URBAN CYCLING EQUITY: AN ANALYSIS OF EQUITY BASED APPROACHES IN PUBLIC BIKE SHARING PROGRAM DEVELOPMENT IN TORONTO

by

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ABSTRACT

The prominence of bike sharing programs as an alternative mode of green transportation has captured the attention and stimulated renewed enthusiasm among urban cyclists, municipalities, and urban planners alike. However, researchers and critics question the distributive effects of these services on marginalized communities. When examined closer, studies demonstrate that bike share users have on average, a high education status, work full time, and have high incomes. Moreover, older adults, women, and low-income communities remain marginally represented in bike share user demographics throughout major North American cities. In recognition of these observations, this Major Research Paper (MRP) explores how these equity considerations are relevant to Bike Share Toronto (BST), the City of Toronto's publicly-owned bike share program. This analysis uses mixed method research including spatial analysis of the existing BST service area, an analysis of BST Equity Survey results, and expert interviews with representatives with key institutional perspectives on bike share equity. Finally, this research highlights key considerations relevant for the development of a bike share equity intervention by BST.

Key Words: Active transportation, Bike Share Toronto, transportation equity, bike share equity programs.

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List of Abbreviations

BST = Bike Share Toronto

BBSP = Better Bike Share Partnerships

BWB = Bikes Without Borders

DHA = Denver Housing Authority

MAMIL = Middle Aged Men In Lycra

NACTO = National Association of City Transportation Officials

NIA = Neighbourhood Improvement Area

NYCHA = New York City Housing Authority

PBS = Public Bike Share

PDI = Pampalon Deprivation Index

TCAT = The Centre for Active Transportation

TCHC = Toronto Community Housing Corporation

TTC = Toronto Transit Commission

TSNS = Toronto Strong Neighbourhoods Strategy

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1. Introduction

Urban cyclists not only use bicycles as a mode of transportation, but the act of cycling has become a symbol that represents the reclamation of space in cities dominated by cars. Cities have also demonstrated an effort towards enhancing the attractiveness and opportunity for more people to engage with cycling and other modes of active transportation[1]. A demonstration of this is clearly illustrated by the prevalence of bike share programs and services adopted in many Canadian cities, which mirror a larger global trend. There are many advantages commonly associated with bike sharing services. For example, many cities view these systems as an opportunity to introduce green transportation infrastructure, that can also facilitate access to affordable transportation networks and encourage public health. According to a 2019 bike share feasibility report for the City of Windsor there were 17 bike share systems in Canada in 2018, four of which were publicly owned or operated by municipal governments or non-profit organizations (Urban Systems, 2019; see Appendix A for more detailed summary). Moreover, the National Association of Transportation Officials (NACTO), which is a coalition of North American transportation agencies based in the United States, has also reported that the number of bike sharing systems in the United States grew from 4 to 55 between 2010-2016 and these numbers only continue to rise (NACTO, 2016). These mobility services are equally met with considerable excitement by members of the public throughout European and North American cities (Carroll, 2019).

Although the micro mobility industry is quickly evolving, the concept of 'bike sharing' has a dynamic history originating in the 1960's in Amsterdam with the '*Witte Fietsenplan'* or *'White Bike Plan'* initiative (van der Zee, 2016). The literature chronicles the history of bike sharing through four key 'generations' that capture a number of innovations that have shaped bike sharing systems as we know them today (Shaheen, Guzman & Zhang, 2010; Parkes et al., 2013). The 'first generation' of bike sharing was characterized by informal and unregulated

[1] Todd Litman states, "active transportation (also called non-motorized transport, NMT and human powered transport) refers to walking, cycling, and variants such as wheelchair, scooter, and handcart use. It includes both utilitarian and recreational travel activity, plus stationary uses of pedestrian environments such as standing on sidewalks and sitting at bus stops" (Litman, 2012, p. 3)

systems where bicycles were used by casual cyclists for unrestricted periods and dropped off when users completed their trips (Midgley, 2011). Users were not overwhelmingly incentivized to care for bicycles, and it was not uncommon to find bicycles abandoned in canals, or for bicycles to occasionally be vandalized or go missing. The 'second' generation during the early 1990's saw the innovation of the first formalized large-scale bike sharing systems as demonstrated by the Bycyklen program in Copenhagen (Midgley, 2011; Gris Orange Consultant, 2009). The advancement of this generation featured functional adjustments such as bike racks with locks, and introduced a coin-based payment system, which helped to facilitate the reduction of vandalized and stolen bikes (Midgley, 2011). By the late 1990's the technology and design of these systems advanced further. The integration of automated payment systems allowed users to purchase passes with debit and credit cards, Global Positioning Systems (GPS) allowed for bicycles to be tracked, and the standardization of equipment (ie. bicycles, locking systems and docks) propelled bike sharing into the 'third' generation (Shaheen, Guzman & Zhang, 2010; Midgley, 2011; Gris Orange Consultant, 2009). The current 'fourth generation' has maintained much of this momentum, but the key development concerns the formal integration of bike share services into larger transportation planning objectives, and the development of strategic service network expansions plans (Shaheen, Guzman & Zhang, 2010; Fishman, 2016). Although some people enjoy bike sharing for leisure, these programs are increasingly used as a regular mode of transportation that can solve first and last mile commutes, which can be used as an alternative to driving a vehicle, public transportation, or even cycling on a personal bike. Moreover, the introduction of electric bikes and dockless bike sharing regimes have welcomed more opportunities for a competitive industry, with both public and private sector interests (Shaheen, Guzman & Zhang, 2010; Fishman, 2016).

Importantly, these programs have also been identified as a way to reduce barriers that may impede diverse communities from engaging in urban cycling. However, the literature exploring the social equity dimensions and equity-based outcomes of these programs identifies contradictory trend. As such, researchers and critics question the distributive effects of these services on marginalized communities. For example, studies demonstrate that bike share users have on average, a high education status, work full time, and have high incomes (Fishman, et. al., 2013; LDA Consulting, 2013; Goodman & Cheshire, 2014). Moreover, older adults, women, and low-income communities remain marginally represented in bike share user demographics

throughout major North American cities (Ursaki & Aultman-Hall, 2015). This has also introduced the concept of transportation equity into the discourse, which is the "social and economic opportunities through equitable levels of access to affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved" (Sandt et al. 2016, p. 1). Broadly, the concept of transportation equity recognizes the essential role that access to transportation has on people's lives, as it facilitates access to employment, education, healthcare and other public services (Bullard, 2003; Litman, 2002). The concept also highlights that not all communities have gained or benefited equally from the many advancements in transportation planning and technology (Bullard, 2003). As such, transportation equity has increasingly become an essential concept used to contextualize and understand the experiences of marginalized communities as this newly emerging micro mobility industry grows.

Although bike sharing services are theoretically available for any member of the public to use, why do these trends recur in multiple cities? Do municipalities and regional governments who own or operate these programs have a responsibility to be sensitive to these exclusionary dynamics? If so, how is transportation equity evaluated, and what strategies are being used to address these user gaps in bike sharing? This Major Research Paper (MRP) engages with these questions in the context of Toronto.

Origins of This Inquiry

The origins of this inquiry are informed by personal interest, in addition to academic and professional experiences and learning. As part of one of my courses in the Masters of Urban Development at Ryerson University, I completed a research paper related to cycling equity and advocacy. I was broadly interested in investigating how contemporary cycling advocacy has understood and addressed issues related to equity, diversity and social inclusion in cycling. Through this research I attempted to articulate key criticisms of contemporary cycling advocacy, which identify that contemporary cycling advocacy largely focuses on issues related to infrastructure, overlooking social equity issues experienced by marginalized communities (Misra, 2018; Angus, 2015; Butler, 2018). Moreover, I explored the different barriers to

participation by examining literature discussing gendered experiences of cycling, the notion of identity and belonging through the concept of bike 'citizenship', and how commodification of space informs cycling experiences (Aldred, 2010; Furness, 2006; Stehlin, 2014). Ultimately, this research demonstrated how cycling advocacy can address these barriers through the theoretical lenses of intersectionality, transformative community planning and visceral geography (Sweet & Ortiz Escalante, 2014; Crenshaw, 1989).

After completing this research, I continued to reflect on my personal experiences cycling. This was an important exercise, because during my graduate studies I exclusively used bike sharing services from Bike Share Toronto every time I cycled, and I began to consider the nuances of how the concept of transportation equity is applied to bike sharing services. Shortly after writing the research paper, I began a position as an intern at Bike Share Toronto and gained considerable insight into how the program functions. Most importantly, I was formally introduced to the idea of *bike share equity*. Collectively, these experiences have undoubtedly informed the formulation of this research, and the results of this research ultimately seek to contribute to the limited literature on bike share equity specifically within the Canadian context.

Research Focus and Scope

This MRP explores how considerations regarding transportation equity are relevant to Bike Share Toronto (BST), the City of Toronto's publicly-owned bike share program. BST was originally launched in 2011 as 'Bixi Toronto' with 80 stations and 1,000 bikes, spanning 10 km of the City (Toronto Parking Authority, 2018). Since then, the program has grown incrementally and currently consists of 465 stations, 5,000 bikes and spans 100km widening the programs service area significantly (Toronto Parking Authority, 2019a). BST ridership has also grown rapidly. From approximately 400,000 rides in 2011, the program reached 2 million rides in 2018 and is projected to achieve an impressive 3.5 million rides after the planned 2020 network expansion (Toronto Parking Authority, 2018; Toronto Parking Authority, 2019a). BST has also demonstrated some interest in investigating the program's equity impacts. In 2018, a bike share equity research project survey was conducted by Bikes Without Borders in collaboration with Bike Share Toronto (BWB Bike Share Equity Survey, 2018). The goal of the survey was to gain

insight into the barriers associated with accessing the BST program. However, whether the findings of that research project will result in changes to the program or not has yet to be seen.

In the context just described, the primary research questions that will frame this Major Research Paper are: *1) How can Bike Share Toronto understand equity-based considerations relevant to bike share use? 2) What equity-based evaluation tools and approaches can BST use to identify service and user gaps?*

In answering these questions, the ultimate goal of this research is to begin to understand the most relevant barriers underrepresented communities face when trying to access the bike share program in the Toronto context. Moreover, I attempt to identify key considerations relevant to the development of a bike share equity intervention. I also attempt to explore the value of partnerships with local cycling advocacy organizations to achieve the objectives of an equity intervention. Finally, the overarching goal of this research is to also contribute to the growing literature regarding bike share equity, specifically within the Canadian context.

Methodological Approach

Following Smith, Oh, and Lei (2015), this research is a descriptive analysis of the BST program and adopts a mixed methods approach in order to understand equity-based challenges underrepresented communities might face when trying to access the program. The area of study is limited to the City of Toronto and the research bounds data collection and events from 2014-2020. The three components of this research include a spatial analysis of the existing BST service area, an analysis of the BST Equity Survey results collected by Bikes Without Borders, and expert interviews with representatives with key institutional perspectives on bike share equity, including Bike Share Toronto and Scarborough Cycles.

Spatial Analysis

The spatial analysis took two forms. Firstly, borrowing from Hosford and Winter's (2018) study of bike share equity in major Canadian cities, I used the Pampalon Deprivation

Index (PDI)[2] as a proxy to visualize spatial equity in the City of Toronto in relation to the geographic location of Bike Share Toronto stations. The index distinguishes and evaluates two different components of socioeconomic deprivation, including material and social deprivation (INSPQ, 2019)[3]. For the purpose of their study, Hosford and Winters use the material component of the PDI as an indicator of equity, because the relevant metrics include income, education and employment,[4] all of which are factors linked to lower bike share use (Hosford & Winters, 2018; see Appendix B for details). They then created a map to display this data and overlaid the geographic location of Bike Share Toronto stations to compare and evaluate the proximity of these variables (Hosford & Winters, 2018). As such, the first spatial analysis in this research primarily displays the same data variables as in Hosford and Winters' study but I present an updated map with the current 465 Bike Share Toronto station network.

The second spatial analysis presents an alternative method of visualizing spatial equity. Specifically, I compared the distribution of Bike Share Toronto stations, existing cycling infrastructure (i.e. bike lanes), and the City of Toronto's 31 established Neighbourhood Improvement Areas (NIAs).[5] The rationale for using these variables is twofold. Firstly, Toronto's City Council in 2019 approved updates to the City's Cycling Network Plan, which for the first time integrates an equity lens as a category of analysis when developing cycling route plans. This update to the methodology now explicitly identifies 'equity' in terms of routes that serve NIA's (City of Toronto, 2019). Secondly, the literature identifies that the availability of cycling infrastructure can be used as an indicator to assess an area's potential for bike share

[2] The PDI was first developed in the late 1990's in Quebec and "the proxy's main purpose is to assign area-based socioeconomic information to every individual by linking the geography of the census with the one found in the administrative databases" (Gamache, Hamel & Blaser, 2019, p.1).

[3] The INSPQ states that while "material deprivation reflects the lack of everyday goods and commodities, social deprivation refers to the fragility of an individual's social network, from the family to the community" (INSPQ, 2019, para. 2).

[4] Using principal component analysis each dissemination area (DA) is assigned a factor score, which is then ranked from most to least deprived (Gamache, Hamel & Blaser, 2019). After this ranking, "the distribution of EAs/DAs is divided into quintiles or increments of 20%. Quintile 1 represents the population living in the most privileged EA/DA and quintile 5 the one living in the most deprived one" (Gamache, Hamel & Blaser, 2019, p. 2). This data can then be visually represented in a map to analyze and compare material deprivation relative to the surrounding DAs.

[5] Designated under the Toronto Strong Neighbourhoods Strategy (TSNS) 2020, Neighbourhood Improvement Areas (NIAs) are a set of 31 neighbourhoods identified by the City of Toronto which experience disproportionate inequitable outcomes that are unfair, and unnecessary. As such, "Because these differences are unnecessary, action can be taken to remedy them. Correspondingly, the NIA selection criterion for TSNS 2020 is to reflect the strategy's goal of building an equitable set of social, economic and cultural opportunities for all residents, leading to equitable outcomes across all neighbourhoods." (City of Toronto, 2014b, p. 2)

stations. As such, this will be used as an opportunity to display the proximity and availability of BST stations to NIA's that are currently serviced by bike lanes, shedding light on the (in)equitable location of cycling infrastructure in the city.

By offering a contemporary snapshot of BST's service area in relation to existing cycling infrastructure in materially deprived areas of the city, these two analyses are used to identify areas of opportunity to achieve spatial equity by applying tools and strategies already established by the City of Toronto. Further detail on the creation of both maps is also included in the section *Visualizing Bike Share Equity: A Spatial Analysis of Bike Share Toronto.*

Equity Survey Data Analysis

The spatial analysis was supported by the responses from the Bike Share Toronto Equity Survey briefly mentioned earlier. The survey was developed and specifically designed to function as an entry point to understand the barriers and challenges experienced by respondents regarding the Bike Share Toronto program (Bike Share Toronto, n.d). This online survey was located on the Bike Share Toronto website, and was open for any member of the public to complete between the months of October 2018 and May 2019. A total of 108 participants completed the survey and all the questions asked in the survey, including any personal information collected, were voluntary (see Appendix E for list of survey questions). The survey also identified that "participants must be 18 years of age or older and will need access to a credit card" (Bike Share Toronto, n.d).

The responses from this survey present a unique opportunity for this research, because the introduce qualitative data to support and substantiate the findings from the spatial analysis. As such, the survey data and responses were grouped and then analyzed in three sections or groups. The first related to general demographic characteristics of the survey respondents (i.e. age, gender and race). The second related to how participants engage with cycling and the BST program. Finally, the last group of questions related to the specific barriers of participating or engaging with the BST program. Using this analysis therefore provides preliminary insight into how perceptions of safety and financial barriers may impact respondents' use of the Bike Share

Toronto program. Additional information regarding the survey will be elaborated on in the section *Understanding Equity Challenges: An Analysis of Bike Share Toronto's Equity Survey.*

Expert Interviews

Finally, two semi-structured expert interviews were conducted with representatives from Bike Share Toronto ('Participant 1') and Scarborough Cycle ('Participant 2') to investigate institutional perspectives on bike share equity. These interviews explored the role of Bike Share Toronto in addressing cycling equity and discussed interest in developing partnerships among organizations on a bike share equity intervention spearheaded by Bike Share Toronto. The interviews lasted between 30 minutes to 1 hour, and the participants were asked a series of five to six questions (see Appendix C). Topics included discussing their organization, the services they provide, perspectives on the role of bike share services in cycling equity, and how a bike share equity intervention can be structured and applied. Together these three data sources, will investigate and attempt to capture relevant barriers impacting bike share use in Toronto.

Structure of MRP

Following the introduction, chapter one will broadly explore the different factors influencing bike share use, such as cycling infrastructure and availability supporting transportation networks, land use and built form. Other factors also include perceptions of safety, financial barriers, social and socioeconomic barriers. Then, using Todd Litman's (2019) articulation and framework of transportation equity, chapter two will explore how bike sharing services can consider transportation equity. This will also include a brief investigation on bike share industry perspectives on equity. Chapter three will then explore bike sharing in the Canadian context, and further articulate the case of the Bike Share Toronto program.

Chapter four will then introduce the spatial analysis performed for this research, including the two maps using data from the Pampalon Deprivation Index (PDI), the City of Toronto's Cycling Network and Neighbourhood Improvement Areas (NIAs). Then, chapter five will first detail the structure of the Bike Share Toronto Equity survey. Results from the survey offer insights into respondent demographics, cycling activity and perceptions of Bike Share Toronto, and explore barriers associated with Bike Share Toronto. Then, chapter six will

describe and elaborate on the questions explored in the expert interviews, and the identified themes with representatives from Bike Share Toronto and Scarborough Cycles.

Chapter seven will describe the constraints and limitations encountered through this research. Finally, chapter eight will present conclusions and reflect on the results and discussions found throughout the research, and provide recommendations on steps forward.

1. Literature Review

There has been a growing interest among researchers, bike share program operators and owners to understand how user preferences impact ridership trends in order to advance efforts to enhance the attractiveness of these programs (Fisherman & Schepers, 2016). Below I elaborate on the main factors affecting bike share use, which are relevant to an equity-based analysis of any bike sharing program. These factors include cycling infrastructure, transportation networks, land use and built form, perceptions of safety, financial barriers, social and socio-economic barriers. I will also discuss the role of community partnerships and elaborate the position of public bike sharing services as a public service.

1.1. Cycling Infrastructure: Transportation Networks, Land Use and Built Form

The availability of cycling infrastructure and transportation networks (ie. subway and bus networks) are key variables that might have a big impact on people's ability to access bike share programs. Key findings indicate that the strategic placement of bike share stations should leverage surrounding services to optimize bike share use (Faghih-Imani, Eluru, 2016). For instance, research in cities such as Washington DC and New York City demonstrate that there is a positive correlation between bike share use and a bike share stations proximity to bike lanes (Buck & Buehler, 2012; Noland, Smart & Guo, 2016). Additionally, the proximity and distance between bike share stations and major transportation nodes can also encourage bike share ridership (Faghih-Imani & Eluru, 2016).

Land use can also be used to identify optimal areas for bike share station locations as demonstrated by research in cities such as Chicago, Montreal and New York City (Faghih-Imani,

et. al., 2014; Faghih-Imani, Eluru, 2016; Faghih-Imani, Eluru & Paleti, 2017; Reynaud, Faghih-Imani & Eluru, 2018). For instance, when bike share stations are supported by adequate cycling infrastructure and are in close proximity to destinations where users are likely to go, users are more likely to view bike sharing as a viable mode of transportation to reach their destination. In summary, the literature highlights a relationship between cycling activity and adequate cycling infrastructure. Moreover, it identifies that for bike sharing to be an attractive and reasonable mode of transportation for users, bike sharing networks should try and connect people to major destinations or transportation nodes. This means that people in areas with limited or deficient access to cycling infrastructure and other transportation networks might be at a disadvantage in terms of their ability to access bike share programs. Importantly, appropriate cycling infrastructure is relevant to perceptions of safety, as explored in the following section.

1.2. Perceptions of Safety

Generally, cycling safety in North America has increased in the last 20 years, which is largely attributed to increased government funding for bike facilities and infrastructure (Pucher & Buehler, 2011). However, concerns with safety and security still largely affect women's travel preferences, even though research demonstrates that women are less likely to be severely injured than men while on a bicycle (Dill, Goddard, Monsere and McNeil, 2014). Although in-depth analysis and research of the safety of bike share is limited and scarce, some existing research has demonstrated that when compared to the use of personal bicycles, bike sharing is associated with lower risks of personal injury and fatality (Fisherman & Schepers, 2016; Martin, et. al., 2016).

In 2016, the Mineta Transportation Institute at San Jose State University performed a comprehensive study exploring safety in relation to bike sharing through a series of interviews and data analysis (Martin, et. al., 2016). The study identified that although bike share users are not more protected, "for one or more reasons, the likelihood of being involved in a collision (particularly one with a motor vehicle) has been lower for those operating a bike sharing bicycle than for those operating a personally owned bicycle" (Martin, et. al., 2016, p.1). Key findings from their research suggested that people consider bike share bikes somewhat safer due to the design elements of the bikes (Martin, et. al., 2016). For example, these bikes are often heavier in weight and have fewer gears, which allow for slower maximum speeds when in use. Moreover,

their research also found that the use of bike sharing demonstrated a reduction of injury and fatality rates despite low rates of helmet use (Martin, et. al., 2016). Their analysis also indicates that although the potential for collisions may remain the same among all cyclists, bike share users may just be more cautious when cycling due to a limited familiarity with the bikes (Martin, et. al., 2016).

These findings suggest that the use of bike share may provoke different behaviour in cyclists, which may contribute to shifting perceptions of safety among marginal cyclists such as women. The literature does not explicitly identify this correlation, but this can be a key area for future research.

1.3. Financial Barriers

A key feature of bike sharing services is the relatively inexpensive cost associated with using these programs, which can be appealing to users from a wide range of income levels. However, although prices may be modest, some low-income users may still not be able to sustain regular trips. For instance, although many programs offer annual or monthly passes, some low-income users may not be able to purchase passes that require one lump sum payment (NACTO, 2015). The literature identifies that reducing user costs alone may not be a sufficient way to meaningfully address financial barriers associated with these services (Kodransky & Lewenstein, 2014; Cohen, 2016). In other words, 'financial barriers' are not limited to an individual's capacity to pay for a bike sharing service. Kodransky and Lewenstein (2014) state,

> These barriers range from the way shared micro mobility systems are physically and operationally designed (structural) to the way users are required to pay for system usage (financial) to the way low-income communities perceive and understand the systems themselves (informational/cultural) (p. 13).

For example, a structural barrier can include the requirement for users to have access to a debit or credit card if a user would like to purchase a pass at a bike share service kiosk. This is a requirement for many bike share services, as it allows for each bicycle to be associated with a unique user, and also ensures that any fees incurred (ie. damaged or lost bicycle, and overage

fees) can be charged directly to the user. Alternatively, if users are interested in purchasing a pass online they will require access to the internet and some technology such as a smartphone or computer. In other words, financial barriers go beyond just the ability to pay for a single trip.

In that sense, simply providing subsidized memberships for bike share services can also ultimately be an inadequate approach to address user service gaps. The informational/cultural barriers identified by Kodransky and Lewenstein suggest that "without a solid understanding of *why* shared mobility offers people unique benefits or how to use a shared mobility system, low-income people are less likely to take advantage of the systems" (2014, p. 17). This was demonstrated by the New York City Housing Authority's (NYCHA) and the Denver Housing Authority's (DHA) attempt to provide subsidized bike share memberships to public housing and low-income communities (Kodransky & Lewenstein, 2014; Cohen, 2016). In the case of NYCHA, "out of 400,000 residents in NYCHA housing, including over 25,000 residents that live within the Bike Share systems' catchment area in the Lower East Side, only 285 NYCHA housing residents became system subscribers" (Kodransky & Lewenstein, 2014, p. 25). Similarly, "when a local organization donated 100 B-Cycle bike share members to Denver Housing Authority residents, only 32 people signed up and only 23 of those used the bike more than once" (Kodransky & Lewenstein, 2014, p.25).

Overall, these findings suggest that it is imperative to consider how financial barriers can manifest in different ways that may not always be obvious, meaning that attempts to address structural and informational financial barriers may be more effective if they are supported by alternative methods of engaging lower income users.

1.4. Social and Socio-Economic Barriers

An important consideration that may help to answer why the subsidy programs introduced by NYCHA and DHA just described were ineffective are the potential social barriers associated with cycling. Individual identities, which shape lived experiences, have increasingly begun to contextualize discussions about cycling advocacy and equity. Common user demographic trends in North American cities demonstrate that bike share users on average have

a high education status, work full time, and have high incomes (Fishman, et. al., 2014; LDA Consulting, 2013; Cheshire & Goodman, 2014). Critics highlight these demographic disparities to suggest that the popularization of cycling in contemporary urban spaces overwhelmingly revolves around specific demographic and socioeconomic communities (i.e. the 'creative class') (Geoghegan, 2016). Therefore, cycling advocacy, and planning often focus on a narrow set of priorities and pursue projects and initiatives that frame equity issues as a one dimensional 'infrastructure issue' that often does not include socioeconomic equity concerns (Goodyear, 2015; Hoffman, 2016; Lugo, 2018; Misra, 2018). In other words, when equity issues are positioned and framed only as infrastructure challenges (i.e. increasing number of bike sharing stations in historically marginalized communities, building more bike lanes, etc.), underlying socio-cultural barriers are displaced from the scope of equity based approaches to address bike sharing access and usage. In doing this, different communities are ignored in the planning and development of bike share programs, therefore reinforcing user gaps. Creative solutions outside of financial subsidies to address these demographic disparities may also be ignored.

Upon studying cycling 'enclaves' in the UK, Aldred (2010) determines that "cycling can indeed be linked to distinctive articulations of citizenship" (p. 49). Collective identities are important because they provide an enhanced sense of security, protection, solidarity and directly contribute to building community networks (Aldred, 2010; Cox, 2015). A demonstration of this can be found in the growth of MAMIL (Middle Aged Men in Lycra) cycling communities throughout North America and Europe (Hughes, 2018). In these communities, identity formation and association is displayed through skills and competencies of bike mechanics, and even clothing, which can directly contribute to conceptions of one's 'belonging' (Aldred, 2013). As such, it is possible for individuals to develop exclusion based on class, gender and physical ability (Aldred, 2013). Melody L. Hoffman (2016) in the book *Bike Lanes Are White Lanes* explores the nuances of this idea of belonging further. She determines that although women, people of colour, low-income and immigrant communities actually do cycle regularly, the way in which bike advocacy describes these cyclists as 'invisible' actually further marginalizes them and creates boundaries around who a cyclist is (Hoffman, 2016). She states that these communities are not actually invisible, rather "the way that bicycling has materialized in places like Portland and Minneapolis works to communicate delineations of who belongs in these

bicycling spaces" (Hoffman, 2016, p.5). This suggests that the development of individual perceptions of belonging is imperative to the inclusion of marginal cyclists in bike sharing programs. This analysis introduces social variables to the trends commonly reflected in bike share user demographics.

In recognition of these factors that may influence the use of bike sharing systems – cycling infrastructure, perceptions of safety, financial barriers and social barriers – it is important to reconsider how they may inform equity-based approaches. In order to address these challenges, multidimensional approaches that work towards addressing access and usage barriers must recognize the interplay and relationship between physical, social, and economic variables. Equal emphasis should therefore be placed on accurately defining the scope of these barriers, which must then align with the objectives of equity-based programs and initiatives.

1.5. Community Partnerships and Positioning Bike Share as a Public Service

In order to address these potential social barriers, the literature also suggests that grassroots and community-based approaches can be used as a key tool. As more North American cities move towards integrating equity as a key pillar of bike share programs, facilitating meaningful and ongoing interaction among program operators, service users, cities and advocates has become increasingly important. This is demonstrated in cities such as Philadelphia (Indego) and Detroit (Mobi), and Hamilton (Sobi), all of which have engaged in collaborative relationships with local community organizations, civic groups, and everyday community members to strategically develop appropriate bike share equity programs. Although a clear blueprint does not yet exist for other cities to follow, organizations such as the National Association of Transportation Officials (NACTO) and the Better Bike Share Partnerships (BBSP) have presented useful tools for practitioners in North American cities to develop this capacity (NACTO, n.d). Although both of these organizations are based in the United States, these organizations provide resources and materials regarding best practices, case studies, research and reports explicitly addressing equity-based approaches to enhancing bike share programs, which can be used by other organizations elsewhere.

Publicly owned and operated bike share systems – which are the focus of this MRP – have increasingly become more prominent in North American cities (Moon et.al, 2019). Moon et. al, (2019) explicates that public programs which are often considered to be public services,

> Are entirely owned and operated by the public sector (e.g., the city's department of transportation, environment, or sustainability) or a public subsidiary agency. The agency is responsible for mobilizing funding, as well as managing all aspects of the BSS [PBS], including preconstruction, construction, operations, and maintenance (p.17).

Proponents of an equity-based approach to bike share programs may articulate that as a public service, publicly owned programs have a responsibility to redistribute the benefits gained by these services (Beroud & Anaya, 2012; Ricci, 2015). In recognizing the unique position of public bike share programs, this research works towards further examining and understanding how these programs can meaningfully address equity for potential users within the objectives of these services.

2. (Active) Transportation and Equity: Defining Scope and Differing Approaches

"Transport equity analysis is often ad hoc, based on the concerns and values of the stakeholders involved in a planning process; other, significant impacts may be overlooked or undervalued"

(Litman, 2002 p. 3)

As introduced earlier, transportation equity broadly describes the "social and economic opportunities through equitable levels of access to affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved" (Sandt et al. 2016, p. 1). Discourse surrounding transportation equity is dynamic and nuanced, but fundamentally attempts to address the implications of the uneven allocation of transportation services and infrastructure by evaluating various factors. These factors can include specific transportation policy, an evaluation of how these policies impact specific neighbourhoods, or an analysis of how these considerations when compounded actually negatively impact communities who rely on these services (Garrett and Taylor, 1999). While

there is no overarching agreement among researchers regarding the exact definition of transportation equity, Todd Litman (2002) proposes a nuanced and comprehensive understanding of the considerations required to accurately define the scope of equity in transportation programs. Litman (2002) also suggests that there is also no single approach or method to evaluate transportation equity. Rather, it is best to consider various perspectives, which can then be used to understand and identify the impacts, the methods used to measure those impacts, and how they are categorized. However, he also identifies that a common definition of transportation equity on a practical level may not appropriately reflect the different histories, challenges, and opportunities experienced by multiple 'publics', their municipalities or regional government, and existing public transportation infrastructure (Herte, Keil & Collens, 2016; Litman 2002).

For the purpose of this MRP, Litman's conceptualization will provide a framework to examine equity-based consideration in the case of Bike Share Toronto. Litman (2002) identifies that there are three types of transportation equity, and further suggests that "how equity is defined and measured can significantly affect analysis results" (p. 2). These different types are:

a. ***Horizontal Equity (Fairness and Egalitarianism):*** "concerns the distribution of impacts between individuals and groups considered equal in ability and need" (p. 4). Horizontal equity emphasizes that relevant policies should therefore not benefit one group or individual, and the benefits received by users should be reflected in what consumers pay for.
b. ***Vertical Equity with Regard to Income and Class (Social Justice, Environmental Justice, and Social Inclusion):*** "concerned with the distribution of impacts between individuals and groups that differ, in this case, by income or social class" (p. 4) This approach articulates that transportation equity is demonstrated when transportation policies are able to effectively address the inequalities experienced by socially and economically disadvantaged communities. This can include discounted transportation fare programs, which can be introduced to subsidize fare rates for users.
c. ***Vertical Equity with Regard to Mobility Need and Ability:*** "concerned with the distribution of impacts between individuals and groups that differ in mobility ability and need, and therefore the degree to which the transportation system meets the needs of travelers with mobility impairments" (p. 4). This approach emphasizes design-based

equity which is used to accommodate and support users with a variety of abilities to access transportation to achieve independent mobility.

Figure 1 below articulates these equity evaluation variables that can be used in an equity analysis, which can be applied to a variety of transportation systems, including bike share programs. It is clear that there are a variety of ways in which to understand equity in transportation policy, infrastructure and service. Litman (2002) also identifies there may be instances in which these three approaches either overlap or conflict with one another. An essential feature of Litman's analysis is that there are multiple ways to not only evaluate, but also to define equity. As such, articulating the scope of equity in transportation should be identified and guided by the concerns and priorities of the affected communities. In the case of Toronto, the results of the BST Equity Survey may present an opportunity to begin to understand these specific concerns to inform a future equity program intervention in Toronto, with the goal of reducing user gaps and making the system more accessible and responsive to the needs of communities historically underrepresented in bike sharing initiatives. In consideration of these variables, the development of a Bike Share Toronto equity intervention or program should identify clear objectives about equity goals that respond to the unique characteristics and interests of underserved communities in the City.

Figure 1: Transportation Equity Evaluation Variables

Types of Equity	*Impacts*	*Measurement*	*Categorization*
Horizontal Equal treatment of equals **Vertical With-Respect-To-Income And Social Class** Transport affordability Housing affordability Impacts on low-income communities Fare structures and discounts Industry employment Service quality in lower-income communities **Vertical With-Respect-To Need And Ability** Universal design Special mobility service Disabled parking Service quality for non-drivers	**Public Facilities and Services** Facility planning and design Public Funding and subsidies Road space allocation Public Involvement **User Cost and Benefits** Mobility and accessibility Taxes, fees and fares **Service Quality** Quality of various modes Congestion Universal design **External Impacts** Congestion Crash risk Pollution Barrier effect Hazardous material and waste Aesthetic impacts Community cohesion **Economic Impacts** Economic opportunities Employment and business activity **Regulation and Enforcement** Traffic regulation Regulations and enforcement Regulation of special risk	**Per Capita** Per adult Per commuter or peak-period travel Per household **Per Unit of Travel** Per vehicle-mile/km Per passenger-mile/km Per trip Per commute or peak-period trip **Per dollar** Per dollar user fees Per dollar of subsidy Cost recovery	**Demographics** Age and lifecycle stage Household type Race and ethnicity group **Income class** Quintiles Poverty line Lower-income areas **Ability** People with disabilities Licensed drivers **Location** Jurisdictions Neighbourhood and street Urban/suburban/rural **Mode** Pedestrians Cyclists Motorists Public transit users **Industry** Freight Public transport Auto and fuel production **Trip Type** Emergency Commutes Commercial/freight Recreational/tourist

There are various types, impacts, measurement units and categories to consider in equity analysis.

Source: Litman, 2002 p. 2

2.1. Studies on Bike Share Equity and Practical Applications of Equity

Upon considering Litman's (2002) variables, how do bike sharing systems articulate equity in theory and practice? What variables are commonly considered, and how do these variables impact findings relating to how different bike share programs address equity considerations or not? In Smith, Oh, and Lei's (2015) report *Exploring the Equity Dimensions of US Bicycle Sharing Systems,* they identify that academic research regarding the equity implications of bike share programs falls into three categories. These general areas include *descriptive studies* which evaluate and report on the existing characteristics of a bike share system; *operations related analysis,* which evaluate logistical and funding challenges or opportunities; *and transportation system impacts,* which consider the impact of a public bike share system within the scope of the larger transportation network (Smith, Oh & Lei, 2015).

Among these categories, the primary lenses of analysis of bike share systems within the existing literature are descriptive studies such as this MRP, as demonstrated by the significant number of spatial analysis research that evaluates the distribution of bike share stations within a service area (Hosford & Winters, 2018; Bhuyan et. al., 2019; Ursaki & Aultman-Hall 2015; Couch and Smalley, 2019). This is an important approach of analysis as it addresses a fundamental barrier encountered by many who may otherwise use a public bike sharing service. This may suggest that operating models of bike sharing systems may influence equity outcomes (Howland et. al., 2017).

In Hosford and Winters's (2019) study of bike share services in Canadian cities, the geographic distribution of bike share stations is evaluated with the Pampalon Deprivation Index (PDI), which is often used in health research to provide an "area-based measure of deprivation" (Hosford and Winters, 2019, p. 44). Key findings from Hosford and Winters' (2018) spatial analysis of the distribution of bike share stations in five Canadian cities – including Bike Share Toronto, Sobi Hamilton, Mobi Vancouver, VeloGo Ottawa-Gatineau, and Bixi Montréal – identified that bike share stations were largely concentrated in densely populated areas. Generally, they also identified that areas with more 'advantage' were better serviced in Vancouver and Ottawa-Gatineau, with a more even distribution in Toronto, Montreal, and Hamilton (Hosford and Winters, 2018). Interestingly, part of their analysis also identified that the

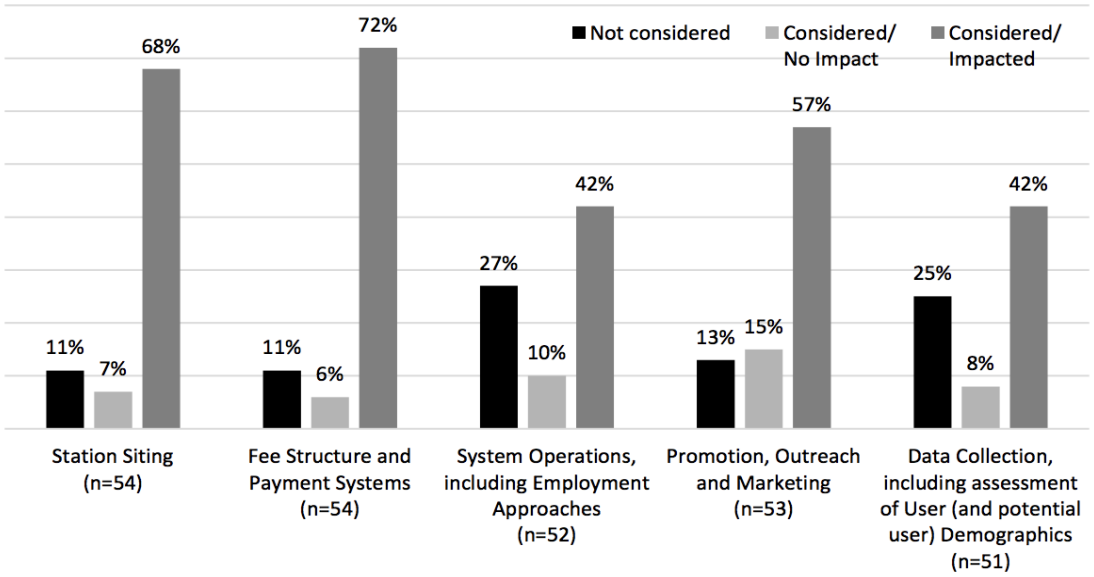
three programs with more of an even station distribution were owned by either non-profits or were municipally publicly owned programs (Hosford and Winters, 2018), suggesting that privately owned and operated programs may not prioritize equity considerations. A recent study by Portland State University also arrived at similar conclusions and identified that large cities are more likely to introduce equity measures targeting specific demographics or regions within the city (McNeil, et.al., 2019). From this research they identified funding and insufficient staff support as a key challenge for supporting equity programs, in addition to logistical challenges with discount pass programs, and community engagement/partnerships (McNeil, et.al., 2019).

A 2017 study published by the National Institute for Transportation and Communities surveyed 75 bike share system owners and operators in the United States to further understand different approaches to servicing 'underserved' communities (Howland, et. al., 2017). Participants were asked a series of open and close-ended questions regarding equity policies, statements, metrics and data collection, and program logistics. From this research, it was identified that "23% of survey systems have adopted an equity statement or policy, and 7% are in the process of developing one" (Howland et. al., 2017, p 20). Larger systems (i.e. programs with more than 500 bikes), which comprised a quarter of the total programs surveyed, were more likely to introduce equity-based considerations to major parts of their program, such as affordable fare rates, outreach programming and station location (Howland et. al., 2017). The survey also attempted to understand what specific aspects of the bike share system design or operations were influenced the most by equity considerations as illustrated in Figure 2. Their research demonstrated that equity considerations most frequently influence program fee structures and payment systems, followed by station location (Howland et. al., 2017). Moreover, this research revealed that only a few systems identified "that equity was not considered in their system's operations (27%) or data collection (25%)" (Howland et.al., 2017, p. 9). Interestingly, this study also reports that although many systems identified that equity is considered in their design or operations, only 23% of the programs actually have adopted equity statements into their programs (Howland, et.al., 2017). According to Howland et.al, (2017),

> Those reporting having an equity statement also had higher mean responses to specific equity consideration and impact in all surveyed areas: station siting, fee structures, operations, promotion, and data collection (p.10).

The researchers of this study concluded that equity considerations can still influence bike share system decisions, however programs with an explicit equity statement "were more likely to consider equity in more elements of their system operations." (Howland, et.al., 2017, p.10). This is an important consideration for the purpose of this MRP, as it demonstrates that establishing a clear equity mandate or statement can help to support and reinforce specific actions to facilitate bike share equity objectives more deliberately through policy.

Figure 2: How is Equity Considered in Bike Share Program Design



Note: Percentages do not total 100% due to "Don't Know/NA" responses. Possible survey responses were: Not considered; considered, no impact; considered, minor role; considered, considerable role; considerations primary driver. We combined minor role, considerable role, and primary driver into the Considered/impacted category here.

Source: Howland et. al., 2017, p.10

As demonstrated, the scope of bike share research addresses many different issues, and although the existing literature is not extensive there are a number of key considerations that can be used to inform this MRP. The literature identifies four key dimensions of equity concerns including, cycling infrastructure and built form, financial barriers, perceptions of safety, and social barriers. It is evident through the literature that none of these barriers can be addressed separately, as they each overlap with one another. One of the more salient demonstrations of this

is described by the inadequacy of program subsidies without adequate network and partnership building support. Litman's (2002) approach to equity in transportation provides a useful framework to understand how to effectively address equity-based concerns as identified by communities. This framework highlights the importance of moving beyond the basic barriers identified broadly, in order to develop equity-based programming that is not only relevant but also sufficiently supports the needs and wants of local communities.

As identified above, this MRP seeks to contribute to the growing literature on bike share equity by investigating Bike Share Toronto through a descriptive study. More importantly, this research hopes to contribute to and encourage the integration of transportation equity considerations in active transportation programs and services within the quickly evolving micro mobility industry. Methodologically, this research examines the four factors influencing bike share use and investigates how these barriers can be analyzed using Litman's (2002) framework of Vertical Equity with Regard to Income and Class. In order to do this, I completed a spatial analysis that investigated the intersection of infrastructure, financial and socio-economic barriers affecting (potential) Bike Share Toronto users. An analysis of the Bike Share Toronto Equity survey added to the spatial analysis, offering a more nuanced and deeper understanding of the infrastructure, financial and socio-economic barriers experienced by Bike Share Toronto users. Finally, expert interviews introduced institutional perspectives on bike share equity.

3. Bike Sharing in The Canadian Context & Bike Share Toronto Program Expansion

3.1. Bike Sharing in The Canadian Context

Prior to the global boom of bike sharing services in 2009, some Canadian cities had already introduced some form of community bike sharing program. For example, the Community Bicycle Network based in Toronto was a small-scale, community-owned bike sharing program which operated between 2001-2006 (Gris Orange Consultant, 2009). Although the program concluded operations due to funding challenges and shortfalls, the program operated at its peak with 450 users (Gris Orange Consultant, 2009). One of Canada's first 'smart' bike share programs *Bixi,* was introduced in 2009 in Montreal under the private non-profit company Public

Bike System Company created by the City . Promptly following Montreal, the City of Toronto launched a bike sharing program in 2011, now known as Bike Share Toronto. Shortly after, the City of Vancouver introduced the Mobi public bike share program in 2016. The only known bike share service that has integrated an equity program belongs to the Sobi Hamilton bike share program. Sobi Hamilton bike share program was first launched in 2015, and shortly after introduced the *Everyone Rides Initiative* (ERI) in 2017. This three-year pilot initiated a multi-pronged approach to addressing service access by expanding the fleet size, community outreach and social marketing, and identifying opportunities for program partnerships and subsidies (Topavolic & Johnson, 2017). Sobi Hamilton partnered with local organizations prior to and during the program launch, including but not limited to the Welcome Inn Community Centre, the Boys and Girls Clubs of Hamilton, the YWCA, and the Hamilton Regional Aboriginal Centre (Topavolic & Johnson, 2017). Through this approach, the ERI addresses two types of vertical equity (with respect to need and ability and with respect to income and social class) as articulated by Litman (2002). According to the 2018 Hamilton Sustainable Mobility Programs report, the ERI has organized more than 70 cycling training sessions and provided 250+ subsidized membership (City of Hamilton, 2018).

3.2. Bike Share Toronto Program Expansion

In 2007, Toronto City Council expressed an interest in the development of sustainable transportation initiatives in order to realize the objectives of the *Climate Change, Clean Air and Sustainable Energy Action Plan: Moving Framework to Action* (City of Toronto, 2009). In order to do this, Council directed City Planning to assess the feasibility of a bike sharing program by developing a business case to be reported back to the Planning and Growth Management Committee. A program was adopted and initiated in 2009 by the City Council under the condition that it would be "at no cost to the City" (City of Toronto, 2009, p.1). The program originally launched in 2011 as 'Bixi Toronto,' which was a subsidiary of a Quebec-based company formerly known as the Public Bike Sharing Company. Council approved the City to enter into a 10-year agreement with the company, which would introduce a PBS system consisting of 80 stations and 1,000 bicycles primarily concentrated in the downtown core (City of Toronto, 2010). In 2013, Bixi Toronto began to encounter some financial challenges.

Although the program generated 1.8 million rides with 4,630 annual subscribers within the first 18 months, the user-generated revenue was not sufficient to sustain its operations (City of Toronto, 2013). The program management responsibilities were then transferred to the Toronto Parking Authority in 2014 – where the program has since remained – and the system was re-branded as 'Bike Share Toronto'.

As previously identified, Bike Share Toronto has undergone yearly incremental expansions since 2016, by approximately 100-120 stations per year (Toronto Parking Authority (d), 2019). In recent years, two new program expansion feasibility studies have been conducted by Williams Sale Partnership (WSP Global Inc.) to examine the potential growth of the Bike Share Toronto. The 2016 Bike Share Toronto feasibility study modelled expansion within the City of Toronto, and the second study also completed in 2017, models expansion within the Greater Toronto and Hamilton Area to create a regional bike share program (WSP Global Inc., 2016; WSP Global Inc., 2017). Both of these reports consider a number of key factors when assessing potential areas for growth, including but not limited to mobility (i.e. proximity to rapid transit networks), population and employment centres (i.e. population and employment density), bikeability (i.e. existing bike lanes and topography), and points of interest (i.e. tourist attractions and shopping centres) (WSP, 2016; WSP, 2017). Map 1 models a concentric phased expansion plan, which identifies green areas with high ridership potential (WSP, 2016). As anticipated, the proposed expansion plans develop from the downtown core and branches out into the inner suburban region. This map clearly demonstrates that the expansion plans of Bike Share Toronto stations are significantly informed by major public transportation stations (TTC and GO) and emphasizes expansion in areas that already have high cycling potential. This also suggests that the factors that most influence expansion plans are related to existing transportation networks, and high population density.

Map 1: Bike Share Toronto Feasibility Study Proposed Expansion Areas

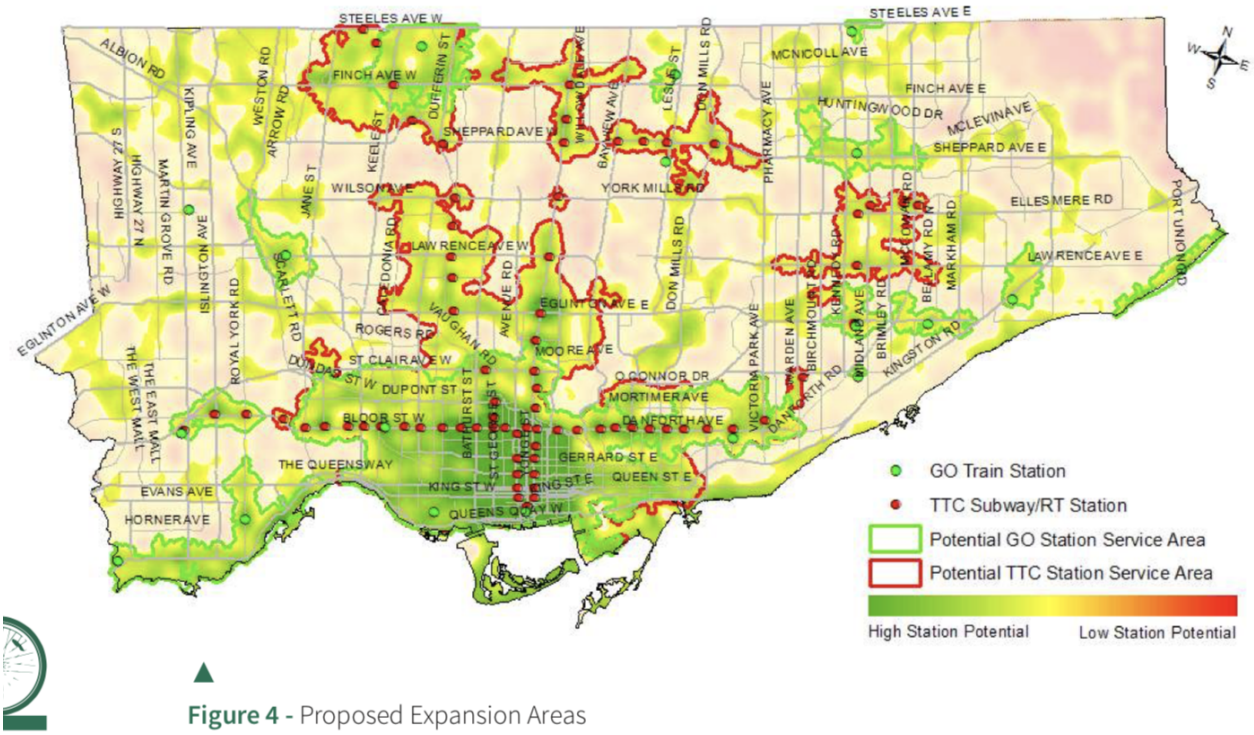


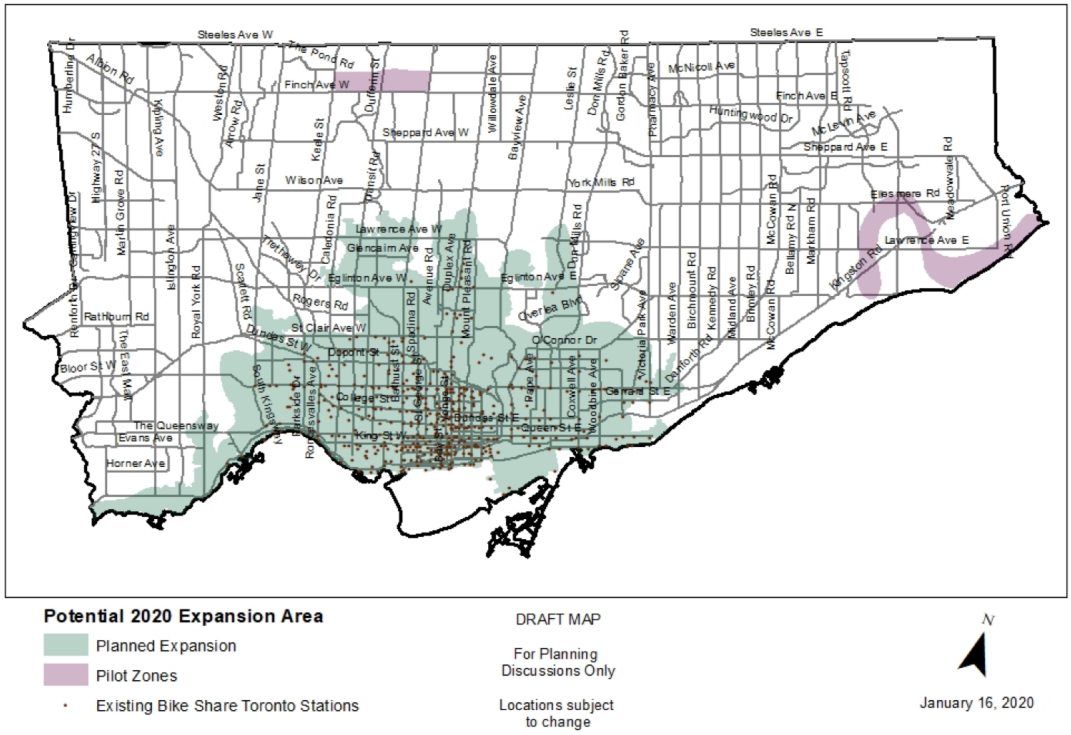
Figure 4 - Proposed Expansion Areas

Source: Williams Sales Partnership (WSP Global Inc., 2016)

Although both of these reports do not explicitly discuss an equity-based approach to planning as part of BST's expansion in the coming years, the City of Toronto Feasibility Report (2017) identifies the potential for a satellite zone expansion. These satellite zones identify areas outside of the existing program network that have high station potential. These areas are also supported by the key factors such as high population density, bikeability and are supported by existing major transit nodes such as TTC or GO stations (WSP, 2017). The proposed satellite zones in Map 1, located in the north south of Steeles Ave. W encompass York University, North York Civic Centre, and the Sheppard Subway Corridor. Another satellite station is also located in the east end of Toronto and encompasses Scarborough Town Centre. The development of these zones into functioning networks presents a unique opportunity to address spatial equity challenges. Expansion into these regions would not only bring the Bike Share Toronto program into suburban areas not currently served by the program, but it would also introduce the program to audiences that may not otherwise use the service.

The Toronto Parking Authority has also recently reported that the 2020 Bike Share Toronto Program Expansion will also include two pilot zones for the first time as seen in Map 2 (2020 Bike Share Expansion Plan, 2020). The 2020 Expansion Plan and the implementation of the two pilot projects is an important hallmark for the Bike Share Toronto program, since "the expansion opportunity completes the phased five-year expansion plan of the Bike Share system established in 2016 with the objective of reaching 6,000 bikes and 600 stations" (Toronto Parking Authority, 2020, p.1). The two pilot zones also mirror the satellite zones identified in the 2016 *Bike Share Toronto Feasibility Study.* According to this plan, "pilots will take place during the summer of 2020 in Wards 6 (York Centre), 24 (Scarborough-Guildwood) and 25 (Scarborough-Rouge Park) to encourage suburban usage of the service and extend deployment beyond the boundaries of the Toronto & East York district" (Toronto Parking Authority, 2020, p.1). This report also explicitly identifies that the pilot programs will include recreational trails in order to connect to key transit nodes such as the Rouge Hill GO (Toronto Parking Authority, 2020). In addition to launching two pilot zones, the expansion of the Bike Share Toronto service into suburban regions is a notable endeavor relevant for this MRP. The pilot zones identified in the expansion plan do have some overlap with variables used to evaluate spatial equity, including NIA's, and areas of 'high deprivation' as identified by the PDI, as I elaborate below.

Map 2: Potential 2020 Bike Share Expansion Plan



Source: 2020 Bike Share Expansion Plan (Toronto Parking Authority, 2019c)

Although future research may include the newly expanded zones in a spatial equity analysis once the expansion is implemented, this MRP will focus on the current Bike Share Toronto service network. The following section will introduce and elaborate on the development of a spatial equity analysis, which will first evaluate the distribution of the Bike Share Toronto stations compared to areas of deprivation using the Pampalon Deprivation Index (PDI).

4. Visualizing Bike Share Equity: A Spatial Analysis of Bike Share Toronto

As identified by Litman (2002), the unique histories, urban characteristics, challenges and opportunities of different regions do not support a generalizable definition of transportation equity. Municipalities, transportation service providers, and operators must consider the ways in which the communities they hope to support are impacted by the local context, which is undoubtedly a difficult task. A tool used by cycling equity advocates and organizations involves using spatial analysis to investigate the intersection of different socioeconomic variables and

cycling infrastructure – including bike share stations – to begin to unpack equity distribution. For the purpose of this MRP, Map 3 compares socioeconomic characteristics of Census dissemination areas using 2016 Pampalon Deprivation Index (PDI) data, with the current distribution of Bike Share Toronto Stations. Then, Map 4 displays Toronto's cycling infrastructure network (i.e. bike lanes) with Neighbourhood Improvement Areas, which are then compared to the current distribution of Bike Share Toronto Stations.

4.1. PDI Spatial Analysis

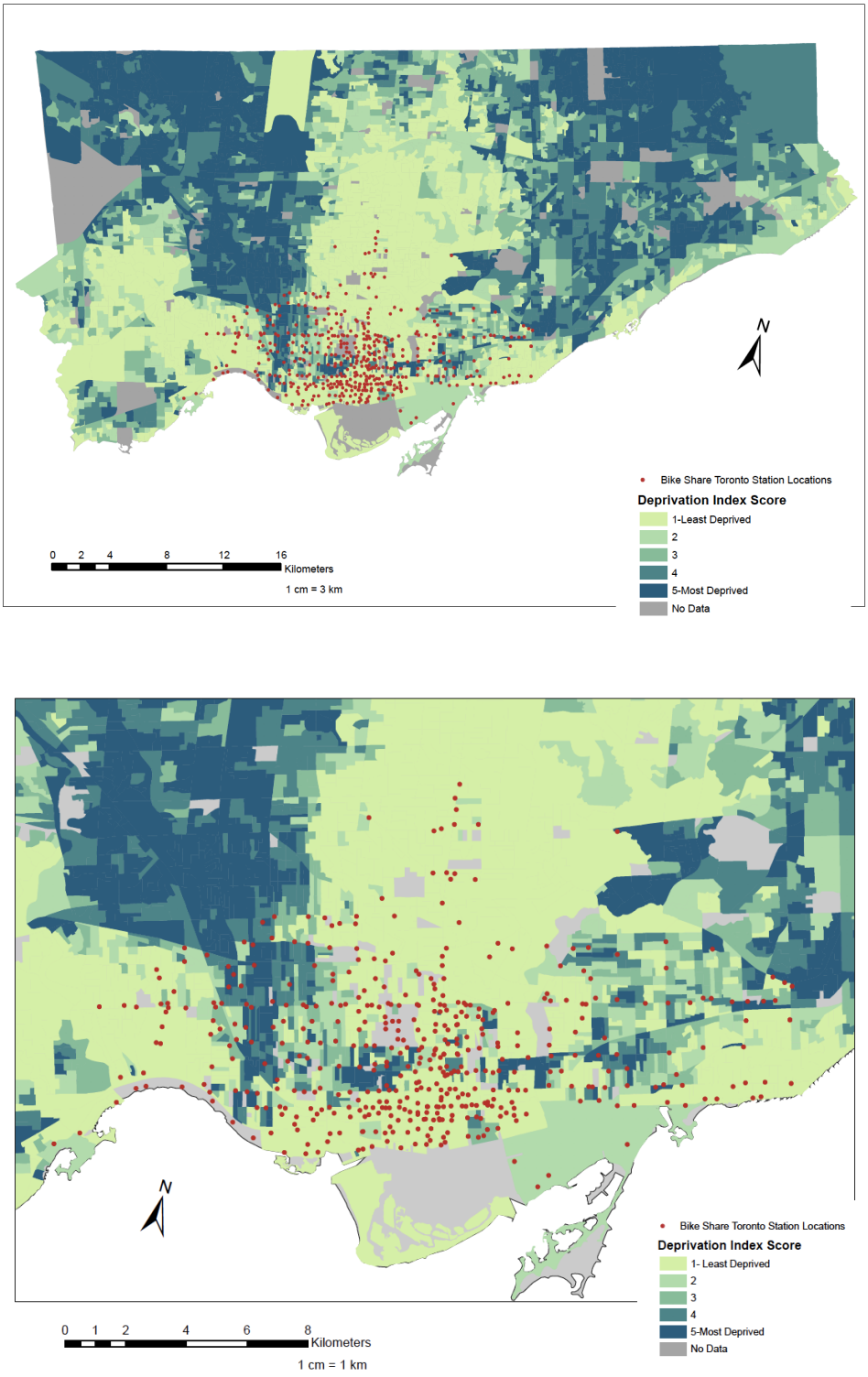
To date, the only spatial analysis evaluating bike share equity in Canada was completed by Kate Hosford and Meghan Winters (2018). Broadly, the purpose of their study was to evaluate how accessible and equitably distributed bike share services (stations) are in Canadian cities, including Toronto (Bike Share Toronto), Hamilton (Sobi), Montreal (Bixi), Vancouver (Mobi) and Ottawa-Gatineau (Velo Go) (Hosford & Winters, 2018). In order to do this, the authors used the material component of the 2016 PDI as captured in Census 2016 data, to compare the socioeconomic characteristics of each Census dissemination area to the location of bike share stations in each city (Hosford & Winters, 2018).

With the exception of the City of Hamilton – the only program with an explicit equity lens – they found that "advantaged areas have greater access to bicycle share infrastructure in Vancouver, Toronto, Ottawa-Gatineau and Montréal" (Hosford & Winters, 2018, p. 6). They specifically identify that out of all the dissemination areas located within the Bike Share Toronto service area, only 26.4% are in the fourth and fifth quintiles with lower income (Hosford & Winters, 2018, p.6). In other words, 73.6% of all Bike Share Toronto stations are located in areas that have more socioeconomic 'advantage' (Hosford & Winters, 2018, p.6). According to Hosford and Winters, although Toronto can be considered to be more equitable than cities such as Vancouver – which only had 3.6% of bike share infrastructure located in the most deprived areas – there is considerable space for improvement. Comparison with other Canadian cities also identified that programs operated by either a non-profit or those that were completely publicly operated were the most spatially equitable (Hosford & Winters, 2018). This assessment highlights similar conclusions as earlier research by Howland et al. (2017) explored earlier in the literature review.

The research methodology articulated by Hosford and Winters (2018) presents a unique and useful lens of analysis. However, they also acknowledge that their study is limited, as it only evaluates equity by comparing the spatial distribution and access of bike share stations (Hosford & Winters, 2018). Moreover, the maps created in their analysis use Bike Share Toronto data from 2017, which only plots 199 stations (Hosford & Winters, 2018). Since then, the program has more than doubled in size and now comprises 465 stations (Bike Share Toronto, 2020). It is therefore important to recognize the significant expansion of the program and consider these changes when analysing spatial equity in this MRP, especially if the ultimate goal is to offer guidance regarding how BST could embed equity considerations into its future planning and expansion plans.

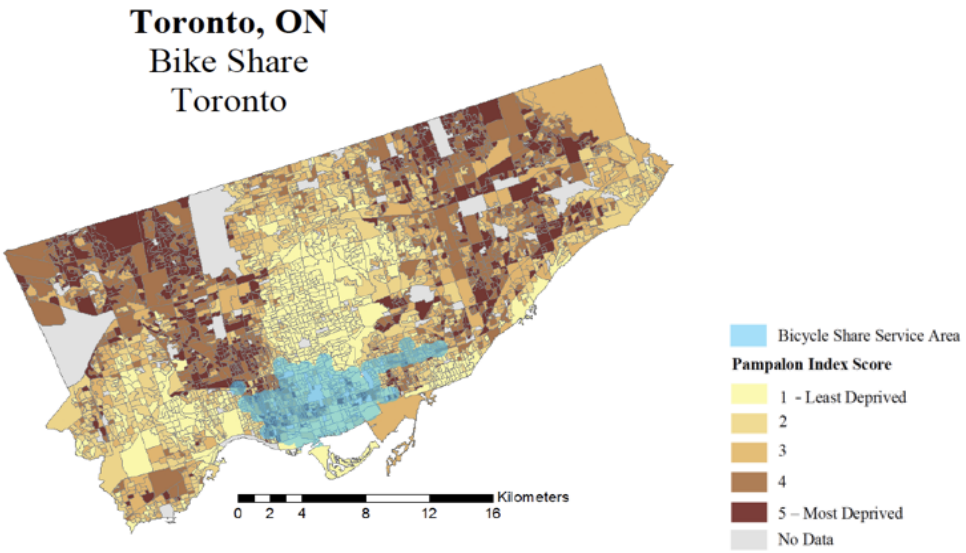
In an effort to provide an updated overview of the (in)equitable distribution of BST stations in Toronto, for this MRP I created maps on ArcGIS using similar data identified in Hosford and Winters' (2018) study. I used the material component of the PDI, which can be retrieved from the Institute National de Santé Publique du Québec's (INSPQ) website, and the current geographic coordinates of BST stations downloaded from ArcGIS Online's publicly available data. This study also uses Ontario's Census Subdivision boundaries to establish the City of Toronto's administrative and geographic boundaries, which I downloaded from Statistics Canada. I also used Dissemination areas to further identify smaller geographic units of analysis to display the material deprivation data from the PDI. Hosford and Winters also indicate in their study that "the geographical size of dissemination areas varies with population density; more densely populated areas will have smaller dissemination areas compared to areas with low population density" (Hosford & Winters, 2018, p.5). As such, Map 3 overlays these two layers of data. For visualization and legibility purposes, I purposefully did not include data displaying City of Toronto bike lanes in Map 3. Map 4 below presents that information.

Map 3: Location of Bike Share Toronto Stations by Pampalon Deprivation Index (PDI) in the City of Toronto (Map not to scale, See Appendix G)



Source: Created by Author

Map 4: Bicycle share docking stations by deprivation quintile for Canadian cities with public bicycle share programs (Map not to scale, See Appendix D)



Source: Hosford and Winters, 2018

Map 3 demonstrates the BST service network has grown significantly when compared to Hosford and Winters' (2018) study (Map 4). Notably, the service area has expanded further east and north, and along the Toronto waterfront into previously underserved areas. Despite this expansion, BST stations are still largely concentrated in the downtown core where there is high density and employment. Interestingly, Map 3 also highlights that the expansion of the BST service to the north is largely concentrated in dissemination areas with the least amount of deprivation (quintiles one and two). This growth towards Toronto's Midtown area happens to also follow the configuration of the Toronto subway system. As demonstrated in the literature, the location of bike share stations in close proximity to other services (ie. public transit) is an important factor for using a bike share service and is an attractive feature for bike share system operators. There is also a large concentration of BST stations along the Toronto waterfront, which also continues to experience considerable development and revitalization targeted to high income populations. Again, as Hosford and Winters (2018) demonstrated, BST stations do

service some dissemination areas with higher deprivation (fourth and fifth quintile), as demonstrated by the two pockets in the downtown core encompassing Regent Park and South Parkdale neighbourhoods. However, this map also demonstrates that the system has not yet entered northwest and northeast regions of the City, where there is a considerable concentration of 'deprived' dissemination areas.

This map suggests similar conclusions to Hosford and Winters' study (2018), confirming that the spatial distribution of BST stations considerably supports areas in the downtown core and surrounding areas that have high population density, high income, and economic activity. However, this spatial analysis using the PDI data is only one measure of low socio-economic status and inequity. Hosford and Winters (2018) also highlight that other relevant factors, such as availability and proximity of bike lanes, topography and public transportation networks are relevant to bike share station location and use. As such, the following spatial analysis will attempt to further expand and deepen these considerations within the Toronto context. In order to do this, the variables included in the following spatial analysis will primarily use data accessible to BST planning staff, which include the City of Toronto cycling network (including separated and shared bike lanes, recreational trails, and multi-use trails) which will be used to display cycling infrastructure, and Neighbourhood Improvement Areas (NIA's) identified by the City of Toronto.

4.1. Cycling Infrastructure and Neighbourhood Improvement Areas

The availability and adequacy of supportive cycling infrastructure remains an important variable when evaluating cycling equity. As demonstrated in the literature, efforts to enhance cycling equity should address both physical cycling infrastructure and work strategically to reinforce positive environments and interactions for diverse socio-economic and cultural communities (Litman, 2002; Kodransky & Lewenstein, 2014). An emphasis in creating physically and socially optimal conditions presents an opportunity for capacity building within diverse communities. One of the ways in which the City of Toronto has attempted to integrate these two key pillars is demonstrated by the newly approved updates to the City's Ten Year Cycling Network Plan (City of Toronto, 2019). Originally adopted in 2016, this implementation plan was developed under both municipal and provincial active transportation policy and is also

informed by a number of additional reports and recommendations (IBI Group, 2017). The 2016 plan proposed nearly 1,000 km of cycling infrastructure, including approximately 560 km of bike lanes and cycle tracks, 55 km of multi-use trails, and 380 km of sharrows (shared bike lanes) along neighbourhood streets (City of Toronto, 2019).

The most recent update to this cycling plan recognizes growing interest in cycling activity and intends to uphold the three key pillars of the original plan, which are to *connect, grow and renew* cycling infrastructure in the city (City of Toronto, 2019). Interestingly, this new update now prominently features equity and safety as key categories of analysis. Importantly, it now includes an equity impact statement, which explicitly addresses the intersectional challenges experienced by vulnerable and equity-seeking groups who are interested in cycling. As the Plan states,

> Cycling can also be a disproportionately negative experience for racialized communities as a result of feelings of discrimination and lack of personal safety due, in part, to the very different infrastructure, planning and design standards historically common in suburban neighbourhoods where more racialized groups live… These inadvertent, adverse impacts of cycling infrastructure can be mitigated through meaningful engagement with equity-seeking groups, by designing infrastructure with, not for, the community, and by incorporating additional measures to address access to existing and planned infrastructure (City of Toronto, 2019).

In an effort to address this equity dimension in the Ten Year Cycling Network Plan, the City has introduced the Toronto Strong Neighbourhoods Strategy (TSNS) 2020 into the methodology used to identify and propose new cycling routes. The TSNS acknowledges that some areas in the City experience disproportionate inequities (City of Toronto, 2020). As such, the strategy initiated in 2005 "[is] premised on the understanding that a historic under-investment in the community infrastructure of some Toronto neighbourhoods has resulted in a variety of challenges, particularly in the area of community safety, and particularly for racialized youth" (City of Toronto, 2014b, p. 3). Originally, the strategy identified thirteen *Priority Improvement*

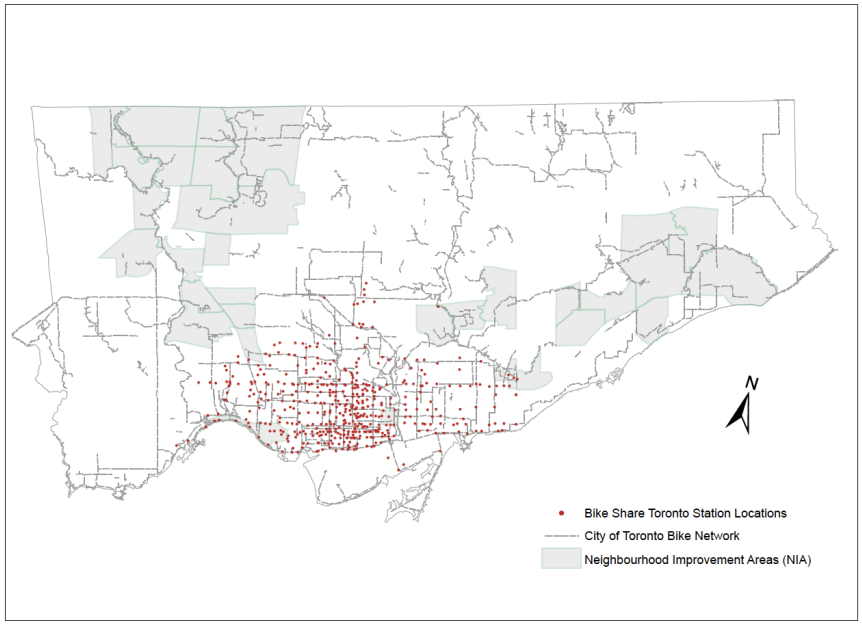
Areas, which have now been expanded to include 31 neighbourhoods that have now been renamed as *Neighbourhood Improvement Areas* (City of Toronto, n.d)[6].

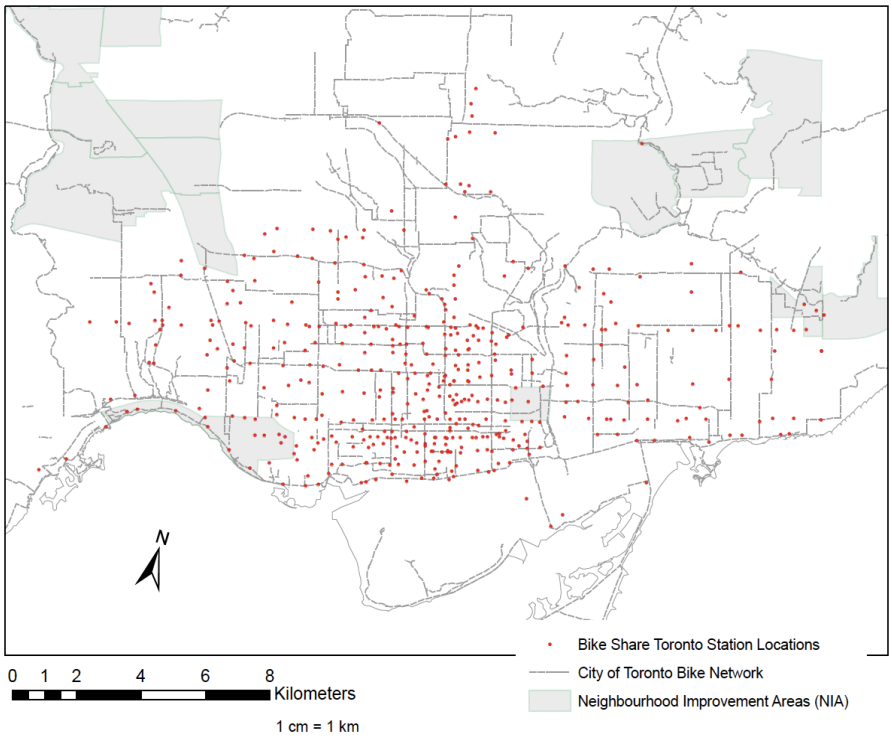
The recent updates to the Cycling Network Plan to include an equity lens through the NIA's presents an interesting opportunity for the Bike Share Toronto program. Specifically, this new emphasis can facilitate a different approach and introduce equity interventions that can encapsulate both physical and social infrastructure support. For example, by introducing Bike Share Toronto stations along established cycling networks within NIA's not only has the potential to expand the service area, but also to introduce and 'normalize' bike sharing as a viable mobility option for populations who may otherwise not engage with the service[7]. Interestingly, the importance of normalizing cycling in NIA's was also expressed during the expert interviews, which will also be explored in the following section.

[6] Each neighbourhood is defined by 2-5 Statistics Canada Census Tracts and has a minimum neighbourhood population of 7,000-10,000 (Neighbourhood Profiles, 2020). These neighbourhood boundaries do not change over time and are meant to provide socio-economic data for governments and community agencies in order to support longitudinal studies at the neighborhood level using this aggregate data (City of Toronto, n.d). In order to identify these new 31 NIA's, the City developed a Neighbourhood Equity Index (NEI) in collaboration with the Urban HEART@Toronto research initiative to quantitatively analyze neighborhoods using five domains of wellbeing including, economic opportunities, social development, participation in decision making, healthy lives, and physical surrounding (City of Toronto, 2014a; see Appendix F for list of domains of 'well-being').

[7] 'Normalize' within this context refers to the growing familiarity and general acceptance of cycling and bike sharing activity.

Map 5: Location of Bike Share Toronto Stations by Neighborhood Improvement Areas and Bike Lanes (Map not to scale, See Appendix H)





Source: Created by the author

As illustrated in Map 5, almost all Bike Share Toronto stations are located within the former municipal boundaries of Old Toronto, with two stations located in Etobicoke and less than 20 stations located in East York. Out of 31 NIA's, only three NIAs are well serviced by the program, two of which are located close to the downtown core. Interestingly, Map 3 reflects similar conclusions drawn from Map where the northeast and northwest regions of the immediate surrounding service area are not serviced by BST stations. Moreover, Map 5 also demonstrates that areas surrounding bike lanes are well serviced and almost evenly distributed. This is clearly demonstrated by the number of BST stations that are concentrated along Toronto's Waterfront trails.

Although aligning cycling infrastructure expansions plans with the goals of the TSNS potentially presents a unique opportunity to address bike share equity concerns, there are limitations to this approach. As highlighted in the Cycling Network Plan,

> Since the approval of the Ten Year Network Plan in 2016, approximately 7 percent of the proposed kilometers of cycling infrastructure has been installed. This rate of implementation reflects that projects take time to move through the design and approval process and need to be coordinated, and often bundled, with other work at least three years out to minimize disruption (City of Toronto, 2019, p. 25).

Moreover, these constraints and conditions related to the actual implementation of the cycling plan would require the Bike Share Toronto program to be included in the initial discussion and development of City capital works such as road resurfacing and road reconstruction. Still, this approach can be used as a preliminary indicator or tool to address service gaps within the existing cycling network that already overlaps with NIA's.

The findings from these two exercises attempted to identify the (in)equitable distribution of Bike Share Toronto stations across the City of Toronto using a range of variables from previously completed studies, and data accessible to BST planning staff. Perhaps not surprisingly, the geographic areas identified as the 'most deprived' based on the PDI in Map 3 largely correlated with NIA's identified in Map 5. This suggests that although Map 3 primarily uses Census data to identify areas of deprivation, and Map 5 uses a methodology developed by

the City, there are clear areas that BST can focus efforts towards introducing bike share stations. This can also indicate regions where alternative outreach and engagement strategies with local residents may be best employed. Moreover, the pilot programs identified in the 2020 Bike Share Toronto Expansion Plan, particularly in the Scarborough region, overlay with some of the most deprived regions in Map 3. These maps also can also suggest that since the BST program has saturated these 'wealthier' areas, future expansion plans can now concentrate on more strategic efforts toward building networks in more 'deprived' regions with an explicit equity lens.

5. Understanding Equity Challenges: An Analysis of Bike Share Toronto's Equity Survey

The analysis from the previous section provides a contemporary snapshot of BST's coverage and offers important contextual information that can be used to geographically understand spatial inequality. However, more substantial research is necessary to understand how users experience barriers to access the program. As previously identified, between the months of October 2018 and May 2019 Bike Share Toronto and Bikes Without Borders initiated a research project survey aimed at "improving access to Bike Share for low-income and marginalized community members. [The survey] aimed at investigating barriers, knowledge, perceptions and usage of the Bike Share programs" (Bike Share Toronto, n.d para. 1). This online survey was found on the Bike Share Toronto website and was open for any member of the public to complete. A total of 108 participants completed the survey, and exactly half of all the survey respondents (54) identified they currently are or have previously been an annual member of the Bike Share Toronto Program. All the questions asked in the survey, including any personal information collected, were voluntary. However, the survey also identified that "participants must be 18 years of age or older and will need access to a credit card" (Bike Share Toronto, n.d para. 1).

The survey questions can generally be grouped into three sections (see Appendix E for a list of survey questions). The first encompasses general demographic information such as age, gender and race. The second group of questions asks participants to identify how they engage with cycling and the BST program. Finally, the last group of questions probe further and ask questions about specific barriers to participating or engaging with the BST program. According

to BST, the results of the survey are intended to inform an equity pilot-program. However, BST has not revealed any concrete plans regarding how the survey findings will be used. Despite the small sample and the self-selection bias among survey respondents, the results from this survey present some key insights and are the closest source of data available that articulates perceptions and use of BST by the program's users themselves.

Access was permitted for the use of this data by both Bike Share Toronto and Bikes Without Borders (BWB). The raw data was obtained by BWB, and all identifiable data (including names, date of birth, contact information) was removed prior to analyzing any of the survey responses to ensure the anonymity of all survey respondents. As previously identified, the responses from the survey questions were grouped and then analyzed in three sections. Responses from the survey were used to investigate the specific answers provided by different demographic groups such as women, and older adults. This allowed for an analysis of specific barriers associated with cycling or bike sharing in more granularity, which can be used to inform the development of a bike share equity intervention by Bike Share Toronto. Since this research does not include interviews with BST users, this section provided some insight regarding how respondents engage with cycling in the City of Toronto and elaborates on specific perceptions of the BST program. This section of the analysis also considered how the respondents' place of residence may influence their answer. For example, this can include an evaluation of how barriers to accessing the BST program, or perceptions of cycling safety may differentiate among repondents depending on where residents live.

Demographic Insights

The demographic information from this equity survey provides a snapshot of not only who participated in the survey, but also of the demographic communities who use Bike Share Toronto services. Moreover, an analysis of this demographic data in further granularity can help to identify the specific barriers experienced by different demographic groups.

From the 108 survey respondents, more than half (57.4%) of all participants self-identified as male, 35.2% identified as female, and less than 8% identified as non-binary or selected 'prefer not to answer'. Although the survey sample size is small, this demographic

distribution of survey respondents reflects and reinforces the trends identified in the literature. As such, it is also interesting to consider this male overrepresentation extends to this equity survey.

Of all male respondents, 37.1% also identified as a visible minority[8], 9.6% identified as a recent immigrant or newcomer[9], and 4.8% identified as both. Comparatively, almost half (48.3%) of all male survey respondents did not identify as any of these groups. This is an interesting trend as it demonstrates that more than half of the respondents belong to historically marginalized communities, which challenges some of the existing literature. This may offer some indication or hope that historically underrepresented men may have different experiences in the Toronto context. However, due to the small survey sample size this data cannot be used to extrapolate to support further conclusions.

On the other hand, of all female survey respondents, only 23.6% identified as a visible minority, and 7.8% identified as a recent immigrant or newcomer [10]. When compared to all female respondents, 68.4% did not identify as any of these groups. This reinforces trends in the literature (i.e. not only are female underrepresented in cycling circles, but also visible minority and immigrant women are further underrepresented among all female).

Furthermore, the equity survey also asked respondents to identify if they previously were or (at the time of the survey) are annual Bike Share Toronto Members. From the 108 respondents, exactly half (54) identified having been or being BST members. From this subset, more than half (61.1%) were male, and 33.3% were female[12]. Moreover, only 27.7% these male respondents, and only 11.1% of female respondents also identified as a visible minority. These two findings reinforce trends reflected in the literature which highlights a disproportionate overrepresentation of male bike share users. This emphasises women, specifically visible minority women are considerably underrepresented as bike share users.

[8] The equity survey identifies 'Visible minority' as "persons, other than Aboriginal peoples, who are non-Caucasian in race or non-white in colour" (Bike Share Equity Survey, 2019).
[9] The survey identifies 'Recent Immigrants/ Newcomers' as persons who "came to Canada since 2011" (Bike Share Equity Survey, 2019).
[10] No non-binary respondents identified as a visible minority, a recent immigrant or newcomer, or both.
[12] The remaining 5.6% selected prefer not to answer'.

The results of the survey highlight key insights relating to the gender and racial distribution of survey respondents to this equity survey. Women remain underrepresented in this data among all respondents. Specifically, women who identified as a visible minority and or as a recent immigrant or newcomer 11% of all survey respondents. Moreover, only 17.5% (9.6% male, and 7.8% female) of all respondents identified as recent immigrants or newcomers. As such, although this survey may be a preliminary source of information, it is important to note this disparity in participation could be used to justify alternative engagement strategies and justify additional research that investigates how women and newcomer communities experience and engage with the Bike Share Toronto program. Although the demographic results of this equity survey cannot be extrapolated to conclusively exclusionary trends of Bike Share Toronto user demographic due to the limited sample size, the results are still compelling.

Cycling Activity and Perceptions of Bike Share Toronto

Among all survey respondents, 95.4% identified that having access to or owning a bicycle would be beneficial to them, and almost three quarters (73.1%) of the respondents already own or have access to a bike. Moreover, 93.5% identified some familiarity with the Bike Share Toronto program, how it operates, and the existing stations near them, even if they are not or have not been active members of the program. This is particularly interesting on at least two fronts. On the one hand, it suggests that although respondents may already have access to a bicycle, there is a sustained interest in the Bike Share Toronto program among them. On the other hand, the data also suggests that survey respondents who are not and/or have never been users of the program are still familiar with it.

Among the 108 respondents, 45 (41.6%) identified that they also live in designated NIA's, including the Regent Park and South Parkdale neighbourhoods. From these respondents, almost half (42.25%) also identified that they (at the time of the survey) are or have previously been a BST annual member. Moreover, individuals who live in a NIA and have used BST comprised 17.5% of all equity survey responses. As demonstrated in Map 3, both of these neighbourhoods are already well serviced by BST stations, which may explain the engagement of these participants in this equity survey. As a whole, this data suggests that residents in NIA

designated areas that have BST presence do in fact use the service, which might mean that extending BST's service area to other NIAs could actually increase membership and help address the program's equity gaps.

Bike Share Toronto Barriers

The final section of the survey asks participants to identify specific barriers or challenges they experience to access BST services, and respondents were able to select multiple answers. In response to the question '*Are there specific barriers stopping you from considering a Bike Share Toronto membership as a transportation option in your regular activity?'* the most commonly identified barrier at 40.7% among all survey participants was 'traffic concerns and road safety'. Following safety concerns, participants then identified 'limited ability to use the system spontaneously', and 'unstable income and cost' at 21.3% and 18.5% respectively, as key barriers[13]. Based on these responses, concerns with income and cost are consistent with the barriers identified in the literature. Concerns associated with the limited spontaneous access to bike sharing stations can also be considered directly related to the spatial distribution of the program, which is also identified in the literature. However, the literature primarily frames the latter concerns as more related to the operations and servicing of the bike share stations, as opposed to social equity considerations.

Participants also had the option to indicate what barriers they specifically experience if they were not already listed. For the purpose of this research, answers that were provided by respondents were grouped into three themes, including cycling infrastructure and safety, financial accessibility, and program operations. Responses included in cycling infrastructure and safety expressed concern with road safety of cyclists, lack of bike lanes, and issues with car traffic. Responses that describe financial accessibility barriers include the requirement of having a credit card or smart phones to purchase passes, the challenge of paying lump sums for memberships, and price for single use trips, especially as they are more expensive than public transit. As explored in the literature, this directly aligns with the structural challenges associated with financial barriers. The final theme identified from these responses highlighted barriers

[13] Other barriers included 'geography (steep hills, etc.) and weather concerns'(17.6%), 'transportation needs are outside Bike Share Toronto service area' (14.8), 'Costs associated with losing or damaging a bicycle' (10.2%), and 'Physical condition or disability inhibiting riding' (1.9%) (Bike Share Toronto Equity Survey, 2018).

related to the service area of operations of the program. This included concerns with inconsistent availability of bikes and docking points to regularly use the service (i.e. stations are always full, and users cannot return bikes after use), and the far distances users must walk to access a bike share station. Although these concerns are challenges associated with program operations and servicing, this can possibly introduce equity concern if users cannot reliably unlock and/or return bicycles regularly, therefore making users vulnerable to things such as overage fees. However, the existing literature does not extensively discuss this specific challenge. Other comments that did not fit within these themes identified a lack of knowledge about how memberships work, a concern with the lack of winter equipment (i.e. winter tires) on bikes, and the need for some to have an appropriate wagon or basket for their belongings.

In summary, the key findings from this survey results echo some of the findings identified in the literature review. The demographic portion of the survey illustrates that women and those who identify as a visible minority remain underrepresented in the survey data. Moreover, the majority of respondents are familiar with the BST program, and identify that having access to a bike would be beneficial to them. Finally, respondents have also identified that road safety is a primary concern and barrier impeding the use of BST services. Although these preliminary findings from the spatial analysis and survey may align with the key themes found in the literature, the perspectives, experiences, and knowledge of bike share service managers, planners, partners and operators are a key dimension to consider when thinking about how Bike Share Toronto might embed an equity lens in its operations and future expansion plans, because these institutional perspectives guide final planning decisions. As such, the following discussion will attempt to understand and articulate key institutional perspectives on bike share equity with representatives from Bike Share Toronto, and Scarborough Cycles.

6. Expert Interviews: Understanding Institutional Perspectives on Bike Share Equity

The findings of the spatial analysis and Bike Share Toronto Equity Survey capture an informative snapshot of some considerations that can be used to develop an equity intervention by Bike Share Toronto. The key informant interviews conducted for this research presented a unique opportunity to investigate and understand if cycling or bike share equity is a lens of analysis currently considered at Bike Share Toronto. It was also used as an opportunity to

understand the role of community cycling hubs to address disparities found in urban and suburban cycling activity, and to explore how the objectives of community cycling hubs align with bike share equity objectives. As such, the following discussion articulates key findings from two semi-structured expert interviews with representatives from Bike Share Toronto ('Participant 1') and Scarborough Cycles ('Participant 2'). The participants were asked a series of five to six questions (see Appendix C) regarding their organization and the services they provide, perspectives on the role of bike share services in cycling equity, and how a bike share planning intervention could be structured and applied.

6.1. Bike Share Toronto

The interview conducted with the representative from Bike Share Toronto was of particular importance. The questions asked attempted to understand how BST defines cycling equity, and how equity considerations have been actively applied to or integrated into the program's history. Moreover, the interview attempted to understand the challenges that have been encountered in developing a scope for an equity intervention, and how partnerships with organizations or departments may facilitate this goal.

Theme 1: Defining Cycling Equity

Although there is evidence to support the conclusion that BST aspires to develop a program or planning intervention that directly and meaningfully addresses equity concerns, a recurring theme highlighted during this interview emphasised the challenge of simply defining what equity means. This is important because any future definition equity that BST accepts will begin to frame the scope of potential equity interventions, including what specific population groups are to be included or excluded from this consideration. For example, Participant 1 identified that not having access to credit cards or level of income can both be considered equity barriers related to financial aspects. Alternatively, the participant also identified that another equity lens could focus on the dimension of health, focusing on reaching Canadians at risk of obesity and inactivity.

Participant 1 also acknowledged that depending on how cycling equity is defined, there are many ways in which it can be analyzed and different programs that can be designed to apply

an equity lens. Importantly, Participant 1 also highlighted that although there may be different examples of programs that have been designed in many cities in the United States, it is very important to understand the different context in which those programs have been developed. This confirms that currently the BST program does not have a clear framework to understand cycling equity that is actively applied to the program.

This definitional challenge may present an opportunity to consider Litman's (2002) contributions. Firstly, depending on what the BST equity intervention or program would like to accomplish, these goals can be framed as horizontal equity, vertical equity with regard to income and class, or vertical equity with regard to mobility need and ability. Based on this expert interview, and past attempts to address cycling equity at BST, using vertical equity with regard to income and class seems to be a practical and preferred framing of equity. Moreover, Litman identifies that the scope of transportation equity should be informed and guided by the concerns of the affected communities. As such, BST should first work towards meaningfully understanding these barriers, while also realistically identifying the limitations of the services the BST program can provide. The results of the equity survey can be used as an introductory and precursory step towards understanding these barriers, opening the door to additional research.

Theme 2: Attempts to Address Cycling Equity at BST

This interview also revealed that BST has actually attempted some kind of equity intervention in the past. Participant 1 mentioned that this intervention provided annual BST membership passes, over a three-year period for public housing residents in the Regent Park community, located in Downtown Toronto. This project was done in partnership with Toronto Community Housing Corporation (TCHC) and Daniels Corporation. Unfortunately, there is no information available regarding how many residents signed up for the passes, and there is minimal to no information available about whether these passes have meaningfully addressed equity barriers. According to Participant 1, this is due to privacy concerns and restricted access to sensitive information of occupants in Regent Park. As such, the only indicator that BST is able to currently use is the data collected by each station surrounding the Regent Park community.

BST is able to monitor activity at all of the stations active in the network, which can generate a report about the number of passes purchased at each station or the number of rides that started or were completed at each station. Although this information can be useful to understand the general activity in the surrounding area, especially when compared over time, the data does not and cannot differentiate or identify who the users are. However, Participant 1 did indicate that through their analysis, the activity of stations around Regent Park did increase significantly over time. The specific data used for this analysis is not made publicly available. Similar to the subsidy programs introduced by the New York City Housing Authority and the Denver Housing Authority described in the literature review, this intervention by BST primarily attempted to target and eliminate the financial barrier associated with engaging with the service. However, the intention and outcomes of these interventions may not always align. As demonstrated in the literature, the barriers that influence bike share use are often layered and must therefore be addressed in conjunction with one another.

Theme 3: Aligning Equity and Environment Objectives

Interestingly, the interview also revealed that the BST program is directly related to the City of Toronto's *Climate Change, Clean Air and Sustainable Energy Action Plan: Moving from Framework to Action*, which was approved in 2007. The action plan attempts to provide a comprehensive approach to facilitate reduction of greenhouse gas emissions and "is founded on the attainment of ambitious emission reduction targets, most notably an 80% reduction in the 1990 levels of greenhouse gas production in the City by the year 2050" (Butts, 2007, p.8). As such, when a bike share program was introduced for the City of Toronto, this objective emerged at the forefront and remains the foundational objective of the program. Although the program may include other objectives such as increasing transportation equity, the interview identified this particular objective as a key goal mandated by the City, which the program works towards adhering to.

Interestingly, the participant suggested that anything that can be done to contribute to this goal of reducing emissions would be a positive thing. This is an interesting finding, as it suggests that an equity program may have to be qualified by supplementary program goals that do not directly concern increasing transportation equity as such. Although the alignment of multiple program goals can be advantageous, this also introduces an interesting discussion about the value

of equity programs as a singular objective. It is important to reaffirm the legitimacy of social equity concerns related to bike sharing outside the scope of environmental and sustainability objectives. For example, if a key sustainability objective is to reduce greenhouse gas emissions created by the use of vehicles, equity interventions should investigate and consider how vehicle use may differ among low income communities who may not have access to or use vehicles extensively. From a transportation equity perspective, this difference in use should not prevent the potential expansion of the program into regions with low vehicle use.

Theme 4: Developing Partnerships

Partnerships can be leveraged to enhance the impact of bike share equity programs. In particular, grassroots and local community partnerships can be an essential feature of not only developing but also implementing these programs as demonstrated in the literature. BST has already demonstrated this precedent by working with Toronto Community Housing Corporation (TCHC) and the Daniels Corporation for the distribution of Bike Share Toronto passes to residents in Regent Park. However, the program has not entered into any partnerships outside of the City's control. As such, when asked about the potential for developing these partnerships Participant 1 identified that currently BST has not been given any authority to enter any partnerships related to equity programs.

This highlights that it is important to understand the limitations and the capacity of the BST. Since the program is owned by the City of Toronto, the program must still function within the framework established by the City, which can be sensitive to evolving political and financial environments.

6.1. Scarborough Cycles

Local organizations and cycling advocacy groups are supported by social networks, which can facilitate and encourage cycling activity in their local communities. One particularly unique approach to cycling advocacy and equity can actually be found in Toronto's suburbs. Located in Toronto's east end, Scarborough Cycles is a suburban community bike hub that offers a variety of opportunities for local community members to engage with cycling. Interestingly,

the very first Scarborough Cycles hub is also currently located a few blocks away from the easternmost BST station available in the network.

The program is operationally based out of the Access Alliance Multicultural Health and Community Services, which is a community health centre that aims to "provide services and address system inequities to improve outcomes for the most vulnerable immigrants, refugees and their communities" (Access Alliance, 2020, para 2). Scarborough Cycles offers access to bicycles, civic and social engagement opportunities, and also offers tools and workshops for participants to learn and develop technical skills to repair bicycles. Based on the success of the first cycling hub, Scarborough Cycles has also introduced two additional community cycling hubs including the Lawrence-Orton Bicycle Repair Hub which is a joint initiative with the City of Toronto and Toronto Community Housing Corporation, and a hub at the Birchmount Bluffs Neighbourhood Centre.

Not only is Scarborough Cycles a key demonstration of community-based cycling advocacy, but also the program is uniquely positioned within the scope of this research. Scarborough Cycles primarily services inner suburban and suburban communities outside of the BST service area, engaging with population groups that may otherwise be underserved by BST. In recognition of these contributions, it is clear that meaningfully consulting organizations and community cycling hubs of this kind can enrich a BST equity intervention by integrating this existing knowledge. As such, the interview conducted with Scarborough Cycle introduced a key perspective that can further inform this research. The following themes summarize key discussions and findings.

Theme 1: Defining Cycling Equity

Participant 2 introduced a number of interesting insights about how Scarborough Cycles defines and engages with cycling equity. Firstly, they highlighted that because cycling can be used as a mode of transportation, and as a tool for health and environmental promotion, equity is truly at the crux of what they do. This is clearly informed by the vision and mission statement established by the Access Alliance, which aims to support diverse communities to achieve health with dignity (Access Alliance, 2020). As such, Participant 2 clearly identifies that their work is

directly related to 1) accurately identifying barriers to participating in healthy lifestyles including cycling, and 2) actively working towards reducing barriers that may be related to social, cultural, economic, and infrastructural considerations. However, there are clear limitations to the way in which efforts to reduce barriers are beyond the capacity of the organization, particularly to the barriers related to cycling infrastructure.

Scarborough Cycles' approach to transportation equity aligns with Litman's (2002) conceptualization of equity as it related to both *Vertical Equity with Regard to Income and Class*, as well as *Mobility Need and Ability*. The program takes a multi-pronged approach to encourage cycling in these communities by designing opportunities to support and facilitate independent mobility, and also by making the resources accessible to community members to develop technical skills to meet personal needs (i.e. bike maintenance). This is linked to the framing of cycling as a tool that can be used to alleviate additional stresses that low income or marginalized groups may encounter. For example, if someone is on a fixed or low income and they are able to integrate cycling into their routines, this may remove transportation related costs, which can then be reallocated for the use of other expenses.

Theme 2: The Role of BST in Cycling Equity

In 2019, The Centre for Active Transportation (TCAT) published a report titled *Building Bike Culture Beyond Downtown: A Guide to Community Cycling Bike Hubs* (Ledsham & Verlinden, 2019). This report specifically identifies the key learnings from the development of the Scarborough Cycles program and outlines the approaches taken to develop the program for others to reference (Ledsham & Verlinden, 2019). This report describes the dilemma of suburban cycling culture as a 'chicken-and-egg' scenario (Ledsham & Verlinden, 2019). Generally, this dilemma describes that suburban road infrastructure clearly prioritizes vehicle use, and cycling infrastructure is scarce and hostile, which directly contributes to fewer people cycling on suburban roads (Ledsham & Verlinden, 2019). As a result of fewer people cycling on suburban roads, politicians and city staff have difficulty introducing plans for cycling infrastructure improvements even though there may be public support for them (Ledsham & Verlinden, 2019). Therefore, the essential challenge and question of this 'chicken-and-egg' scenario is should people ride bikes to encourage the development of more cycling infrastructure, or should the

appropriate infrastructure be introduced first to encourage more cyclists? Through the experience of Scarborough Cycles, the report identifies that enhancing community capacity and investing in community support to incubate cycling culture is an essential component of solving this dilemma.

Participant 2 also elaborated on the importance of confidence-building, particularly among younger demographics. Moreover, when asked about the role of BST in helping to address this dilemma, Participant 2 overwhelmingly agreed that BST has a key role to play and ignoring this opportunity would be a considerable oversight. By introducing BST stations into inner suburban and suburban communities, this can directly address and help to satisfy Scarborough Cycles' limitation by introducing hard cycling infrastructure into suburban streets including the BST stations themselves. This is an interesting point, because Participant 2 also identified that through their research with TCAT and experience, long cycling distances are not actually a huge factor dissuading people from cycling. Rather, it is a concern with personal safety that remains prominent. When compared to the conclusions about perceptions of safety as highlighted in the literature review, bike sharing may actually serve a unique purpose to alleviate safety concerns by unintentionally encouraging users to be more cautious due to their limited familiarity with the bicycles for example.

Participant 2 specifically identified that another component of Scarborough Cycles' role is to also encourage the normalization of cycling in these communities and introducing BST services deeper into suburban communities can contribute to this normalization. Interestingly, Participant 2 also referenced a number of conversations with community members who have a few BST stations in the surrounding neighbourhoods and have expressed interest and curiosity about the program. From the perspective of Participant 2 there are many opportunities for BST to engage in community and grassroots level programming that can be facilitated through existing programs such as Scarborough Cycles.

This discussion also revealed that Scarborough Cycles is also aware of the different financial and potentially political limitations of expanding BST into suburban regions. For example, Participant 2 acknowledged the reality that BST expansion resources may be limited,

and this may therefore limit the immediate expansion of the service into suburban regions. Moreover, they also acknowledged that the program is expected to also operate as a revenue-neutral service at no additional cost to the City. Therefore, bike share planning will likely prioritize the installation of stations in areas that are expected to generate higher user revenue. However, if bike share is to be used as a viable transportation service for community members, the program must expand further. When asked about other equity considerations or strategies that should or can be introduced into an equity intervention, Participant 2 primarily emphasized removing financial barriers associated with using the service, including lower costs and finding alternative methods of payment beyond credit cards. This is a different approach than simply providing free passes, as it introduces the potential to connect potential users to the program through the existing social infrastructure within the community. For example, allowing potential users to sign up for a BST membership through Scarborough Cycle at discounted rates would not only reduce financial barriers, but it may also reduce the social barriers associated with signing up with the program. More importantly, Participant 2 highlighted that by introducing BST or an equity program as a celebratory event, local community members may actually be more inclined to participate. Organizing events such as membership drives, or community rides has the capacity to simulate but also sustain interest in participating.

Theme 3: Fostering Community Partnerships and Capacity Building

> Scarborough Cycles has identified that,
>
> Over five years, this community bike hub project repaired over 2,200 bicycles, collaborated with over 50 community groups/organizations, and trained over 200 people in cycling skills – in a part of Toronto where there are few bike lanes and only one bike shop (Scarborough Cycles Research, 2020, para 2).

Community partnerships are a key component of facilitating the programs and services provided by Scarborough Cycles. Participant 2 reinforced that the idea of community cycling hubs is not a particularly new idea. However, the innovation that has made the program successful is that it used an existing program structure of community cycling hubs commonly found in urban areas and applied it to a suburban context by leveraging existing community interests in cycling.

Participant 1 identified that if cycling initiatives want to address cycling equity building the necessary community knowledge and relationships is essential. There can be varying approaches to accomplish this, but Participant 2 identified that Scarborough Cycles completed some preliminary research and made a list of potential program partners and agencies, reviewed their mission statements, and actually met with and interviewed members of these organizations to identify viable partnership opportunities. In doing this, community-based partnership organizations both have the capacity to not only disseminate information, but also encourage their community members who come from a range of communities to participate and engage with Scarborough Cycles.

7. Conclusion

It is evident that bike sharing programs are uniquely positioned to address mobility and transportation gaps in urban landscapes. Acknowledging this, this Major Research Paper sought to explore how Bike Share Toronto can understand equity-based considerations relevant to bike share use, and what equity-based evaluation tools and approaches can BST use to identify service and user gaps. This research involved three primary components, including a spatial analysis of the existing BST service area, an analysis of the Equity Survey results collected by Bikes Without Borders, and expert interviews with representatives with key institutional perspectives on bike share equity, including Bike Share Toronto and Scarborough Cycles. Together, these data collection tools offered a contemporary snapshot of the program's geographic service area from an equity lens, provided a high-level overview of demographic trends and access barriers among BST users (current and potential), and delved into institutional challenges and opportunities regarding the adoption of a BST equity action plan.

This research revealed a number of key findings that can be used to inform the development of an equity intervention for the Bike Share Toronto program. The spatial analysis revealed that the BST program has saturated the downtown and surrounding areas. The equity survey analysis further revealed that in those NIA that are well served by BST stations, NIA residents do in fact use the program. Therefore, future expansion plans can now concentrate on more strategic efforts toward building networks in more 'deprived' regions. Building on Litman's (2002) work, this MRP aligns with the view that there are different variables that can

be used to analyze the spatial equity of the BST program. This research performed two spatial analysis to assess the spatial (in)equity of the BST stations, including data from the material component of the Pampalon Deprivation Index (PDI) based on Hosford and Winters' 2018 study, the City of Toronto's Cycling Network and Neighbourhood Improvement Areas (NIAs). Therefore, when thinking about potential interventions to increase equitable access to a bike share program it is important to know what variables are relevant to the objectives of a given bike share initiative, in this case Bike Share Toronto. Moreover, this analysis demonstrated that aligning relevant City of Toronto policies and strategies such as the Ten Year Cycling Plan and the Toronto Strong Neighbourhoods Strategy can be used to effectively frame a Bike Share Toronto equity intervention.

The research also revealed that identifying a clear scope of what equity means within the context of the Bike Share Toronto program is essential. Although the literature identifies that defining an equity statement may not be necessary, equity is given greater consideration if explicitly stated (Howland et.al, 2019). This definition and scope should be informed by communities who will be directly affected by the development of an equity intervention. In this regards, local community and grassroots engagement efforts can be also be facilitated by organizations such as Scarborough Cycles. Local organizations already have important formal and informal relationships with potential users that can be used to encourage local community members to participate or learn about the Bike Share Toronto program.

This research also reveals that any analysis of transportation (in)equity must be informed by diverse qualitative and quantitative research tools. In addition to the spatial analysis, the findings from the Bike Share Toronto Equity Survey demonstrate that respondents were overwhelmingly familiar with the program, but women and those who identify as a visible minority remain underrepresented in the survey data. However almost all respondents still identified that they believe having access to a bicycle would be beneficial to them. Although the Bike Share Toronto Equity Survey is an important step towards understanding the barriers associated with using the Bike Share Toronto program, further investigation will be required. The spatial analysis and the survey responses performed presents only a fraction of the necessary research required to develop a comprehensive and strategic equity planning intervention.

The overarching goal of problematizing bike sharing is not to prohibit the prominence of the services, but rather to strengthen and comprehensively grapple with the complex and nuanced social equity dimensions of these services. Criticism of bike sharing, and bike share equity should be seen as an opportunity to accurately identify and understand barriers in order to introduce innovative ideas to address them.

8. Research Constraints and Limitations

With all research there are constraints and limitations that must be acknowledged. Firstly, the availability of existing literature on bike share equity, specifically within the Canadian context is scarce. There is a growing body of literature based in the United States, and as such the literature used in this research is largely supported by the key findings within that context. However, it is important to highlight that the different social and cultural histories between Canada and the United States must be acknowledged. For example, discourse surrounding transportation equity in the United States is considerably linked and consistent with the civil right and environmental justice movement and is largely informed by the deep history of racial segregation (Bullard, 2003). Moreover, there are considerably more public and/or private bike share programs in cities across the United States than there are in Canadian municipalities. However, the insights from the US literature are relevant to the Canadian context, because it is broadly concerned with understanding the intersection of factors that support inequities.

Another constraint in this research is in regard to the use of NIA's as a geographic representation of inequality. The NIA Neighbourhood Profiles identified by the City were developed in 2014, and sources of data used include the 2011 Census and National Housing Survey (NHS) data. Although the NIAs presents convenient geographic and spatial information, the data used to define these areas was collected in 2014 and does not reflect the most recent information. Moreover, the methodology used to identify the NIAs does not include an appropriate indicator that evaluates neighbourhood access to transportation. In other words, this evaluation of neighbourhood 'well-being' presented by the TSNS does not evaluate transportation equity considerations. This can be considered a limitation of this data because it does not capture transportation infrastructure-related inequity. This was also identified as a

limitation during the consultative period of selecting NIA's (TSNS 2020 Neighbourhood Equity Index Methodological Documentation, 2014).

There are also limitations regarding the PDI data. The data set used to create the PDI uses 2016 Census data, which may now be an outdated, although it reflects the most recent census data. Moreover, this research can be updated as the next census data becomes available in future years. It is important to also carefully consider the term 'deprived' in this research. Although this research follows a similar methodological path to Hosford and Winters' (2018), it is essential to reinforce that neighbourhoods and communities are diverse and dynamic. The term 'deprived' for the purpose of this study is for comparative purposes and focuses on socioeconomic factors only. As such, it does not reflect the wider context, nuances, and resilience of each community or dissemination area.

Finally, there are also constraints related to the Bike Share Toronto Equity Survey. The survey has a modest sample size of 108 survey respondents. Although a more robust survey may be conducted in the future, the survey responses currently available present preliminary insights about (potential and current) user experiences that are useful for the purpose of this Major Research Paper.

Appendix A

Bike Share in Canada: System Summary (2018)
(Urban Systems, 2019. p.9-13)

City / Campus	System Name	Type	Start / End Trip Location	Mode	Year Started	Interface	Business Model	Fleet Size	User Cost
BIKE SHARE IN CANADIAN MUNICIPALITIES									
Victoria	U-Bicycle	Hybrid – can terminate within 10m of dropzone only (geo-fence)	Public bike racks in designated drop zones	Bike (interested in e-scooters)	2017	App only	Private Business (city pays nothing)	550 bikes	$50 deposit; $1 per 30 min. Day pass for $15.75. Annual pass for $157.50.
Vancouver	Mobi	Docked	Docking stations	Bike	2016	Member card (App available for reservations)	City contracted private operator (CycleHop) who owns all assets	2,000 bikes; 150 stations	$9.75 (day), $75 (3 mo), $129 (1 yr) for 30 min rides; add'l 30 min $2
University of British Columbia	Dropbike	Dockless	Anywhere on UBC campus-lock to infrastructure; parking in havens recommended but not required	Bike (interested in e-bikes and e-scooters)	2018	App only	Private Business (University pays nothing)	200 bikes	$1 for 60 min + deposit
Other Lower Mainland	U-Bicycle (Richmond, Port Moody/ Port Coquitlam)	Dockless (attach to any infrastructure or end in havens)	Public bike racks-lock-to infrastructure or havens.	Bike (interested in e-scooters)	2018	App only	Private Business (city pays nothing)	Lanford – 35 bikes; Richmond 56 bikes; Port Moody/ Port Coquitlam – 30 bikes	$50 deposit; $1 per 30 min. Day pass for $15.75. Annual pass for $157.50.
Kelowna	Dropbike	Dockless	Anywhere in homezone; parking in havens recommended but not required	Bike (interested in e-bikes, e-scooters as well)	2018	App only	Private Business (city pays nothing)	Up 1,500 bikes	$1 for 60 min + deposit
Calgary	Open Market (multiple companies)	Dockless	Anywhere (no lock-to required)	Bike	2019	App only	Private businesses	Currently 375 bikes, licensed up to 10,000 bikes	Multiple companies
Waterloo Region	Dropbike	Dockless	Anywhere in homezone; parking in havens recommended but not required	Bike (interested in e-bikes as well)	2018	App only	Private Business (city pays nothing)	200-300 bikes	$1 for 60 min + deposit
Elgin (Port Stanley)	Dropbike	Dockless	Anywhere in homezone	Bike (interested in e-bikes, e-scooters as well)	2018	App only	Private Business (city pays nothing)		$1 for 60 min + deposit
Hamilton	SoBi	Hybrid (attach to	Anywhere in homezone (130	Bike	2015	Member card (App	Non-profit (though City	825 bikes; 130 hubs	9c per min (pay as you

City / Campus	System Name	Type	Start / End Trip Location	Mode	Year Started	Interface	Business Model	Fleet Size	User Cost
		hubs or any bike locks)	hubs for free or any bike lock for a $1 fee)			available for reservations)	and Metrolinx are 'sponsors')		go) OR $15/mo (90 min trip)
Toronto	Toronto Bike share	Docked	Docking stations	Bike	2011	App, credit card	Public; run by Toronto Parking Authority; city paid capital costs ($4-6M); sponsorship pays op costs	3,750 bikes; 360 stations	$3.25 (ride); $7 (day); $15 (3 day); $99 (1 yr) for 30 min trips; +$4 for extra 30 min
Oshawa	Dropbike	Dockless	Anywhere in homezone; parking in havens recommended but not required	Bike (interested in e-bikes, e-scooters as well)	2019 2 year pilot set to begin	App only	Private Business (city pays nothing)	TBD	$1 for 60 min + deposit
Kingston	Dropbike	Dockless	Anywhere in homezone; parking in havens recommended but not required	Bike (interested in e-bikes, e-scooters as well)	2017 pilot; 2019 full launch	App only	Private Business (city pays nothing)	200+	$1 for 60 min + deposit
Ottawa	VeloGo (CycleHop /HOPR)	Dockless	Anywhere in home zone though 'ponds' / havens are identified	Bike (HOPR has e-bikes and e-scooters in their offerings so could pivot to other technology if desired)	2018	App only	Private business	500	$1 to start ride; 16c per min; $15/mo (30 min)
Montreal	BIXI	Docked	Docking stations	Bike	2009	Credit card, enter unlock code, bike key (for members). App available for reservations.	Public; run by Stationnement de Montreal	6,250; 540 stations	$2.75 (trip); $5 (day), $14 (3 days), $30.25 (month); $80.50 (year) for 30 min trip
Westmount	Dropbike	Dockless	Anywhere in homezone; parking in havens recommended	Bike (interested in e-bikes, e-scooters as well)	2017	App only	Private Business (city pays nothing or gets paid)	50+	$1 for 60 min + deposit

BIKE SHARE ON CANADIAN UNIVERSITY CAMPUSES									
University of Manitoba (Winnipeg)	Dropbike	Dockless	Anywhere in homezone; parking in havens recommended but not required		2019	App only	Private Business (University pays nothing)	TBD – Estimated 50 bikes at launch	$1 for 60 min + deposit
University of British Columbia	Dropbike	Dockless	Anywhere on UBC campus-lock to infrastructure; parking in havens recommended but not required	Bike (interested in e-bikes and e-scooters)	2018	App only	Private Business (University pays nothing)	200 bikes	$1 for 60 min + deposit

Appendix B

List of Six Socio-Economic Indicators to
Develop the Deprivation Index
(Gamache, Hamel & Blaser, 2019, p.1)

"The deprivation index is built from six socioeconomic indicators drawn from the 1991, 1996, 2001, 2006, 2011 and 2016 censuses, including the 2011 National Household Survey (NHS). These indicators were selected because of their known relationship with health status, because of their association with both the material and the social aspects of deprivation, and because of their availability by EA/DA.

These indicators are:

1. The proportion of the population aged 15 years and over without a high school diploma or equivalent;
2. The employment to population ratio for the population 15 years and over;
3. The average income of the population aged 15 years and over;
4. The proportion of the population aged 15 and over living alone;
5. The proportion of the population aged 15 and over who are separated, divorced or widowed;
6. The proportion of single-parent families.

Since the variations sought by the index are mainly socio-economic and not demographic, and because those indicators can be biased by the age and sex structure of the EA or DA populations, they were all standardized according to the age and sex structure of the Canadian population (except for the lone-parent family indicator) using the direct standardization method. When needed and possible, a linear transformation was carried out to preserve data normality."

Appendix C

List of Preliminary Interview Questions for Semi-Structured Interviews

Bike Share Toronto:

a. How does your organization define cycling equity, and how is it reflected in your organizations planning objectives?

b. What key objectives would a Bike Share Toronto Equity program hope to achieve?

c. What are the primary equity barriers associated with accessing Bike Share Toronto? What opportunities has your organization identified to address challenges or barriers?

d. How can partnerships between Bike Share Toronto and community organizations (ie. Scarborough Cycle, Culture Link) help to address these barriers?

e. Are there any challenges that have prevented the adoption of an equity intervention in the Bike Share Toronto program?

Scarborough Cycles:

a. How does your organization define cycling equity? How has this definition informed the goals and objectives of the program?

b. Prior to the launch of the program, how did your organization identify community interest in this project? What were the most significant barriers and areas of opportunity identified?

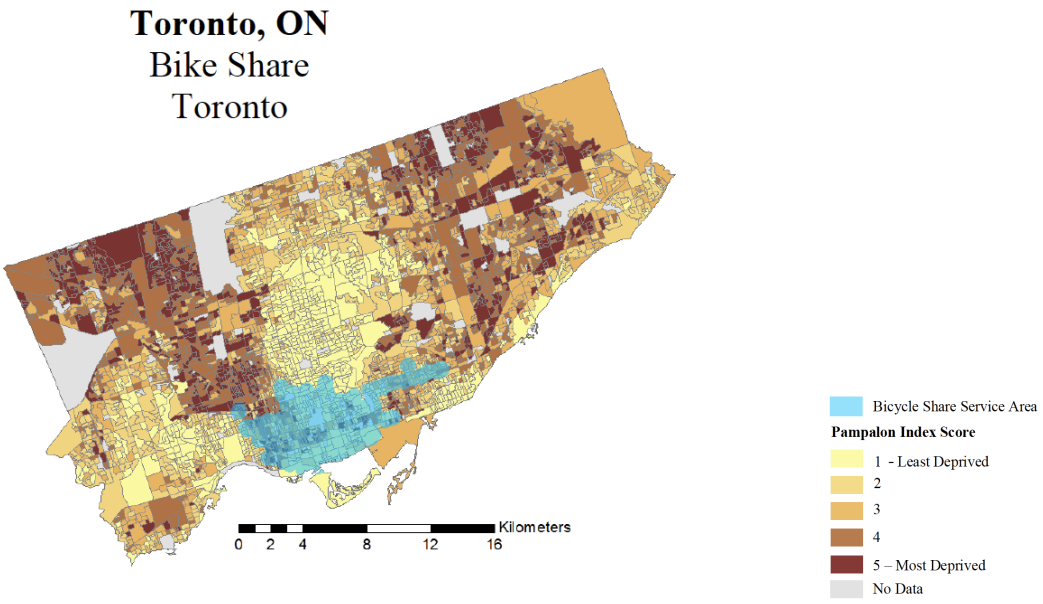
c. In the report Building Bike Culture Beyond Downtown, it references a chicken-and egg scenario when trying to determine what comes first- people riding bikes, or the cycling supports and infrastructure. How can a service like Bike Share Toronto help to address this challenge.

d. To the best of your knowledge, do members who engage with Scarborough Cycle use Bike Share Toronto? Can you identify potential barriers or perceptions of the Bike Share Toronto program that may discourse the use of the service?

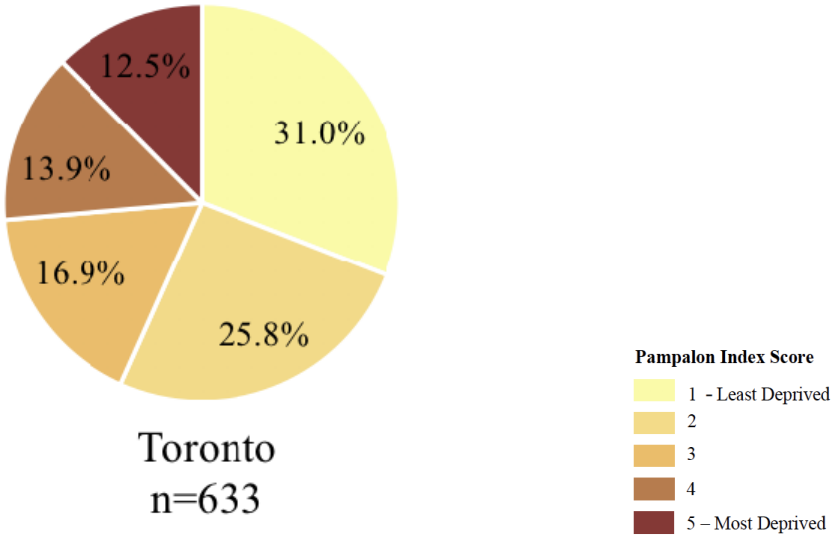
e. If the Bike Share Toronto program were to adopt a mandate to develop an equity program, from your experience what key considerations or approaches that would be essential to frame the development of such a program?

Appendix D

Bicycle share docking stations by deprivation quintile for Canadian cities with public bicycle share programs (Hosford & Winters, 2018, p. 17)



The proportion of dissemination areas inside the bicycle share service area by deprivation quintile in Toronto (Hosford & Winters, 2018, p. 18)



Appendix E

Bike Share Equity Survey

Bikes Without Borders (in partnership with Bike Share Toronto and via the City of Toronto's Community Projects & Events Investment Funding Program) is conducting a research project on improving access to Bike Share for low-income and marginalized community members. All answers provided are confidential and will not be shared or distributed beyond facilitators of the research project. All questions are optional; if you wish to not answer a question, please select "prefer not to answer".

1) Please select the area of Toronto you reside in
    - ❑ Moss Park
    - ❑ Kensington/Chinatown
    - ❑ South Parkdale
    - ❑ Regent Park
    - ❑ Other
    - ❑ Prefer not to answer
2) How comfortable are you with riding a bicycle?
    - ❑ Very uncomfortable
    - ❑ Somewhat uncomfortable
    - ❑ Somewhat comfortable
    - ❑ Very comfortable
    - ❑ Prefer not to answer
3) Do you have access to/own a bicycle?
    - ❑ Yes- I own/have access to a bicycle
    - ❑ No- I do not have access to/own a bicycle
    - ❑ Prefer not to answer
4) Do you feel that having access to a bicycle would be beneficial to you?
    - ❑ Yes
    - ❑ No
    - ❑ Prefer not to answer
5) Are you familiar with Bikeshare / Bike share Toronto, how it operates and Bikeshare stations close to you?
    - ❑ Yes
    - ❑ No
    - ❑ Prefer not to answer
6) Are you / have you ever been an annual member of Bike Share Toronto?
    - ❑ Yes
    - ❑ No
    - ❑ Prefer not to answer
7) Are there specific barriers stopping you from considering a Bikeshare membership as a transportation option in your regular activity?
    - ❑ Unstable income and costs

- ❑ Costs associated with losing or damaging a bicycle
- ❑ Physical condition or disability inhibiting riding
- ❑ Transportation needs are outside bikeshare service area
- ❑ Traffic concerns and road safety
- ❑ Geography (Steep hills, etc.) and weather concerns
- ❑ Limited ability to use the system spontaneously
- ❑ Other (please specify)

8) Assuming Bike Share stations are located near your residence and in areas you frequently visit, what do you think is an appropriate/affordable yearly fee to access the service?
   - ❑ __(Insert Answer)__
   - ❑ Prefer not to answer
9) Do you have access to (select all applicable)
   - ❑ A credit card
   - ❑ A smart-phone with data access
   - ❑ None
   - ❑ Prefer not to answer
10) If you are interested in accessing a subsidized Bike Share Toronto membership, please provide the following contact information:
   - Name, Contact Information
11) Your age:
   - ❑ 18-28
   - ❑ 28+
   - ❑ Prefer not to answer
12) Your gender
   - ❑ Male
   - ❑ Female
   - ❑ Non-binary
   - ❑ Prefer not to answer
13) Do you identify yourself as one of the following groups?
   - ❑ Indigenous Peoples in Canada (First Nations/Inuit/Metis)
   - ❑ Visible Minority (persons, other than Aboriginal peoples, who are non-Caucasian in race or
   - ❑ non-white in colour.)
   - ❑ Recent Immigrants/ Newcomers (came to Canada since 2011)
   - ❑ Low-Income
   - ❑ No
   - ❑ Prefer not to answer

Appendix F

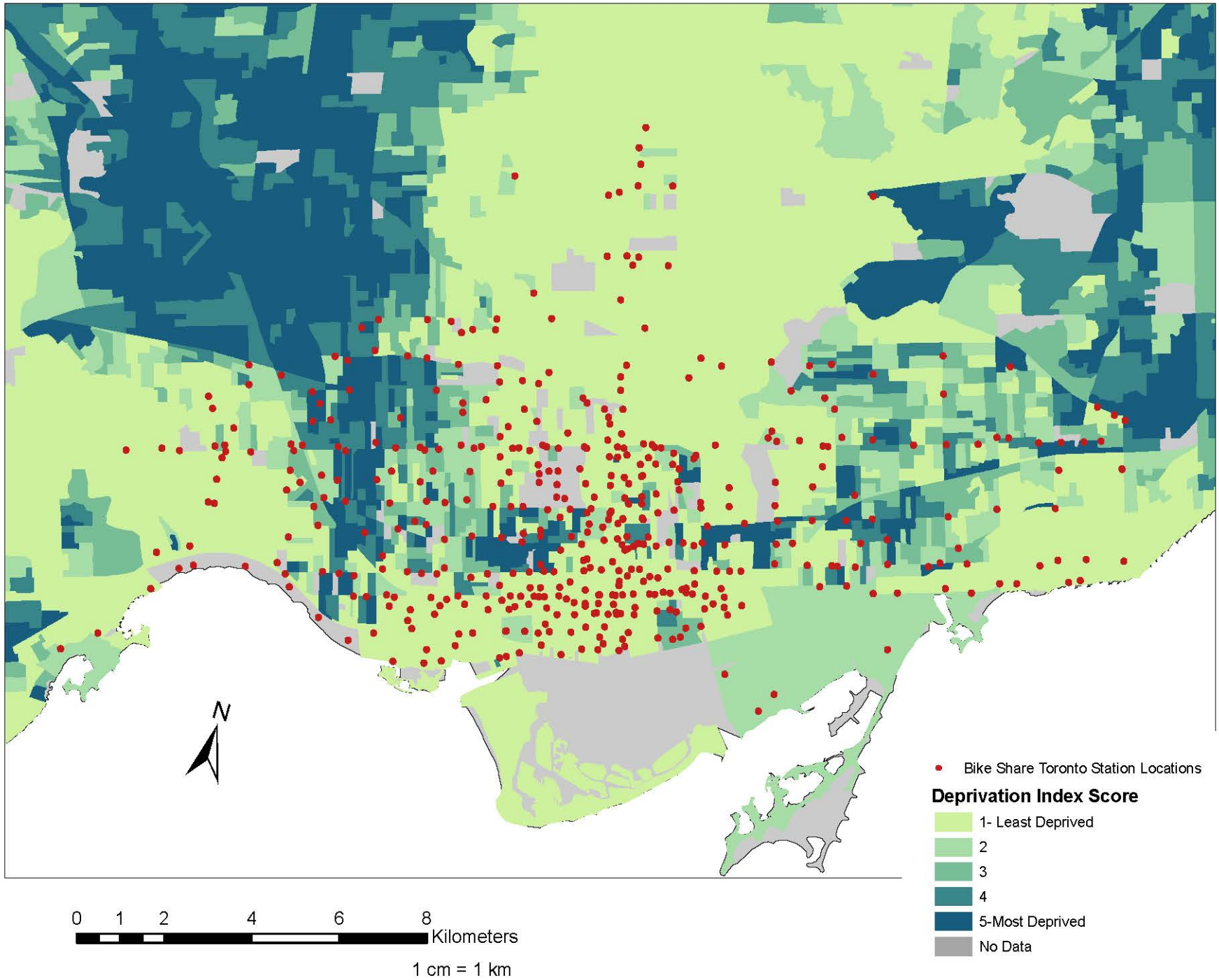
Neighbourhood Equity Index:
Description of Domains of Wellbeing and Indicators
(TSNS 2020 Neighbourhood Equity Index, 2014. p.5-6)

Domains	Indicator	Data Source
Economic Opportunities	**Unemployment** Number of unemployed persons age 15+.	2011 National Household Survey
	Low Income Percentage of persons living below the after-tax low income measure.	2010 T1 Family File, Statistics Canada
	Social Assistance Percentage of persons who are recipients of Ontario Works, persons on ODSP participating in OW employment programs and non-OW persons receiving assistance with medical items.	Toronto Employment & Social Services
Social Development	**High School Graduation** Composite measure of four indicators predicting the rate of youth graduation from high school (2006-2011).	TDSB, TCDSB, 2006 Census
	Marginalization A combined measure of 18 variables representing residential instability, ethnic concentration, dependency and material deprivation.	Ontario Marginalization Index, 2006 Census
	Post-Secondary Completion Percentage of persons age 25-65 with post-secondary certificate, diploma or degree.	2011 National Household Survey
Participation in Decision-Making	**Municipal Voting Rate** Percent of eligible voters who voted in the last municipal election.	Municipal Voting Rate Percent of eligible voters who voted in the last municipal election.
Physical Surroundings	**Community Places** Meeting Average number of meeting places within a 10 min. walking distance measured from each residential block in the neighbourhoods (incl. libraries, recreation facilities, places of worship).	Toronto Open Data

	Walkability A walkability score between 0 (not very walkable) and 100 (very walkable).	Walkscore.com
	Healthy Food Stores The average number of healthier food stores within a 10 minute walking distance from each residential block in a neighbourhood.	Toronto Dinesafe 20134, Toronto Open Data
	Green Space Average amount of green space (incl. parks and public areas) per km2 in a 1 km circular buffer from each residential block in the neighbourhood.	DMTI, University of Toronto
Healthy Lives	**Premature Mortality** Age-adjusted number of deaths under age of 75 per 100,000 population age under 75.	Ontario Mortality Data 2005- 2009, Ontario Ministry of Health and Long-Term Care
	Mental Health Percentage of those age 20+ reporting very good or excellent mental health.	2005-2011 Canadian Community Health Survey
	Preventable Hospitalizations Age and sex adjusted number of ambulatory care sensitive condition hospitalizations per 100,000 population	2009-2011 Discharge Abstracts Database, Canadian Institute for Health Information
	Diabetes Age and sex adjusted number of persons age 20+ with diabetes per 100 population.	Ontario Diabetes Database, Ontario Registered Persons Database, Ontario Ministry of Health and Long-Term Care

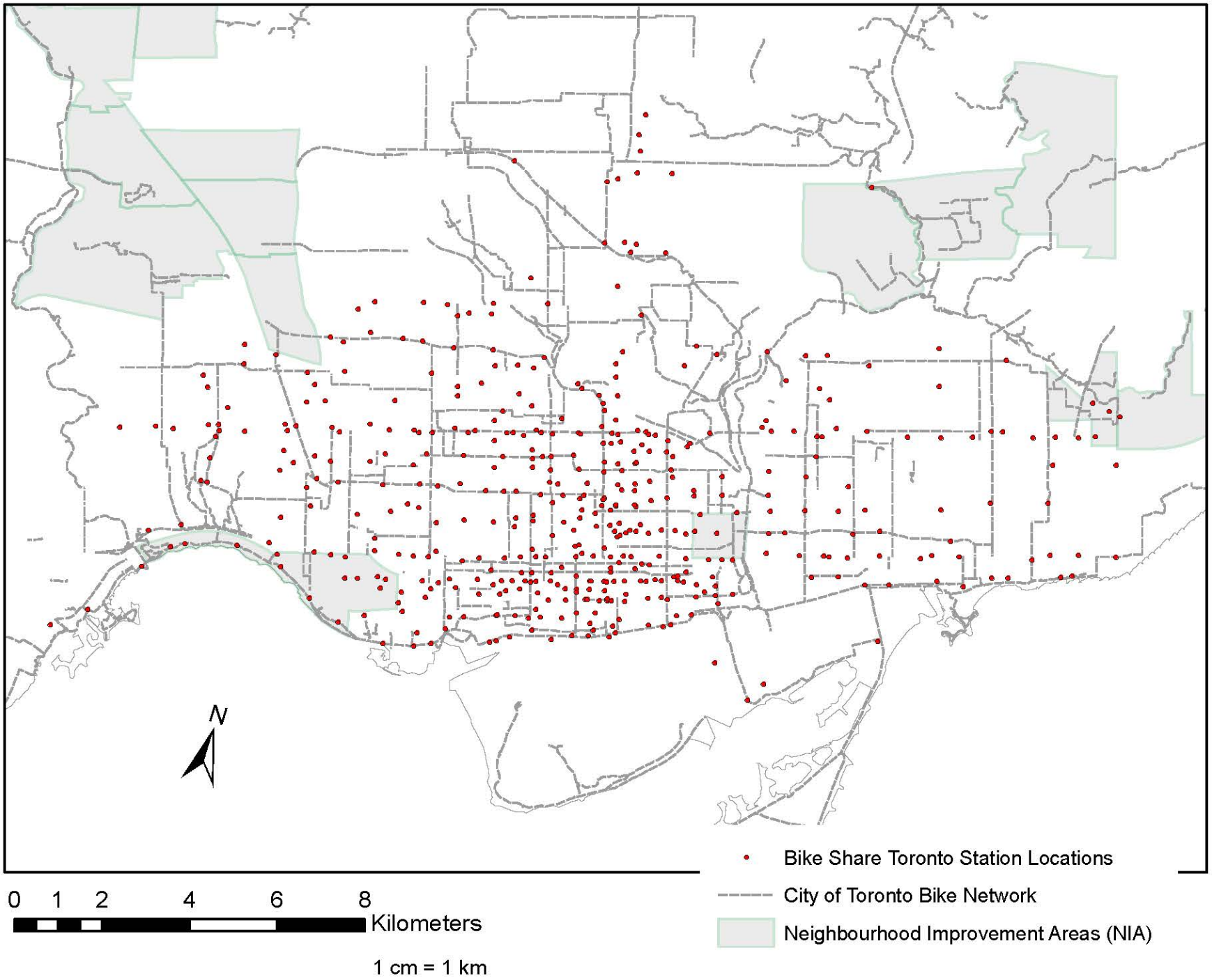
Appendix G

Location of Bike Share Toronto Stations by Pampalon Deprivation Index (PDI) in the City of Toronto (Source: Created by Author)



Appendix H

Location of Bike Share Toronto Stations by Neighborhood Improvement Areas and Bike Lanes (Source: Created by Author)



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