirão, G. and J. Cabral (2008). "Market segmentation analysis using attitudes toward transportation: Exploring the differences between men and women." <u>Transportation Research Record: Journal of the Transportation Research Board</u> **2067**(1): 56-64.

Bhat, C. (1997). "An endogenous segmentation mode choice model with an application to intercity travel." <u>Transportation science</u> **31**(1): 34-48.

Black, E. (2006). <u>Internal Combustion: How Corporations and Governments Addicted the World to Oil and Derailed the Alternatives</u>, Macmillan.

Bloemer, J., K. De Ruyter and P. Peeters (1998). "Investigating drivers of bank loyalty: The complex relationship between image, service quality and satisfaction." <u>International Journal of Bank Marketing</u> **16**(7): 276-286.

Bohte, W., K. Maat and B. van Wee (2009). "Measuring attitudes in research on residential self-selection and travel behaviour: A review of theories and empirical research." <u>Transport reviews</u> **29**(3): 325-357.

Bridges, R. (2015). Driverless car revolution: Buy mobility, not metal.

Brown, A., E. Blumenber, B. Taylor, K. Ralph and C. Voulgaris (2016). "A taste for transit? Analyzing public transit use trends among youth." Journal of Public Transportation **19**(1).

Burkhardt, J. (2003). "Critical measures of transit service quality in the eyes of older travelers." Transportation Research Record: Journal of the Transportation Research Board **1835**(1): 84-92.

Button, K. (2010). Transport economics, Edward Elgar Publishing.

Cain, A., J. Flynn, M. McCourt and T. Reyes (2009). Quantifying the importance of image and perception to Bus Rapid Transit.

Car2Go. (2015). "Car2Go."   Retrieved 8 December 2015, from www.car2go.com.

Carreira, R., L. Patrício, R. Jorge and C. Magee (2014). "Understanding the travel experience and its impact on attitudes, emotions and loyalty towards the transportation provider–A quantitative study with mid-distance bus trips." Transport Policy **31**: 35-46.

Carreira, R., L. Patrício, J. Natal and C. Magee (2014). "Understanding the travel experience and its impact on attitudes, emotions and loyalty towards the transportation provider–A quantitative study with mid-distance bus trips." Transport Policy **31**: 35-46.

Cervero, R. (2013). "Bus Rapid Transit (BRT): An efficient and competitive mode of public transport." IURD Working Paper 2013-01.

Cervero, R., C. Ferrell and S. Murphy (2002). "Transit-oriented development and joint development in the United States: A literature review." TCRP research results digest(52).

Chakrabarti, S. and G. Giuliano (2015). "Does service reliability determine transit patronage? Insights from the Los Angeles Metro bus system." Transport Policy **42**: 12-20.

Chan, N. and S. Shaheen (2012). "Ridesharing in north america: Past, present, and future." Transport Reviews **32**(1): 93-112.

Chen, C. (2008). "Investigating structural relationships between service quality, perceived value, satisfaction, and behavioral intentions for air passengers: Evidence from Taiwan." Transportation Research Part A: Policy and Practice **42**(4): 709-717.

Chen, C. and W. Chao (2011). "Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit." Transportation research part F: traffic psychology and behaviour **14**(2): 128-137.

Chou, J. and C. Kim (2009). "A structural equation analysis of the QSL relationship with passenger riding experience on high speed rail: An empirical study of Taiwan and Korea." Expert Systems with Applications **36**(3): 6945-6955.

Chou, P., C. Lu and Y. Chang (2014). "Effects of service quality and customer satisfaction on customer loyalty in high-speed rail services in Taiwan."

Conlon, M., P. Foote, K. O'Malley and D. Stuart (2001). "Successful arterial street limited-stop express bus service in Chicago." Transportation Research Record: Journal of the Transportation Research Board(1760): 74-80.

Cox, T., J. Houdmont and A. Griffiths (2006). "Rail passenger crowding, stress, health and safety in Britain." Transportation Research Part A: Policy and Practice **40**(3): 244-258.

Curry, B. (2016). Where have all the transit riders gone? The Globe and Mail. Ottawa, Phillip Crawley.

Curtis, C. and P. Headicar (1997). "Targeting travel awareness campaigns: Which individuals are more likely to switch from car to other transport for the journey to work?" Transport Policy **4**(1): 57-65.

D'Alessandro, A. and M. Des (2008). Fare-Free Transit–A Strategy for Sustainable Transportation. 2008 Annual Conference of the Transportation Association of Canada.

Damant-Sirois, G., M. Grimsrud and A. El-Geneidy (2014). "What's your type: A multidimensional cyclist typology." Transportation **41**(6): 1153-1169.

Das, A., M. Ladin, A. Ismail and R. Rahmat (2013). "Consumers satisfaction of public transport monorail user in Kuala Lumpur " Journal of Engineering Science and Technology **8**(3): 272-283.

de Oña, J., R. de Oña, L. Eboli and G. Mazzulla (2013). "Perceived service quality in bus transit service: A structural equation approach." Transport Policy **29**: 219-226.

dell'Olio, L., A. Ibeas and P. Cecín (2010). "Modelling user perception of bus transit quality." Transport Policy **17**(6): 388-397.

dell'Olio, L., A. Ibeas and P. Cecín (2011). "The quality of service desired by public transport users." Transport Policy **18**(1): 217-227.

Demby, E. (1994). "Psychographics revisited: The birth of a technique." Marketing Research **6**: 26-26.

Diab, E., M. Badami and A. El-Geneidy (2015). "Bus transit service reliability and improvement strategies: Integrating the perspectives of passengers and transit agencies in North America." Transport Reviews **35**(3): 292-328.

Diab, E. and A. El-Geneidy (2014). "Transitory optimism: Changes in passenger perception following bus service improvement over time." Transportation Research Record **2415**: 97-106.

Diab, E. and A. El-Geneidy (2015). "Transitory optimism: Changes in passenger perception following bus service improvement over time." Transportation Research Record **2415**: 97-106.

Diab, E., D. van Lierop and A. El-Geneidy (2017). "Recommending transit: Disentangling users' willingness to recommend transit and their intended continued use." Travel Behaviour and Society **6**: 1-9.

Dibb, S. and L. Simkin (2010). "Judging the quality of customer segments: segmentation effectiveness." Journal of Strategic Marketing **18**(2): 113-131.

Dixon, M., K. Freeman and N. Toman (2010). "Stop trying to delight your customers." Harvard Business Review **88**(7/8): 116-122.

Doloreuxa, D. and R. Shearmur (2013). "Innovation Strategies: Are Knowledge-Intensive Business Services Just Another Source of Information?" Industry and Innovation **20**(8): 719-738.

Dunlop, D. and A. Tamhane (2000). Statistics and data analysis: from elementary to intermediate. Upper Saddle River, NJ, Prentice Hall.

Dutzik, T. and P. Baxandall (2013). A new direction: Our changing relationship with driving and the implications for America's future, United States PIRG Education Fund

Frontier Group.

Easterbrook, P., R. Gopalan, J. Berlin and D. Matthews (1991). "Publication bias in clinical research." The Lancet **337**(8746): 867-872.

Eboli, L. and G. Mazzulla (2009). "A new customer satisfaction index for evaluating transit service quality." Journal of Public Transportation **12**(3): 21-37.

Eboli, L. and G. Mazzulla (2010). "How to capture the passengers' point of view on a transit service through rating and choice options." Transport reviews **30**(4): 435-450.

Eboli, L. and G. Mazzulla (2012). "Structural equation modelling for analysing passengers' perceptions about railway services." Procedia-Social and Behavioral Sciences **54**: 96-106.

Eboli, L. and G. Mazzulla (2014). "Relationships between rail passengers' satisfaction and service quality: a framework for identifying key service factors." Public Transport: 1-17.

El-Geneidy, A. and J. Surprenant-Legault (2010). "Limited-stop bus service: an evaluation of an implementation strategy." Public Transport **2**(4): 291-306.

Evans, J. (2004). Transit scheduling and frequency: In traveler response to transportation system changes. Washington D.C, Transportation Research Board.

Fagnant, D. and K. Kockelman (2015). "Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations." Transportation Research Part A: Policy and Practice **77**: 167-181.

Ferris, B., K. Watkins and A. Borning (2010). OneBusAway: A transit traveler information system. Mobile Computing, Applications, and Services, Springer**:** 92-106.

Figler, S., P. Sriraj, E. Welch and N. Yavuz (2011). "Customer Loyalty and Chicago, Illinois, Transit Authority Buses: Results from 2008 Customer Satisfaction Survey." Transportation Research Record: Journal of the Transportation Research Board(2216): 148-156.

Fornell, C., M. Johnson, E. Anderson, J. Cha and B. Bryant (1996). "The American customer satisfaction index: Nature, purpose, and findings." Journal of marketing **60**(4).

Foth, N. (2010). "Long-Term Change Around SkyTrain Stations in vancouver, Canada: A Demographic Shift-Share Analysis." The Geographical Bulletin **51**: 37-52.

Friman, M. and M. Fellesson (2009). "Service supply and customer satisfaction in public transportation: The quality paradox." Journal of Public Transportation **12**(4): 57-69.

Garrison, W. and D. Levinson (2006). The transportation experience: Policy, planning, and deployment, Oxford University Press.

Garvill, J., A. Marell and A. Nordlund (2003). "Effects of increased awareness on choice of travel mode." Transportation **30**(1): 63-79.

Githui, J., T. Okamura and F. Nakamura (2010). "The structure of users' satisfaction on urban public transport service in developing country: The case of Nairobi." The Journal of the Eastern Asia Society for Transport Studies **8**.

Gountas, J. and S. Gountas (2007). "Personality orientations, emotional states, customer satisfaction, and intention to repurchase." Journal of Business Research **60**(1): 72-75.

Grimsrud, M. and A. El-Geneidy (2014). "Transit to eternal youth: lifecycle and generational trends in Greater Montreal public transport mode share." Transportation **41**(1): 1-19.

Grujičić, D., I. Ivanović, J. Jović and V. Đorić (2014). "Customer perception of service quality in public transport." Transport **29**(3): 285-295.

Guerra, E. (2015). "Planning for Cars That Drive Themselves Metropolitan Planning Organizations, Regional Transportation Plans, and Autonomous Vehicles." Journal of Planning Education and Research: 0739456X15613591.

Habib, K., L. Kattan and M. Islam (2011). "Model of personal attitudes towards transit service quality." Journal of Advanced Transportation **45**(4): 271-285.

Hair, J., W. Black, B. Babin and R. Anderson (2010). Multivariate data analysis (7th ed.). Upper Saddle River, NJ, Prentice-Hall, Inc.

Hayes, B. (1997). Measuring customer satisfaction: survey design, use, and statistical analysis methods. Milwaukee, Wisconsin, ASQ Quality Press.

Heisz, A. and G. Schellenberg (2004). "Public transit use among immigrants." Canadian Journal of Urban Research **13**(1): 170-191.

Heskett, J., T. Jones, G. Loveman, W. Sasser and L. Schlesinger (2008). "Putting the service-profit chain to work." Harvard Business Review.

Hess, D., J. Brown and D. Shoup (2004). "Waiting for the bus." Journal of Public Transportation **7**(4): 67-84.

Hodge, D., J. Orrell III and T. Strauss (1994). "Fare-free policy: costs, impacts on transit service, and attainment of transit system goals." Washington State Department of Transportation. Report Number WA-RD **277**.

Hoyle, R. and A. Panter (1995). Writing about structural equation models. Structural equation modeling: Concepts, issues, and applications. R. Hoyle. Thousand Oaks, CA, Sage Publications**:** 158-176.

Hu, L. and P. Bentler (1999). "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives." Structural equation modeling: a multidisciplinary journal **6**(1): 1-55.

Hussein, A. and R. Hapsari (2015). "How quality, value and satisfaction create passenger loyalty: An empirical study on indonesia bus rapid transit passenger " The International Journal of Accounting and Business Society **22**(2): 95-115.

Iacobucci, D. and A. Duhachek (2003). "Advancing alpha: Measuring reliability with confidence." Journal of consumer psychology **13**(4): 478-487.

Imaz, A., K. Habib, A. Shalaby and A. Idris (2015). "Investigating the factors affecting transit user loyalty." Public Transport **7**(1): 39-60.

Ipsos Reid (2013). Customer service performance: Quarter 3 2013. Vancouver, Canada, TransLink**:** 1-99.

Iseki, H. and B. Taylor (2009). "Not all transfers are created equal: Towards a framework relating transfer connectivity to travel behaviour." Transport Reviews **29**(6): 777-800.

Jacobson, S., D. King and R. Yuan (2011). "A note on the relationship between obesity and driving." Transport Policy **18**(5): 772-776.

Jacques, C., K. Manaugh and A. El-Geneidy (2013). "Rescuing the captive [mode] user: An alternative approach to transport market segmentation." Transportation **40**(3): 625-645.

Jain, A. (2010). "Data clustering: 50 years beyond K-means." Pattern Recognition Letters **31**(8): 651-666.

Jen, W. and K. Hu (2003). "Application of perceived value model to identify factors affecting passengers' repurchase intentions on city bus: a case of the Taipei metropolitan area." Transportation **30**(3): 307-327.

Jensen, M. (1999). "Passion and heart in transport—a sociological analysis on transport behaviour." Transport Policy **6**(1): 19-33.

Joewono, T., D. San Santoso and D. Ningtyas (2012). "The causal relationship of the service quality of the TransJakarta Busway." Public Transport **4**(2): 77-100.

Kenyon, S. and G. Lyons (2003). "The value of integrated multimodal traveller information and its potential contribution to modal change." Transportation Research Part F: Traffic Psychology and Behaviour **6**(1): 1-21.

Kim, S. and G. Ulfarsson (2012). "Commitment to light rail transit patronage: Case study for St. Louis Metrolink." Journal of Urban Planning and Development **138**(3): 227-234.

Kline, R. B. (1998). Principles and practices of structural equation modeling. New York, NY, Guilford Press.

Krizek, K. and A. El-Geneidy (2007). "Segmenting preferences and habits of transit users and non-users." Journal of Public Transportation **10**(3): 71.

Kunze, R., R. Ramakers, K. Henning and S. Jeschke (2009). Organization and operation of electronically coupled truck platoons on German Motorways. International Conference on Intelligent Robotics and Applications, Springer.

Lai, W. and C. Chen (2011). "Behavioral intentions of public transit passengers—The roles of service quality, perceived value, satisfaction and involvement." Transport Policy **18**(2): 318-325.

Lee, J., B. Jin and Y. Ji (2009). "Development of a Structural Equation Model for ride comfort of the Korean high-speed railway." International Journal of Industrial Ergonomics **39**(1): 7-14.

Levinson, D. and K. Krizek (2015). The end of traffic and the future of transport.

Li, L., J. Xiong, Z. Dong, Y. Bai and B. Wu (2013). Exploring factors affecting transit current customers' loyalty by Structural Equations Model: Case study of Shanghai, China. Transportation Research Board 92nd Annual Meeting.

Loveman, G. (1998). "Employee satisfaction, customer loyalty, and financial performance an empirical examination of the service profit chain in retail banking." Journal of Service Research **1**(1): 18-31.

MacCallum, R., M. Browne and H. Sugawara (1996). "Power analysis and determination of sample size for covariance structure modeling." Psychological methods **1**(2): 130.

Mahajan, V. and Y. Wind (2002). "Got emotional product positioning?" Marketing Management **11**(3): 36.

McLaughlin, J. and D. Boyle (1997). "Transit incentive program for transit-dependent riders." Transportation Research Record: Journal of the Transportation Research Board(1604): 139-145.

Merkert, R. and J. Pearson (2015). "A non-parametric efficiency measure incorporating perceived airline service levels and profitability." Journal of Transport Economics and Policy **49**(2): 261-275.

Miller, S. and B. Heard (2016). "The Environmental Impact of Autonomous Vehicles Depends on Adoption Patterns." Environmental Science & Technology.

Minser, J. and V. Webb (2010). "Quantifying the Benefits: Application of customer loyalty modeling in public transportation context." Transportation Research Record: Journal of the Transportation Research Board **2144**(1): 111-120.

Mishalani, R., M. McCord and J. Wirtz (2006). "Passenger wait time perceptions at bus stops: Empirical results and impact on evaluating real-time bus arrival information." Journal of Public Transportation **9**(2): 89-106.

Molander, S., M. Fellesson, M. Friman and P. Skålén (2012). "Market orientation in public transport r esearch — A review." Transport Reviews **32**(2): 155-180.

Morfoulaki, M., Y. Tyrinopoulos and G. Aifadopoulou (2010). Estimation of satisfied customers in public transport systems: A new methodological approach. Journal of the Transportation Research Forum.

Mouwen, A. (2015). "Drivers of customer satisfaction with public transport services." Transportation Research Part A: Policy and Practice **78**: 1-20.

Mouwen, A. and P. Rietveld (2013). "Does competitive tendering improve customer satisfaction with public transport? A case study for the Netherlands." Transportation Research Part A: Policy and Practice **51**: 29-45.

Neff, J. and M. Dickens (2013). 2013 Public Transportation Fact Book. Washington, D.C., American Public Transportation Association.

Newbold, K., D. Scott, J. Spinney, P. Kanaroglou and A. Páez (2005). "Travel behavior within Canada's older population: a cohort analysis." Journal of Transport Geography **13**(4): 340-351.

Nwachukwu, A. (2014). "Assessment of passenger satisfaction with intra-city public bus transport services in Abuja, Nigeria." Journal of Public Transportation **17**(1).

Ogilvie, D., M. Egan, V. Hamilton and M. Petticrew (2004). "Promoting walking and cycling as an alternative to using cars: Systematic review." Bmj **329**(7469): 763.

Oliver, R. (1999). "Whence consumer loyalty?" the Journal of Marketing: 33-44.

Olsen, L. and M. Johnson (2003). "Service equity, satisfaction, and loyalty: From transaction-specific to cumulative evaluations." Journal of Service Research **5**(3): 184-195.

Olsen, S. (2007). "Repurchase loyalty: the role of involvement and satisfaction." Psychology & Marketing **24**(4): 315-341.

Ory, D. and P. Mokhtarian (2005). "When is getting there half the fun? Modeling the liking for travel." Transportation Research Part A **39**: 97-123.

Páez, A. and K. Whalen (2010). "Enjoyment of Commute: A comparison of different transportation modes." Transportation Research Part A **44**: 537-549.

Palmer, R. and P. Millier (2004). "Segmentation: Identification, intuition, and implementation." Industrial Marketing Management **33**(8): 779-785.

Pawson, R., T. Greenhalgh, G. Harvey and K. Walshe (2005). "Realist review - A new method of systematic review designed for complex policy interventions." Journal of Health Services Research and Policy **10**(SUPPL. 1): 21-34.

Peden, M., R. Scurfield, D. Sleet, D. Mohan, A. Hyder, E. Jarawan and C. Mathers (2004). "World report on road traffic injury prevention." World Health Organization, Geneva.

Perk, V., J. Flynn and J. Volinski (2008). Transit ridership, reliability and retention, State of Florida Department of Transportation: National Center for Transit Research & Center for Urban Transportation Research

Peter, J. and J. Olson (1999). Consumer behavior and marketing strategy, McGraw-Hill London.

Petrick, J. (2004). "The roles of quality, value, and satisfaction in predicting cruise passengers' behavioral intentions." Journal of travel research **42**(4): 397-407.

Pnevmatikou, A., M. Karlaftis and K. Kepaptsoglou (2015). "Metro service disruptions: How do people choose to travel?" Transportation **42**(6): 933-949.

Politis, I., P. Papaioannou, S. Basbas and N. Dimitriadis (2010). "Evaluation of a bus passenger information system from the users' point of view in the city of Thessaloniki, Greece." Research in Transportation Economics **29**(1): 249-255.

Polzin, S. and X. Chu (2005). "A closer look at public transportation mode share trends." Journal of Transportation and Statistics **8**(3): 41-53.

Psarros, I., K. Kepaptsoglou and M. Karlaftis (2011). "An empirical investigation of passenger wait time perceptions." Journal of Public Transportation **14**(3): 109-122.

Rayle, L., S. Shaheen, N. Chan, D. Dai and R. Cervero (2014). App-based, on-demand ride services: Comparing taxi and ridesourcing trips and user characteristics in San Francisco San Francisco, UCTC-FR-2014-08.

Reichheld, F. (2003). "The one number you need to grow." Harvard business review **81**(12): 46-55.

Rietveld, P., F. Bruinsma and D. van Vuuren (2001). "Coping with unreliability in public transport chains: A case study for Netherlands." Transportation Research Part A: Policy and Practice **35**(6): 539-559.

Rigby, D. and D. Ledingham (2004). "CRM done right." Harvard business review **82**(11): 118-130.

Rose, G. and E. Ampt (2001). "Travel blending: An Australian travel awareness initiative." Transportation Research Part D: Transport and Environment **6**(2): 95-110.

Rosenbloom, S. (2004). "The mobility needs of older Americans." Taking the high road: A transportation agenda of strengthening metropolitan areas: 227-254.

Sallis, J., L. Frank, B. Saelens and K. Kraft (2004). "Active transportation and physical activity: opportunities for collaboration on transportation and public health research." Transportation Research Part A: Policy and Practice **38**(4): 249-268.

Schweitzer, L. (2014). "Planning and social media: a case study of public transit and stigma on Twitter." Journal of the American Planning Association **80**(3): 218-238.

Sheller, M. (2004). "Automotive emotions feeling the car." Theory, culture & society **21**(4-5): 221-242.

Shiftan, Y., Y. Barlach and D. Shefer (2015). "Measuring Passenger Loyalty to Public Transport Modes." Journal of Public Transportation **18**(1): 7.

Şimşekoğlu, Ö., T. Nordfjærn and T. Rundmo (2015). "The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public." Transport Policy **42**: 113-120.

Smith, M. and R. Clarke (2000). "Crime and public transport." Crime and Justice: 169-233.

Song, Y. and G.-J. Knaap (2007). "Quantitative classification of neighbourhoods: The neighbourhoods of new single-family homes in the Portland Metropolitan Area." Journal of Urban Design **12**(1): 1-24.

Srinivasan, K., G. Naidu and T. Sutrala (2009). "Heterogeneous decision rule model of mode choice incorporating utility maximization and disutility minimization." Transportation Research Record: Journal of the Transportation Research Board(2132): 59-68.

St-Louis, E., K. Manaugh, D. van Lierop and A. El-Geneidy (2014). "The happy commuter: A comparison of commuter satisfaction across modes." Transportation Research Part F: Traffic Psychology and Behaviour **26, Part A**(0): 160-170.

Stanley, J. and K. Lucas (2008). "Social exclusion: What can public transport offer?" Research in Transportation Economics **22**(1): 36-40.

Statistics Canada. (2011). "Visible Minority and Population Group Reference Guide, National Household Survey, 2011." 2016.

Statistics Canada (2012). Median total income, by family type, by census metropolitan area. All census families. Ottawa, Government of Canada.

Statistics Canada. (2014). "Commuting to work." Retrieved 21 July 2014, 2014.

Statistics Canada. (2014). "Focus on Geography Series, 2011 Census." Retrieved 21 July 2014, 2014.

Stuart, K., M. Mednick and J. Bockman (2000). "Structural equation model of customer satisfaction for the New York City subway system." Transportation Research Record: Journal of the Transportation Research Board(1735): 133-137.

Stuart, K., M. Mednick and J. Bockman (2000). "Structural equation model of customer satisfaction for the New York City subway system." Transportation Research Record: Journal of the Transportation Research Board **1735**(1): 133-137.

Sullivan, P. (2015). Getting Ready for Driverless Cars: Everything you need to know to invest now in the companies developing the technology that will revolutionize the way we commute.

Susilo, Y. and O. Cats (2014). "Exploring key determinants of travel satisfaction for multi-modal trips by different traveler groups." Transportation Research Part A: Policy and Practice **67**: 366-380.

TransLink (2014). 2013 Bus service performance review appendix A: report definitions and assumptions. Vancouver, Canada**:** 1-5.

TransLink (2014). 2013 Bus service performance review appendix C: Route summaries routes 1–99. Vancouver, Canada**:** 1-67.

TransLink (2014). Bus service performance review. Vancouver, B.C.

Transportation Research Board (1998). A Handbook: Integrating Market Research into Transit Management. Washington, DC, Transportation Research Board: United States Federal Transit Administration.

Transportation Research Board (1998). A Handbook: Using Market Segmentation to Increase Transit Ridership. Washington, DC, Transportation Research Board: United States Federal Transit Administration.

Transportation Research Board (1999). A Handbook for Measuring Customer Satisfaction and Service Quality. Washington, DC, Transportation Research Board: United States Federal Transit Administration.

Transportation Research Board (2002). A guidebook for developing a transit performance-measurement system. Transit Cooperative Research Program. Washington, DC, Transportation Research Board: United States Federal Transit Administration. **88**.

Tri-County Metropolitan Transportation District of Portland Oregon (1995). Customer satisfaction index for the mass transit industry. Transit IDEA Project 1. Washington, DC.

Turcotte, M. (2011). "Commuting to work: Results of the 2010 General Social Survey." Canadian Social Trends, Statistics Canada Catalogue no. 11-008-X.

Tyrinopoulos, Y. and C. Antoniou (2008). "Public transit user satisfaction: Variability and policy implications." Transport Policy **15**(4): 260-272.

Uber. (2015). "Uber."   Retrieved 8 December 2015, from www.uber.com.

United States Department of Energy. (2016). "Maps and Data - Annual Vehicle Miles Traveled in the U.S."   Retrieved 9 October 2016, from http://www.afdc.energy.gov/data/.

van Acker, V., B. van Wee and F. Witlox (2010). "When transport geography meets social psychology: Toward a conceptual model of travel behaviour." Transport Reviews: A Transnational Transdisciplinary Journal **30**(2): 219-240.

Van Exel, N. and P. Rietveld (2009). "When strike comes to town… anticipated and actual behavioural reactions to a one-day, pre-announced, complete rail strike in the Netherlands." Transportation research part A: policy and practice **43**(5): 526-535.

van Lierop, D. and A. El-Geneidy (2016). "Enjoying loyalty: The relationship between service quality, customer satisfaction, and behavioral intentions in public transit." Research in Transportation Economics **In Press**.

van Lierop, D. and A. El-Geneidy (2016). "Enjoying loyalty: The relationship between service quality, customer satisfaction, and behavioral intentions in public transit." Research in Transportation Economics.

van Lierop, D. and A. El-Geneidy (2017). "Getting committed: A perspective on public transit market segmentation." <u>Journal of Public Transportation</u> **Volume 20.1**.

Vuchic, V. (2002). Urban public transportation systems. <u>University of Pennsylvania, Philadelphia, PA, USA</u>.

Vuchic, V. (2007). <u>Urban Transit - Systems and Technology</u>. Hoboken, New Jersey, John Wiley and Sons, Inc.

Wasfi, R., N. Ross and A. El-Geneidy (2013). "Achieving recommended daily physical activity levels through commuting by public transportation: Unpacking individual and contextual influences." <u>Health & place</u> **23**: 18-25.

Weinstein, A. (2000). "Customer satisfaction among transit riders: How customers rank the relative importance of various service attributes." <u>Transportation Research Record: Journal of the Transportation Research Board</u>(1735): 123-132.

Weinstein, A. (2004). <u>Handbook of market segmentation: Strategic targeting for business and technology firms</u>, Routledge.

Wen, C., L. Lan and H. Cheng (2005). "Structural equation modeling to determine passenger loyalty toward intercity bus services." <u>Transportation Research Record: Journal of the Transportation Research Board</u> **1927**(1): 249-255.

Wilson, F., A. Stevens and J. Robinson (1984). "Identifying mode choice constrained urban travel market segments." <u>Canadian Journal of Civil Engineering</u> **11**(4): 924-932.

Yavuz, N. and E. Welch (2010). "Addressing fear of crime in public space: Gender differences in reaction to safety measures in train transit." <u>Urban studies</u>.

Zaichkowsky, J. (1994). "The personal involvement inventory: Reduction, revision, and application to advertising." <u>Journal of advertising</u> **23**(4): 59-70.

Zhao, J., V. Webb and P. Shah (2014). "Customer loyalty differences between captive and choice transit riders." <u>Transportation Research Record: Journal of the Transportation Research Board</u>(2415): 80-88.

9 APPENDIX I: 121 BUS STUDY SURVEY

McGill 2016 _____, Arrêt : _____ ☐E ☐O **T R A M**

Sondage – 121 Sauvé / Côte-vertu – Survey

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FRANÇAIS	ENGLISH

FRANÇAIS

1. Depuis l'introduction de l'embarquement toutes portes sur la ligne121 en mars 2016, quelle **différence** avez-vous observée dans votre **temps de transport**?
   - ☐ Plus long de _____ minutes
   - ☐ Aucun changement
   - ☐ Plus court de _____ minutes

2. Au cours de la dernière semaine, par quelle porte êtes-vous embarqué.e le plus fréquemment?
   - ☐ Porte avant   ☐ Porte du milieu   ☐ Porte arrière

3. Depuis **combien de temps** utilisez-vous cette ligne?
   Années:_____ Mois:_____

4. Combien de **fois par semaine** utilisez-vous cette ligne?
   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7

5. À quel arrêt allez-vous **descendre?** _____

6. Sur une échelle de un à cinq, quel est votre niveau de satisfaction actuel envers la ligne 121?

	Très insatisfait.e	→			Très satisfait.e
Satisfaction générale	1	2	3	4	5
Ponctualité	1	2	3	4	5
Temps de transport	1	2	3	4	5

7. Depuis l'introduction de l'embarquement toutes portes sur la ligne 121, votre satisfaction a-t-elle changé?

	Ma satisfaction: a diminué / est restée la même / a augmenté / N.A.
Satisfaction générale	☐ ☐ ☐ ☐
Ponctualité	☐ ☐ ☐ ☐
Temps de transport	☐ ☐ ☐ ☐

8. Dans un future proche, planifiez-vous prendre le transport en commun :
   ☐Moins que maintenant ☐À la même fréquence ☐Plus que maintenant

9. Dans quelle mesure êtes-vous **en accord** avec les énoncés suivant:

	En désaccord → En accord
J'ai une perception positive du transport en commun.	1 2 3 4 5
Le transport en commun est un service important.	1 2 3 4 5

10. Quel type de titre de transport utilisez-vous?
    ☐1 passage ☐2 passages ☐10 passages ☐1 jour ☐3 jours
    ☐Hedbo ☐Mensuel ☐Quatre mois ☐Autre: ____

11. Quel est le **motif principal** de votre déplacement? *(Encercler une seule réponse)*
    ☐ Travail ☐ Études ☐ Magasinage ☐ Autre

12. **Sexe** : ☐M ☐F   **Âge** : _____ ans

13. Avez-vous accès à une voiture ? ☐ Oui   ☐ Non

14. SVP, veuillez inscrire **tout autre commentaire** au verso.

ENGLISH

1. Since the introduction of the all-door-boarding service on the 121 in March 2016, what **difference** in your **travel time** have you observed?
   - ☐ Longer by _____ minutes
   - ☐ No change
   - ☐ Shorter by _____ minutes

2. On your most recent trip, which door did you use to board the 121?
   - ☐ Front door   ☐ Middle door   ☐ Back door

3. For **how many years or months** have you been using this route? Years:_____ Months:_____

4. How **many days a week** do you usually use this route?
   ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7

5. At which stop will you **get off?** _____

6. On a scale from one to five, indicate how satisfied you currently are with the 121?

	Very unsatisfied	→			Very satisfied
Overall satisfaction	1	2	3	4	5
On-time arrival	1	2	3	4	5
Travel time	1	2	3	4	5

7. Has your satisfaction with route 121 changed since the implementation of the all-door-boarding service?

	It has Decreased / Stayed the same / Increased / N.A.
Overall satisfaction	☐ ☐ ☐ ☐
On-time arrival	☐ ☐ ☐ ☐
Travel time	☐ ☐ ☐ ☐

8. In one year from now, do you plan to be using public transit:
   ☐Less than you do now ☐The same ☐More than you do now

9. How much do you **agree** with the following statements?

	Disagree → Agree
I have a positive image of public transit.	1 2 3 4 5
Public transit is an important public service.	1 2 3 4 5

10. What kind of public transit pass do you have?
    ☐1 trip ☐2 trips ☐10 trips ☐1 day ☐3 day
    ☐Weekly ☐Monthy ☐Four month ☐Other: ____

11. What is the **primary** purpose of this trip ? *(select one)*
    ☐ Working ☐ Studying ☐ Shopping ☐ Other

12. Do you have access to a car? ☐ Yes   ☐ No

13. **Gender:** ☐ ☐   **Age:** _____ years old

14. Please write any **other comments** on the back side.