

Sustainability Through Accessibility:  
Evaluating the Accessibility of Toronto's Public Transportation

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## **Abstract**

Public transportation is one of the most sustainable transportation options in terms of greenhouse gasses emitted per rider due to the high capacity of transit vehicles. Resultantly the sustainability of public transportation is dependent on high levels of ridership. Increasing accessibility, particularly through affordability and proximity, may encourage public transit ridership. A document analysis was conducted on sustainability documents published by Metrolinx, and the Toronto Transit Commission to evaluate the degree to which these agencies reflect best practices for sustainable public transportation in these documents. Both affordability and proximity were measured on the basis of total instances and proportional document coverage. Results show that these themes were not prevalent in the documents. Specifically, accessibility was found to be prominent, but through the theme of corporate social responsibility rather than affordability or proximity. Thus, this MRP highlights the need to focus on these themes in future public transit sustainability strategies.

**Key words:** *Affordability, proximity, transit, environment, ridership*

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## Introduction

In the fall of 2018, the Intergovernmental Panel on Climate Change (IPCC) released a special report on global warming of 1.5°C (IPCC, 2018). The report concluded that if global greenhouse gas (GHG) emissions continue to increase at the current rate, global temperatures will warm by 1.5°C in comparison to pre-industrial levels as soon as 2030 (IPCC, 2018). This report adds to the scientific consensus that there is a need for urgent action to reduce greenhouse gas emissions to secure sustainable futures for people and the planet (Rockström et al., 2016).

Among the multitude of mitigation strategies required to curb climate change, public transportation has gained prominence due to its ability to significantly reduce greenhouse gas emissions (Pasha, Rifaat, Tay, & De Barros, 2016). Reducing greenhouse gas emissions from transportation is considered particularly significant due to the industry's high contribution to global emissions, which amount to approximately 23% of total emissions worldwide (Griswold, Sztainer, Lee, Madanat, & Horvath, 2017). Public transportation options remain the most environmentally sustainable out of all motorized transportation options when measured in terms of carbon dioxide emissions per kilometre per person ( $\text{CO}_2$  g/km/person) (Mathez, Manaugh, Chakour, El-Geneidy, & Hatzopoulou, 2013). In particular, busses and trains emit 40  $\text{CO}_2$  g/km/person and 80  $\text{CO}_2$  g/km/person, respectively (Mathez et al., 2013). Single occupancy cars, on the other hand, emit between 180 and 650  $\text{CO}_2$  g/km/person, and single occupancy sport utility vehicles emit between 230 and 770  $\text{CO}_2$  g/km/person (Mathez et al., 2013). Based on these figures, a particularly fuel efficient car would still need to travel at full capacity (i.e. a driver and four passengers) in order to be more environmentally sustainable than taking the bus.

Yet, the need to reduce greenhouse gases requires intensive mitigation actions on all fronts – even those deemed to be environmentally sustainable, including public transportation.

The environmental sustainability of any given public transportation network is closely related to the number of people that utilize the network (Griswold, Cheng, Madanat, & Horvath, 2014). This can largely be attributed to the fact that the amount of fuel required to mobilize people via public transportation is static, and does not change according to ridership. Resultantly, with increases to the number of people utilizing public transportation comes a decrease in the amount of fuel used per person over the same distance, with complete fuel efficiency occurring when a vessel is filled to capacity. Consequently, the GHG emissions produced per person are considerably greater “when vehicles run with ridership significantly below capacity” (Griswold et al., 2014, p. 1). This same principle is applicable to private vehicles as well, as oftentimes commuters opt to carpool in order to mitigate their fuel costs, which in turn limits the amount of GHG emissions produced per rider (Olsson, Maier, & Friman, 2019). Public transportation can thus be made more environmentally sustainable by increasing ridership, thereby ensuring that each vessel’s emission of CO<sup>2</sup> g/km/person is as low as its capacity will permit (Griswold et al., 2014). One critical pathway for increasing ridership (Chakour & Eluru, 2016) as well as retaining existing riders (Chowdhury, Zhai, & Khan, 2016) is through increasing the accessibility of public transportation.

Accessibility can be promoted by ensuring that public transportation services are both affordable and proximal (Karjalainen & Juhola, 2019). While the accessibility of public transit is addressed in an emerging academic literature, most empirical analyses are focused on cities throughout Europe (Audouin, & Finger, 2018; Cats, Susilo, & Reimal, 2017; Heinen, Panter, Dalton, Jones, & Ogilvie, 2015) and Oceania (Liu, Wang, & Xie, 2019; Mavoia, Witten, McCreanor, & O’Sullivan, 2012; Truong, & Somenahalli, 2015). By comparison, relatively few studies have explored the accessibility of public transportation in North American cities and

fewer still within Canada. This major research paper (MRP) will attempt to lessen this gap through an analysis of Toronto, Canada's two transit authorities, namely Metrolinx and the Toronto Transit Commission (TTC).

The purpose of this research was to evaluate the degree to which best practices for accessible public transportation are reflected in Toronto's two public transit authorities' sustainability strategies. A document analysis was conducted in an effort to uncover the efficacy of these transit authorities' efforts at promoting public transportation sustainability, by uncovering if the lessons related to sustainability that are propagated in the academic literature are used in practice in Toronto. To achieve this purpose, this MRP addressed the following research questions:

1. Do the sustainability strategies of Metrolinx and the Toronto Transit Commission (TTC) reflect the proven importance of making services more *accessible* in order to make them more sustainable?
  - a. Is economic accessibility (*affordability*) given importance in the sustainability strategies of Metrolinx and the TTC?
  - b. Is proximal accessibility (*proximity*) given importance in the sustainability strategies of Metrolinx and the TTC?

## Literature Review

The literature on public transportation is characterized by considerable ambiguity concerning the critical variables that influence accessibility (Carleton & Porter, 2018; Carpentieri, Guida, & Masoumi, 2020). In order to maintain a feasible scope therefore, this MRP will focus on affordability and proximity due to the relatively high consensus on the importance of these variables in the literature.

### **Affordability**

Affordability is a critical determinant of public transit accessibility. Karjalainen and Juhola (2019) argue that “accessibility can be measured either spatially or on the basis of individual socio-economic traits” (p. 5). One method of ensuring the affordability of public transportation is by lowering fare prices. However, in order to do so transit authorities oftentimes require technical and financial assistance from higher levels of government, particularly to make transit subsidies feasible (Karjalainen & Juhola, 2019). Scott, George, and Prybutok (2016) note that the price of public transportation services influences attitudes toward public transportation, and high prices will inevitably affect the transportation mode one selects. Further, in a study conducted in the South East Queensland administrative region of Australia, Liu et al. (2019) found that “public transit ridership can be boosted by reducing the fare cost per journey” (p. 78). This was determined by analysing two sets of data on public transportation ridership, with one being publicly collected before the implementation of a new fare policy, and one after (Liu, et al., 2019). Despite the reduction in the cost of fares, revenue was recovered in this scenario due to the higher numbers of trips taken (Liu et al., 2019).

El-Amine, Galland, and Koukam (2018) similarly note that decreasing the overall cost of utilizing public transportation through government subsidies increases ridership. Guzman and

Oviedo (2018) likewise find that public transportation subsidies targeted at low-income households increased ridership in Bogota, Colombia. Lovrić et al. (2016) similarly examine a public transportation policy in Singapore that tested ridership levels at fare discounts of 25%, 50%, 75%, and 100% (the last fare discount making transit free). Although these discounts were tested during off-peak times, there was a marked increase in the number of riders utilizing public transportation with each discount regardless (Lovrić et al., 2016). Discounts of 100% are referred to as fare-free public transportation, which has seen success in bolstering transit ridership (Hess, 2017). Similarly to what Liu et al. (2019) found in the Australian context, Cats et al., (2017) note that in Tallinn, Estonia, fare-free public transportation produced a 14% increase in public transportation use in one year. Regarding the social sustainability of this endeavour, it is also noted that “the mobility of low-income residents has improved” with fare-free public transportation (Cats et al., 2017, p. 1083).

Further, in March 2020 Luxembourg committed to a free public transportation system throughout the entirety of the (small) country, illustrating the perceived efficacy of such policies (Kirby, 2020; Lo, 2020). Though fare-free public transportation can increase transit demand and ridership by extension, Hess (2017) notes that this usually comes “at the expense of walking trips and bicycle trips more than driving trips” (p. 692). This illustrates the importance of ensuring that public transportation outlets are also spatially proximal and accessible through active transportation, in order to circumvent such limitations. As public transportation cost reductions have been shown to bolster ridership in several contexts, it is recommended that governments implement such measures in the interest of sustainability. Despite the reduction in revenue per ride, this policy is nonetheless feasible due to its potential for increasing the total number of rides, thus adhering to economic, social, and environmental sustainability (Liu et al., 2019).

## **Proximity**

In addition to affordability, Karjalainen and Juhola (2019) note that proximity is also an important component of public transportation accessibility. Manifestations of the proximity variable can emerge as either instances of spatial proximity, or active transportation integration (i.e. the ease at which one can walk or cycle to a transit station). Regarding spatial proximity, Daniels and Mulley (2013) assert that spatial access to public transportation influences transit usage. They note that in Sydney, Australia 89% of bus riders access bus stops on foot, while just 11% access them by car, either as a driver or passenger (Daniels & Mulley, 2013). Resultantly, it is imperative for public transportation to be spatially proximal to the homes and workplaces of potential riders, in order to promote usage.

Truong and Somenahalli (2015) similarly find that proximity is important for public transportation and argue that it “is associated with higher public transport use” (p. 153). Brown et al. (2016) corroborate this finding, as they note that proximity and walkability encourage transit usage in Salt Lake City, Utah. In particular, it was found that for every one hundred metres that a potential rider lived from a newly implemented light rail system, there was an 11% reduction in willingness to utilize the service (Brown et al., 2016). Further, Pawlasová (2015) notes that station proximity is among the variables that “are the most important indicators of satisfaction” among transit users (p. 30). Following this point, it is likely that riders will continue utilizing a service that they are satisfied with, indicating that public transportation networks should be optimized to be available within walking distance of as many dwellings as possible. This may also prove to be beneficial for vulnerable populations such as the elderly, which require ample access to public amenities such as health services, which may be facilitated by public transportation (Carpentieri et al., 2020). Carpentieri et al. (2020) note that “proximity is

one of the most influential, if not the most influential, factors affecting accessibility” to such services among the elderly, further illustrating the social need for proximal public transportation (p. 5).

Regarding the active transportation integration component of proximity, Lachapelle and Pinto (2016) report that public transportation use “has been positively associated with active transportation” (p. 173). This is due to the fact that one must arrive at a public transportation outlet before utilizing it, and individuals often begin or conclude these trips through active transportation (Glazener & Kheris, 2019). Those outside of walking or cycling distance may opt to drive to their destination instead. This is referred to as the first and last mile problem in the literature, as “poor local public transport coverage or long walking distances” can deter ridership (Rahat, Ledbetter, Dawn, Byrne, & Everson, 2019, p. 397). For instance, in a study conducted in Melbourne, Australia Boulange et al. (2017) found that the probability that riders walk to a public transportation outlet increases when one lives within 800 metres of a train station, or 400 metres of a bus stop. Also in Melbourne, Saberi, Wu, Amoh-Gyimah, Smith, and Arunachalam (2017) report that private vehicle usage is more prominent in the outer areas of the city, due to the greater distance from public transportation outlets in these areas. Consequently those living closer to the Melbourne City Centre are more likely to cycle, walk, or use public transportation (Saberi et al., 2017).

The likelihood that one utilizes public transportation also increases when there are several transit stops within 400 metres of ones home (Truong & Somenahalli, 2015). Chan and Farber (2019) similarly note that while the 400 metre and 800 metre radii discussed by Boulange et al. (2017) are generally used to indicate proximal accessibility, in practice individuals may walk significantly greater distances. Djurhuus, Hansen, Aadahl, and Glümer (2014) corroborate this

finding in their study on active commuting in Copenhagen, Denmark. Specifically, they consider transit to be accessible on foot if it can be accessed within 1 kilometre from one's home, and accessible by bicycle if it can be accessed within 3 kilometres (Djurhuus et al., 2014). It is found that those living within these radii of transit stops have "significantly higher odds of being an active commuter" (Djurhuus et al., 2014, p. 5). This highlights the fact that the spatial proximity and active transportation integration variables are both critical aspects of proximity in its capacity as a variable denoting accessibility. For instance, Heinen et al. (2015) found that those who reside closer to Cambridgeshire's busway were more likely to utilize this service, and were also more likely to utilize its integrated walking and cycling path. Resultantly it is important to note that by bolstering accessibility to public transportation, transit authorities may simultaneously bolster both social and economic sustainability as well as a result of the variables discussed above.

### **Public Transit Literature and COVID-19**

It is worth bringing attention to the fact that while public transportation draws its strength as a sustainable institution from its ability to transport large numbers of passengers at once, maintaining high ridership rates is problematic in the wake of the COVID-19 pandemic. This is due to the fact that in order to have a significantly higher capacity, and thus emit fewer emissions per rider than private transportation methods, public transportation must fill its vehicles to capacity. In doing so, customers are not awarded the commonly recommended minimum distance of two metres away from other patrons to help prevent the transmission of COVID-19 (Prin & Bartels, 2020). Both transit agencies studied here have seen their ridership decrease, and have also implemented safety measures in response to the pandemic. Specifically, Metrolinx has reported that the COVID-19 pandemic has reduced ridership "by over 90 per cent" (Gray &

Childs, 2020, p. 6). To promote the safety of riders, Metrolinx has committed to implementing measures recommended by the Ontario Ministry of Health, including physical distancing of at least two metres between passengers, utilizing physical barriers between seats, providing alcohol-based hand sanitizer on vehicles, and frequently cleaning surfaces (Aikins, 2020). Similarly, the TTC has reported that ridership is “down 86 percent” (TTC, 2020, p. 1). Similarly to Metrolinx, the TTC has implemented additional safety measures such as plexiglass barriers, frequent disinfecting with hydrogen peroxide, and decals promoting customer awareness for face coverings and physical distancing (TTC, 2020). It is acknowledged that given the current global health crisis, it is not possible to safely fill public transit vehicles to their full capacity. That being said, the research presented here nonetheless presents a starting point for resuming the commitment public transit has to sustainability, when the pandemic is eventually controlled.

## Methods

### Study Site

This MRP focuses on the two main public transportation providers for the city of Toronto: Metrolinx and the Toronto Transit Commission, which are described below. These two agencies are purposefully selected for analysis since they provide the public transportation services for the largest urban centre in Canada, and operate on different scales. This selection, therefore, provides both broad coverage of public transportation across the Greater Toronto Area (GTA) and the opportunity to draw inferences from cross-scalar comparisons.

Metrolinx provides public transportation for the city of Toronto, and the surrounding region commonly referred to as the GTA. As a regional transit body, it connects suburbs and exurban towns to the city centre, thereby providing a sustainable alternative to driving for commuters. The Toronto census metropolitan area, which better represents (albeit not perfectly) the area serviced by Metrolinx stretches west to the town of Oakville, east to the town of Ajax, and north to the shore of Lake Simcoe (Statistics Canada, 2016a). This area houses almost 6 million people, inclusive of the city of Toronto proper (Statistics Canada, 2016a). Approximately 24% of commuters in this area utilize public transit as their main mode of commuting, illustrating the need for sustainable public transportation (Statistics Canada, 2016a). Concerning the ridership of Metrolinx, approximately 1.1 million rides are taken each weekday using this agency's transportation services (Metrolinx, 2018). If this figure is extrapolated to represent an entire calendar year, it may be inferred that approximately 286 million rides are taken during the week throughout this timeframe.

The TTC, on the other hand, is the transportation network that serves the city of Toronto proper, and does not operate outside of Toronto's municipal boundaries. The city of Toronto proper houses approximately 2.7 million people (Statistics Canada, 2016b). Approximately 3

million rides (inclusive of ride transfers) are taken on the TTC's transportation services on a typical weekday (TTC, 2018). Extrapolated to an entire calendar year, approximately 782 million rides are taken during the week throughout this timeframe.

### **Data Collection & Analysis**

In order to analyse the accessibility of Toronto's public transportation, a document analysis was conducted (Bowen, 2009). The document analysis covered the most current publicly available document, relevant to sustainability, for both Metrolinx and the TTC. In order to evaluate the efficacy of Metrolinx's sustainability planning, the *Metrolinx Sustainability Strategy: 2015-2020*, (Metrolinx, n.d.) was analysed, as this document outlines how the agency will adapt its services to become more sustainable. Due to the fact that this strategy is nearing its end date, it is likely that a new plan will be implemented relatively shortly. Thus, it is important to analyse the efficacy of this document, to uncover whether or not changes need to be made in the next iteration of the agency's sustainability strategy. Additionally, this document is publicly available on Metrolinx's website, which facilitates its capacity to be evaluated by both scholars and the public alike.

Document analysis was also conducted on a document that is similar in scope published by the TTC. Since the TTC delivers Toronto's intra-city public transportation, the agency's sustainability strategy should provide a valuable comparison to contrast with Metrolinx's sustainability performance. The agency's latest publicly available sustainability document is the *TTC Sustainability Report 2013*, (TTC, 2013) and is likewise available on the agency's website. While some time has passed since this report was published, it may nonetheless provide a comparative case from which to draw inferences (TTC, 2013). Further, the fact that a seven-year-old report is the most recent iteration of the TTC's sustainability plan that is publicly

available perhaps also speaks to the efficacy of the TTC's relationship with sustainable transportation.

The qualitative coding software *NVivo* was used in order to conduct this analysis. The process by which this document analysis was completed was guided by Bowen's (2009) conception of this qualitative research method. As such, both deductive and inductive coding methods were utilized in this document analysis, which is considered to be an iterative process (Bowen, 2009). Specifically, the first interaction with these documents was a straightforward read through, in order gain a rudimentary, yet thorough understanding of each text. This first interaction with the text is generally superficial, in that the researcher's goal is to gain a level of familiarity prior to coding (Bowen, 2009). The initial read through is intended to elucidate how the themes that are hypothesized to be prominent in the texts are represented in terms of wording and phrasing. This sort of content analysis that "entails a first-pass document review" is intended to yield "meaningful and relevant passages of text or other data" (Bowen, 2009, p. 32). Once a basic familiarity with each text had been achieved to a satisfactory extent, a round of deductive coding then commenced.

Deductive coding involves applying the researcher's hypothesized themes to the text, in order to uncover the extent to which those themes are represented in reality. The codes that were used for this initial round of deductive coding are the variables that were found to impact accessibility of public transportation in the academic literature, namely *affordability* and *proximity* (which is inclusive of spatial proximity and active transportation integration). In doing so, it may be uncovered whether or not the sustainability measures of Metrolinx and the TTC are in part focused on accessibility, and are thus consistent with best practices for accessible public

transportation based on the literature review. Further, this allows for comparison between Metrolinx's sustainability measures and those of the TTC.

After the initial round of deductive coding, a round of inductive coding was also performed, in order to uncover any other significant measures that each agency takes to become more sustainable through increasing accessibility. Inverse to deductive coding, inductive coding involves the identification of emergent themes in the text that were not initially anticipated by the researcher as potential themes. As such, these themes may not be directly related to the research questions, though such themes provide valuable insight about the nature of the text nonetheless. Bowen (2009) identifies this approach as a thematic analysis, through which the researcher engages in "pattern recognition within the data" and constructs categories "based on the data's characteristics, to uncover themes pertinent to a phenomenon" (p. 32). In doing so, themes other than those related to accessibility were identified as potentially important to Metrolinx and the TTC in the first round of inductive coding. As such, themes unrelated to accessibility will not be excluded from this study. Afterward in a second round of inductive coding, these identified themes were re-categorized in order to more accurately reflect the nature of the documents, in alignment with the iterative nature of document analysis (Bowen, 2009). Resultantly, the themes utilized in the final round of coding were the most reflective of the documents at large, as they were developed after several read-throughs.

Multiple new themes were identified in the initial round of inductive coding. Specifically, four main themes were identified, and six subthemes were identified, in addition to affordability and proximity, which were both re-categorized as subthemes. The first main theme was called *accessibility by*, meaning the coverage that public transportation provides to areas of the region serviced. The second was called *accessibility of* in reference to how accessible the transit

agency's services and infrastructure are to riders. This included the subthemes of access for those with disabilities, as well as affordability and community stakeholder engagement. The third main theme was *accessibility to*, or the ease with which one could utilize public transportation from their journey's origin. A single subtheme was evaluated to be within this sphere, namely proximity. The fourth main theme was simply named other, and included the subthemes of environmental stewardship, continuous improvement, accountability, and self-evaluation. These themes and subthemes are displayed in Table 1 below on page 15.

As expected, a large contingent of these themes were related to accessibility, despite the fact that the purpose of each planning document was to provide an overview of the sustainable practices each respective agency has and will undertake. This highlights the connection between accessibility and sustainability in the realm of public transportation. After completion of the initial round of inductive coding described above, it became clear that the themes and subthemes used could be better organized to reflect the themes of the documents with more accuracy. As such, the themes and subthemes were re-organized at this point (with some being omitted or combined with others) to better reflect the most prominent emergent themes. The finalized themes utilized in this analysis are discussed in the subsequent section.

**Table 1.** Emergent accessibility related themes from the second round of qualitative coding of the Metrolinx and TTC sustainability documents. These codes were further adapted and finalized in the third round of coding (see Table 2). An asterisk (\*) indicates the two original themes identified in the literature review.

<b>Second Round of Coding (Inductive) Themes and Subthemes</b>	
<b>Themes</b>	<b>Subthemes</b>
<b>Accessibility by</b>	<b>N/A</b>
<b>Accessibility of</b>	<ul style="list-style-type: none"> <li>• <b>Access for those with disabilities</b></li> <li>• <b>Affordability*</b></li> <li>• <b>Community stakeholder engagement</b></li> </ul>
<b>Accessibility to</b>	<ul style="list-style-type: none"> <li>• <b>Proximity*</b></li> </ul>
<b>Other</b>	<ul style="list-style-type: none"> <li>• <b>Environmental stewardship</b></li> <li>• <b>Continuous improvement</b></li> <li>• <b>Accountability</b></li> <li>• <b>Self-evaluation</b></li> </ul>

## Findings

Through the coding process, three key accessibility-related themes were identified in the sustainability documents of Toronto’s two public transit authorities, Metrolinx and the TTC. These themes include: 1) accessibility of public transit services, 2) spatial accessibility to public transit, and 3) corporate social responsibility (Table 2). This section begins by presenting each theme, its associated subthemes, and illustrative quotations from the documents’ analysed. Next, the frequency and proportional coverage of the key themes and subthemes is presented. It is worth noting that each phrase that was identified for a subtheme was also categorized as the corresponding main theme. Other data points, however, are only recognized as part of one of the main themes, as these data were found to be in line with the overarching theme, but not with any of the subthemes associated with said overarching theme. In addition, any given phrase was coded to as many or as few themes and subthemes as was thematically appropriate.

**Table 2.** Key accessibility related themes coded in sustainability documents from Toronto’s two public transportation authorities. Themes were derived through document analysis, which involved qualitative coding of Metrolinx and TTC sustainability documents. An asterisk (\*) indicates the two original themes identified in the literature review.

<b>Third and Final Round of Coding (Inductive) Themes and Subthemes</b>	
<b>Theme</b>	<b>Subthemes</b>
<b>Accessibility of Public Transit Services</b>	<ul style="list-style-type: none"> <li>• <b>Access for those with disabilities</b></li> <li>• <b>Affordability*</b></li> <li>• <b>Service Extensions</b></li> </ul>
<b>Spatial Access to Public Transit</b>	<ul style="list-style-type: none"> <li>• <b>Accessibility to (origin access)</b></li> <li>• <b>Accessibility by (destination access)</b></li> <li>• <b>Proximity*</b></li> </ul>
<b>Corporate Social Responsibility</b>	<ul style="list-style-type: none"> <li>• <b>Environmental Stewardship</b></li> <li>• <b>Stakeholder Engagement</b></li> <li>• <b>Accountability and Transparency</b></li> <li>• <b>Self Evaluation</b></li> <li>• <b>Statistical Improvement</b></li> </ul>

## **Accessibility of Public Transit Services**

Accessibility of services emerged as a key accessibility-related theme in the sustainability strategies of Toronto's two transit authorities. This conception of accessibility appeared in both documents, and refers to the notion that accessibility can be measured by the ease at which all prospective riders can utilize public transit services. According to Steinfeld et al. (2012) "the term 'services,' in the context of accessible transportation is generally meant to include traditional operational issues" such as elevators, bus ramps, vehicle punctuality, effective fare policies, fare machines, and customer services such as boarding assistance and the provision of information (p. 1). Resultantly, this theme encompasses a variety of subthemes that relate to ensuring equal and reliable access for all patrons in issues related to transit operations including: i) access for those with disabilities, ii) affordability, and iii) service extensions.

The first subtheme, access for those with disabilities, is vital to ensure that that riders with disabilities can safely and effectively utilize public transportation (D'Souza, Paquet, Lenker, & Steinfeld, 2019). For instance, auditory announcements stating station stops are necessary for many visually impaired people to utilize public transit, and thus fit within this subtheme (Kim & Sohn, 2020). Speaking to the importance of providing access to those with disabilities, the TTC sustainability strategy states that "[w]heel-Trans and Community Bus represent divisions of the TTC that are responsible for door to door accessible transit for people with physical mobility limitations and for those with some difficulty accessing the conventional transit system respectively" (TTC, 2013, p. 36). Similarly, Metrolinx's sustainability strategy states that "the benefits and challenges of developing and operating public transportation affect everyone – passengers, residents, businesses, students, seniors, persons with disabilities, and

many more” illustrating the agency’s commitment to providing adequate access for those with disabilities (Metrolinx, n.d., p. 24).

The subtheme of affordability, which was identified through the literature review, also emerged as a subtheme within accessibility of services, due to the fact that the more affordable a service is, the more equally accessible it is. As such, mentions of transit subsidies are included here as well. Many references are made to making the Greater Toronto Area more prosperous as a region. These phrases were coded to represent the affordability subtheme, as part of the intent of such statements is to allow riders to increase their level of prosperity, thereby allowing them to comfortably take transit. Additionally, if the region’s economic performance improves, it may be better equipped to deliver better transit services through subsidies, and increased service levels. The affordability subtheme is evident in phrases such as: “public transit represents the fastest and most cost-effective way to move around Toronto” (TTC, 2013, p. 8) and “[t]his is to be incorporated into RFP Schedule 3, ‘RFP responses regarding Technical, Financial, Affordability, Scope, and submittal format’ by 2015” (Metrolinx, n.d., p. 31). As such, affordability is often mentioned in the context of operational goals and plans.

The final subtheme to emerge under the theme of accessibility of public transit services was service extensions, which refers to any other action taken to facilitate access for more patrons through transit operations, such as the construction of new lines, and posting adequate signage. Among the phrases that speak to the important of service extensions, the TTC document notes that “the accessibility of the TTC’s conventional transit services has been improved through numerous initiatives, including elevator construction, designated waiting areas, tactile edges on subway platforms, low-floor accessible buses, and modern subway trains” (TTC, 2013, p. 28). In a similar light, Metrolinx states that “[the organization] is embarking upon the largest

transportation infrastructure and service expansion initiative in North America: GO RER” (Metrolinx, n.d., p. 18). It is worth noting that while these quotes speak to each corresponding subtheme, they differ in the sort of information conveyed, highlighting the possibility of each document having a different goal or intended audience despite similar perspectives or content related to the accessibility of services.

### **Spatial Accessibility to Public Transit**

Riders’ access to public transit from their journey’s origin, and the access or lack thereof, to the destination at which they wish to arrive is a critical component of accessible public transportation. This sort of spatial accessibility to transit emerged as one of three key themes through inductive coding. This theme is inclusive of text describing any and all policies and operations that bolster a rider’s ability to access public transit from their journey’s origin, and in getting to their destination. While this concept is notably related to the proposed variable of proximity, spatial accessibility is inclusive of both origin and destination, while proximity is more broadly conceived as the distance one must travel to generally access public transit. Thus, proximity was reclassified as a subtheme under the broader theme of spatial accessibility. In some cases, spatial accessibility was clearly indicated in a capacity related to either access from the origin of one’s journey, or access to the place that one wishes to arrive at. With no reference to proximity in such cases, there was a need for this distinction in classification. Resultantly, the three subthemes enclosed within the theme of spatial access are i) access to, ii) access by, and iii) proximity.

It is noted that the subthemes of access to and access by are tightly interwoven with one another, as the former denotes access to the transit network from the origin of one’s journey, and the latter denotes access to other areas of the region utilizing the transit network. Several

mentions of one came with a mention of the other, either explicitly or implicitly. Regarding access to, the TTC document states that their network “includes buses, streetcars, subways, Intermediate Capacity Transit (Scarborough RT Line) and special access vehicles which provide door-to-door services, for those challenged by mobility, known as Wheel-Trans” (TTC, 2013, p. 7). Within the Metrolinx document, similar phrases mentioning network coverage and projects (such as GO Regional Express Rail) are found. Specifically, it is noted that “GO Regional Express Rail (GO RER) is a \$13.5 billion project that will introduce two-way, all day service and electrification of core areas of our rail network” (p. 16). As such, this theme is largely represented by phrases stating how specific projects affect spatial access.

The *access by* subtheme follows a similar pattern, in that it manifests through statements relating to network coverage over Toronto and the Greater Toronto Area. For instance, the TTC document notes that the York-Spadina “subway line will help manage traffic congestion and ease commute times for all travellers and help create a seamless transit network across the Greater Toronto and Hamilton Area” (TTC, 2013, p. 59). Regarding Metrolinx, it is mentioned that the GO Transit Customer Service Strategy “[o]utlines GO Transit’s strategic priorities for 2016-2019 that will help GO Transit maintain its focus on being a customer-first regional transit service while integrating with service across the GTHA” (Metrolinx, n.d., p. 27). Collectively, these quotations and those mentioned in the above paragraph on the *access to* subtheme illustrate the interconnectivity of these two themes. However, the *access to* theme is more represented by phrases related to current network connections, contrasting the *access by* phrases, which give greater attention to planning and goal setting.

The proximity theme on the other hand did not frequently mirror another code. Like the other subthemes of spatial access to public transit however, phrases denoting proximity often did

so implicitly rather than explicitly. For instance, regarding TTC's community engagement, the TTC document states that the organization's "proactive engagement often lead to improved safety and access for pedestrians" (TTC, 2013, p. 47). While the phrase does not specifically communicate the importance of proximity, it nonetheless states that the TTC is committed to providing access for pedestrians, which must be within walking distance to access the service. The Metrolinx document similarly assures the reader that the organization "provide[s] access to car and bike share services at many of [their] stations," the latter of which again implies proximal access (Metrolinx, n.d., p. 7). While these quotes are implicitly about proximity rather than explicitly, this may be attributed to the low number of mentions for this subtheme in the text of each document. Proximity in both documents is represented in greater volume through pictures and other graphics. Collectively, these quotes represent the theme of spatial access to public transportation.

### **Corporate Social Responsibility**

A final key theme that was present in the sustainability strategy of both Metrolinx and the TTC is corporate social responsibility. It is worth noting that the original focus of this MRP did not encompass this theme, and instead focused on accessibility as a pathway to sustainability. However, the document analysis revealed that most direct commitments to sustainability that are external to accessibility (e.g. emissions reductions, conservation efforts) were found to be common in each document. While accessibility is an important component of public transportation, evaluating sustainability is the ultimate goal of this research. As such, the subthemes related to corporate social responsibility account for the aspects of sustainability that are unrelated to accessibility, in an effort to ensure all efforts toward sustainability taken by the transit agencies are accounted for.

In a study on corporate social responsibility of a public transit provider in Taiwan, Chang and Yeh (2017) define this concept as “the commitment of business to contribute to consumer wellbeing, employee wellbeing, community engagement and environmental issues” (p. 39). Several similar themes emerged in each of the documents analysed. Specifically, it is apparent that both agencies are committed to i) environmental stewardship, ii) engaging internal and external stakeholders for their input, iii) accountability and transparency, iv) self-evaluating current performance, and v) supporting employees and customers by statistically improving performance. As such, each of these components has been made a subtheme, contained within the overarching theme of corporate social responsibility.

Environmental stewardship is one of the main components of each transit agency’s apparent commitment to corporate social responsibility. For each agency, this subtheme most commonly manifested through phrases displaying efforts made to improve organizational environmental sustainability. For instance, the TTC document states that regarding the natural environment, the organization’s “goal is to minimize [its] impacts on air, water and land while maximizing mobility in Toronto” (TTC, 2013, p. 39). This represents a commitment to cause as little environmental disruption as possible, while still maintaining adequate service levels. Some of the efforts taken by Metrolinx are within this scope as well, though this organization also demonstrates commitment to the conservation of species. It is mentioned that Metrolinx works to “identify and implement opportunities to support and enhance biodiversity conservation efforts to meet or exceed applicable legislation and guidelines” (Metrolinx, n.d., p. 23). As such, it is apparent that these transit agencies actively acknowledge their environmental impacts, and are committed to mitigation efforts as a result.

Stakeholder engagement was another subtheme that emerged throughout the coding process. While it had originally been referred to as *community* stakeholder engagement, it has been broadened to reflect the variety of stakeholders that the documents refer to. The TTC document specifically points to both internal and external stakeholders, stating that the “report conveys [the TTC’s] journey to sustainable development to our key stakeholders: customers, communities and employees” (TTC, 2013, p. 10). While the TTC notes that the report is intended to relay information to stakeholders, Metrolinx notes that they have engaged different stakeholders in their document’s creation. Specifically, Metrolinx “[has] engaged internal and external stakeholders to assess and prioritize the sustainability areas on which [the agency] will focus” (Metrolinx, n.d., p. 2). Thus it is clear that in line with each agency’s commitment to corporate social responsibility, each agency values deliberation in their policies and processes.

As such, the stakeholder engagement subtheme is closely tied to the accountability and transparency subtheme. This stems from the fact that one cannot claim to be accountable and transparent without internal and external observers. The TTC document notes that the agency aspires to be “an organization that is transparent and accountable, well-regarded by stakeholders and peers, in which employees are proud to play a part” (TTC, 2013, p. 9). The commitment to accountability and transparency displayed by Metrolinx similarly makes reference to stakeholders. In specific, it is noted that the Metrolinx sustainability “strategy serves not only as a statement of [the agency’s] commitment but also as a framework for decision-making and a tool of accountability for our stakeholders” (Metrolinx, n.d., p. 8). While these quotes illustrate the connection between this subtheme and that of stakeholder engagement, they are considered separate themes due to the prevalence of the stakeholder engagement subtheme absent of the accountability and transparency subtheme.

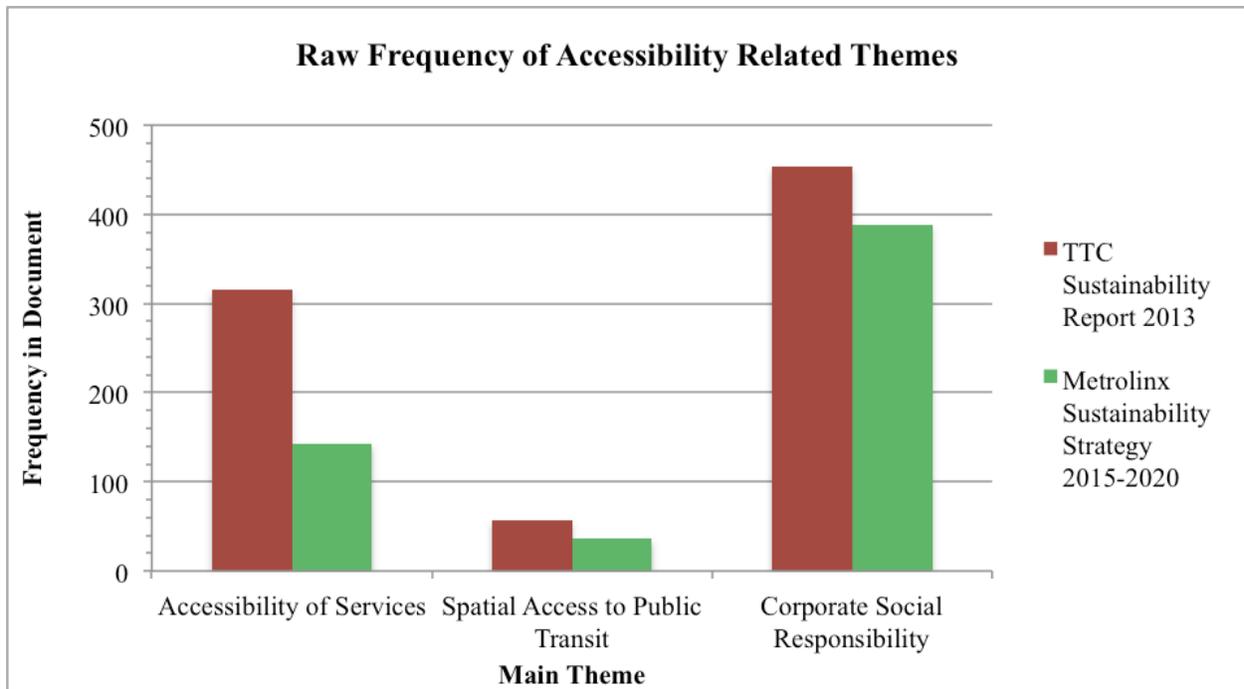
The self-evaluation subtheme primarily manifested as statements of how each agency is measuring and ensuring their success with respect to their sustainability plans, which are expectedly connected to the environmental stewardship theme. The TTC makes reference to a specific branch of the organization, the Strategy and Customer Experience Group, as the body responsible for measuring success. In particular, it is mentioned that “the group will review, via market research, what was actually achieved and thereby create a cycle of continuous improvement” (TTC, 2013, p. 17). Metrolinx attributes this same function to the organization at large, and notes that “[the agency] will adopt processes, programs, and technologies that allow [Metrolinx] to effectively track, monitor, and reduce [its] energy consumption, and carbon and air emissions” (Metrolinx, n.d., p. 16). As such, each agency plans to take different actions, though they each consider the importance of self-evaluation to achieve their goals.

The statistical improvement subtheme mainly consisted of statements reporting quantitative improvements that were made prior to the publishing of the report, or numeric goals for future improvement. While the self-evaluation theme was more qualitative in terms of goal setting, the statistical improvement theme is strictly quantitative. For instance, the TTC notes that “through [the agency’s] commitment to safety, [the TTC has] seen the employee lost time injury incident rate consistently fall from 2007 to 2013, with a drop of 4% from 2012 to 2013” (TTC, 2013, p. 36). In a capacity related to future improvement rather than past, Metrolinx reports that the organization plans to “achieve 20% reduction in total CAC per revenue seat km by 2020” (Metrolinx, n.d., p. 17). Again, quotes such as this demonstrate the interconnectedness that subthemes within corporate social responsibility have with environmental stewardship. Collectively, all of these quotations illustrate a commitment to the recurrent theme of corporate social responsibility.

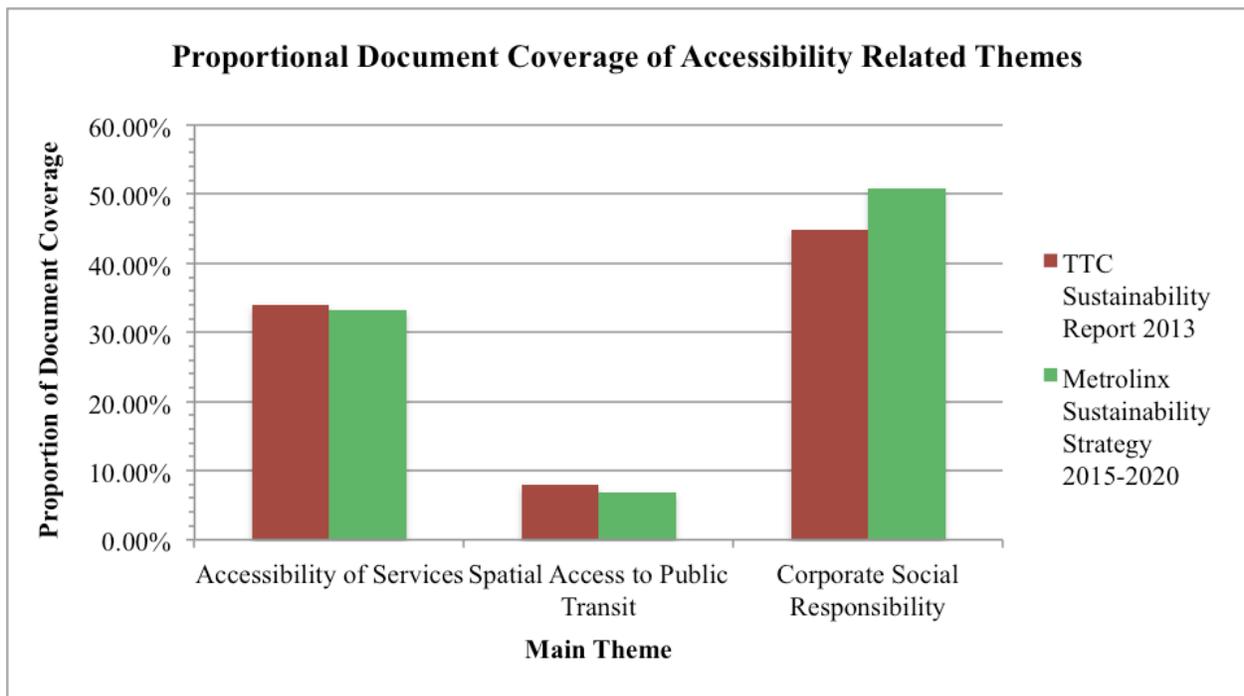
## **Frequency and Proportional Coverage**

A total of 3,293 instances of the stated themes and subthemes were identified throughout the final round of the document analysis, from which the following findings have been drawn. Of this figure, the Metrolinx Sustainability Strategy 2015 - 2020 (Metrolinx, n.d.) contains 1,309 of the data points, and the TTC Sustainability Report 2013 (TTC, 2013) contains 1,984 of the data points. As the document published by Metrolinx is 37 pages total inclusive of front and back matter, the density of themes and subthemes for this document is measured at 35.4 per page. The document published by the TTC is 72 pages in length inclusive of front and back matter, making the density of themes and subthemes for this document is measured at 27.6 per page. As such, the Metrolinx document had more thematically relevant information per page (i.e. approximately 7.8 themes and subthemes more per page) than the TTC document, though it was roughly only half the total length. The following section evaluates each document in terms of raw total instances of main themes and subthemes recorded, with the former displayed in Figure 1 below on page 26.

However, raw totals do not account for the difference in length of these documents. In addition to these raw totals therefore, each theme and subtheme is evaluated on the basis of the proportion of information in the document it covers, as displayed in Figure 2 below on page 26. Due to the varying length of each phrase that has been coded, two separate themes or subthemes may have the same number of instances in a document, but still have slightly different proportional coverage due to varying lengths among phrases coded. As such, each of these metrics will be taken into account when making internal comparisons. Due to the varying lengths of the documents studied, the proportional coverage metric will be given precedence when making comparisons between the documents.



**Figure 1.** Raw frequency of the three key main themes coded in Toronto’s two transit authorities’ sustainability documents.



**Figure 2.** Proportional document coverage of the three key main themes coded in Toronto’s two transit authorities’ sustainability documents.

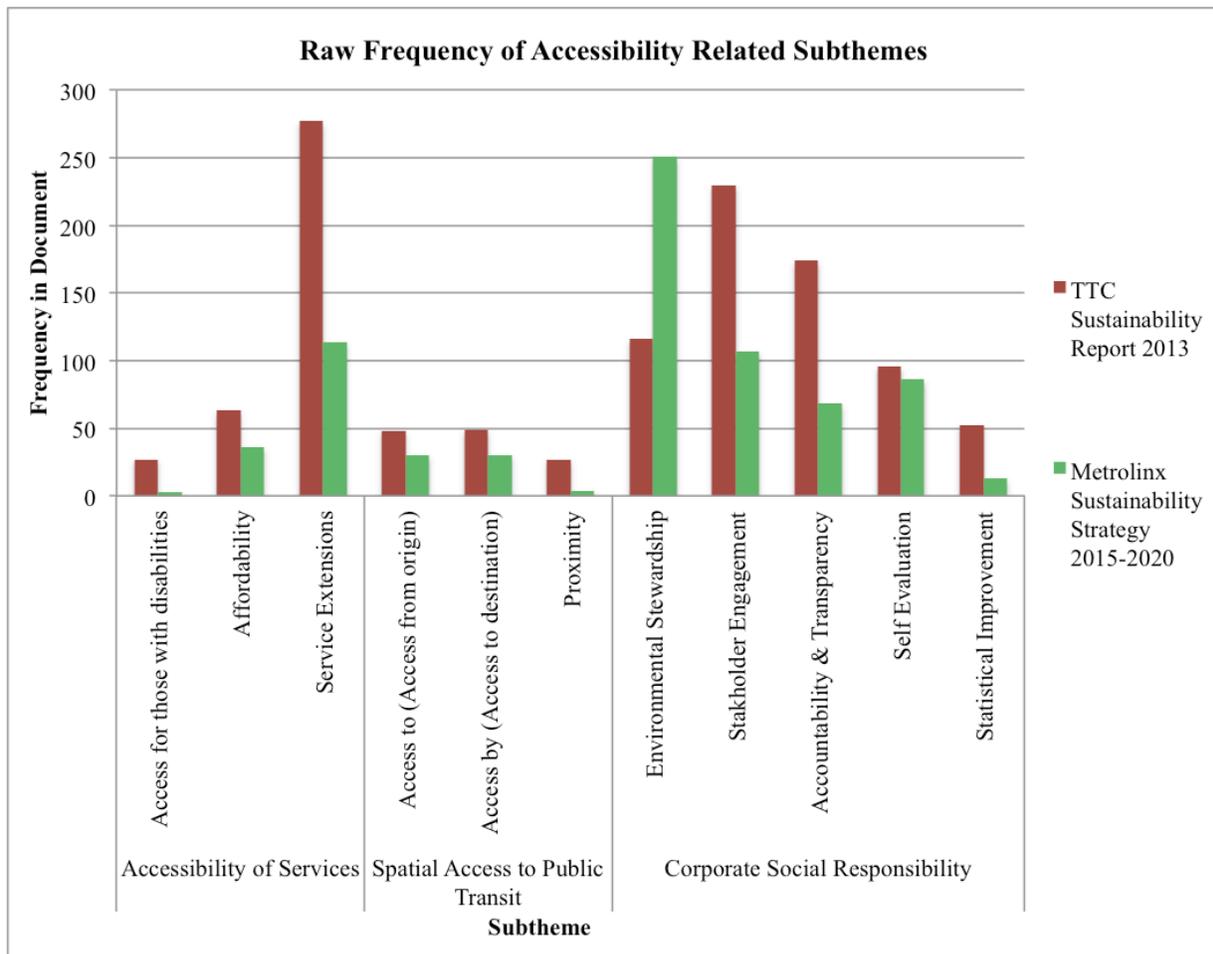
### ***Accessibility of Public Transit Services***

The Metrolinx Sustainability Strategy 2015-2020 (Metrolinx, n.d.) and the TTC Sustainability Report 2013 (TTC, 2013) have comparable levels of document coverage for the accessibility of services theme. In specific, it was found that the Metrolinx document (n.d.) has a total of 143 instances of this theme, amounting to 33.26% coverage of the document. Similarly the TTC document has a total of 315 instances of this theme, amounting to 34.07% coverage of the document. Regarding the inductive subthemes associated with accessibility of services, namely access for those with disabilities, and service extensions, the two documents are again proportionally similar. In particular, there were 3 instances of access for those with disabilities within the Metrolinx document (n.d.) representing 0.94% coverage, with the TTC document (2013) containing 27 instances representing 3.53% coverage. The service extensions subtheme is represented by 114 instances in the Metrolinx document (n.d.) amounting to 28.36% coverage, whereas the TTC document (2013) contains 277 instances of this subtheme, amounting to 31.23% coverage. It is worth noting that as illustrated in Figure 3 below on page 28, the service extensions subtheme is the most prominent subtheme within the TTC document (2013). The final subtheme for this theme is affordability, which will be elaborated upon at the end of this section.

### ***Spatial Access to Public Transit***

Out of the three main themes identified throughout the text, the spatial access to public transit theme is by far the least prominent, and is eclipsed in both raw totals and proportionally by several subthemes within the other overarching themes mentioned prior. In the TTC document (2013) this theme has 57 instances, amounting to 7.97% of the text, and in the Metrolinx document (n.d.) it has 36 instances, covering 6.82% of the text. At the same time, the set of subthemes that correspond with this theme are the most consistent between documents,

though they are still among the lowest subthemes measured. The access by (or access to destination) subtheme has 49 instances throughout the TTC document (2013) amounting to 6.70% coverage, and the Metrolinx document (n.d.) has 30 instances representing 6.14% coverage. Due to the similar nature that the access to (or access from origin) subtheme has to the access by subtheme (especially in visual data such as pictures) its figures are similar. In particular, the access to subtheme has 48 instances in the TTC document, (2013) with 6.64% coverage of the document. In the Metrolinx document (n.d.) there are 30 instances of this subtheme, amounting to 5.93% of the document. The final subtheme for this theme is proximity, which is elaborated upon at the end of this section along with affordability, the other deductive subtheme.



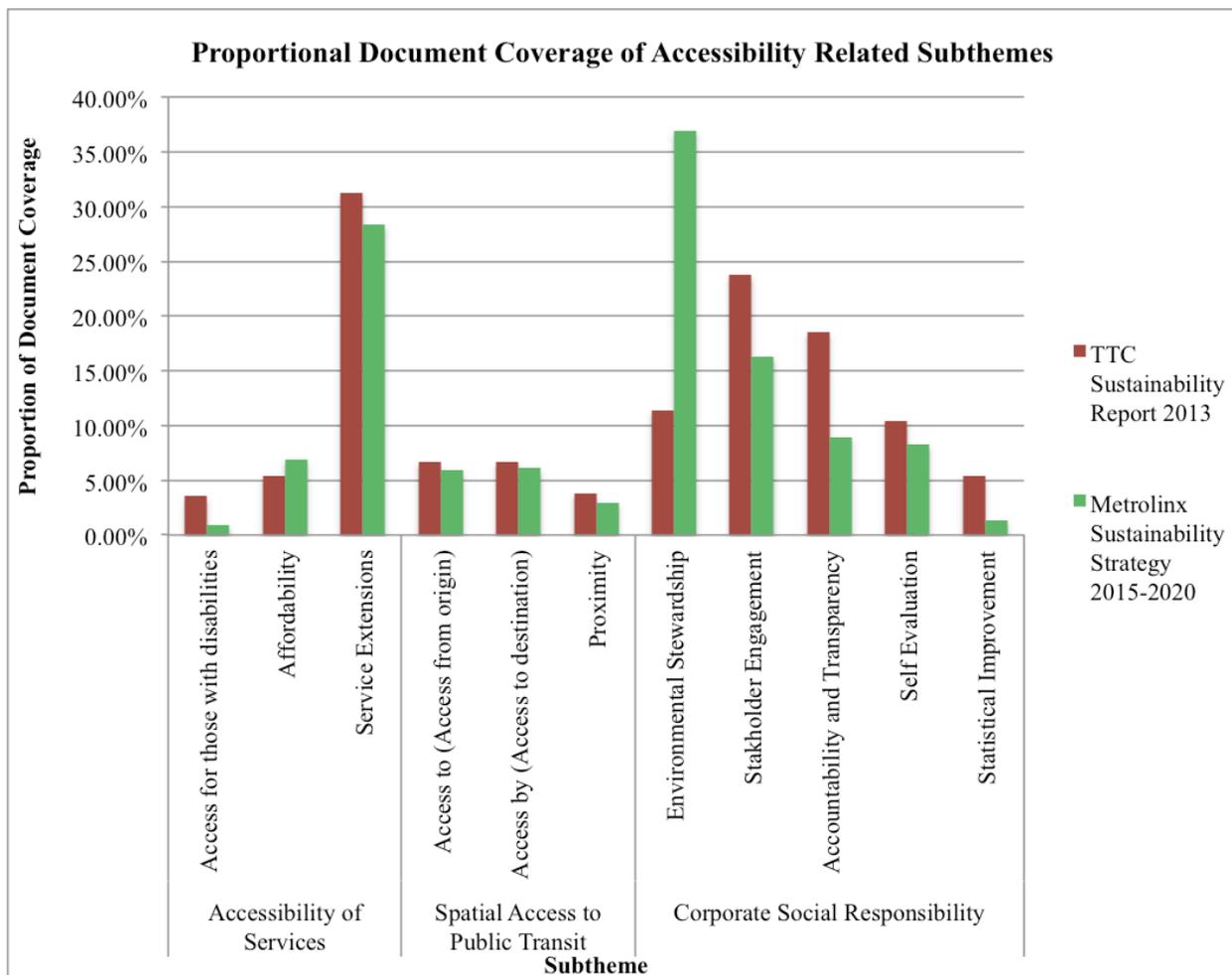
**Figure 3.** Raw frequency of the eleven subthemes within the three overarching themes coded in Toronto’s two transit authorities’ sustainability documents.

### ***Corporate Social Responsibility***

The corporate social responsibility theme was by far the most representative theme throughout either document. Within the Metrolinx Sustainability Strategy 2015-2020 (n.d.) there were 388 instances of the corporate social responsibility theme, representing 50.92% of the document. This is the only theme or subtheme that is present in a majority of either of the documents' text and accompanying graphics. While representation of corporate social responsibility within the TTC Sustainability Report (2013) is also substantial, it does not eclipse a majority of the text, but rather is represented by 453 instances of this theme covering 44.79% of the text. Regarding environmental stewardship, the Metrolinx document (n.d.) far outclasses that of the TTC (2013), as the former contains 251 instances of this subtheme, while the former only contains 116, despite being roughly twice the length. In terms of proportional coverage, environmental stewardship covers 36.92% of the Metrolinx document, (n.d.) while this subtheme represents 11.41% of the TTC document (2013). Just as service extensions is the most prominent subtheme in either document in terms of raw totals, environmental stewardship is the most prominent subtheme across either document in terms of proportion of coverage, as illustrated in Figure 4 below on page 30.

The two documents also differ in their proportional representation of stakeholder engagement, though not to the same degree as they do in the aforementioned subthemes. In specific, the TTC document (2013) contains 230 instances of the stakeholder engagement subtheme, amounting to 23.81% coverage, whereas the Metrolinx document contains 107 instances, covering 16.32% of the document. The subtheme of accountability and transparency is more prominent in the TTC document (2013), which contains 174 instances of this subtheme, covering 18.56% of the document. Meanwhile the Metrolinx document (n.d.) contains 68

instances of accountability and transparency, amounting to 8.92% total coverage. As displayed in Table 3 below on page 31, the self evaluation subtheme was relatively even between the two documents, proportionally speaking. In particular, the TTC document (2013) was found to have 96 instances of this subtheme, covering 10.38% of the document, with the Metrolinx document (n.d.) containing 86 instances of this code representing 8.26% of the document. The two documents have a noticeable representational gap in their proportional coverage of the statistical improvement subtheme. While the TTC document (2013) contains 52 instances of the statistical improvement subtheme, covering 5.42% of the document, the Metrolinx document (n.d.) has just 13 instances of this subtheme, covering 1.38% of the document.



**Figure 4.** Proportional document coverage of the eleven subthemes within the three overarching themes coded in Toronto’s two transit authorities’ sustainability documents.

**Table 3.** Total instances and proportional document coverage of each theme/subtheme in the sustainability documents of Metrolinx and the TTC. In the leftmost column, themes are displayed in boldface, while subthemes are not.

Theme/Subtheme	Metrolinx Sustainability Strategy 2015 - 2020		TTC Sustainability Report 2013	
	Total Instances	Document Coverage	Total Instances	Document Coverage
<b>Accessibility of Services</b>	143	33.26%	315	34.07%
Access for those with Disabilities	3	0.94%	27	3.53%
Affordability	36	6.91%	63	5.39%
Service Extensions	114	28.36%	277	31.23%
<b>Spatial Access to Public Transit</b>	36	6.82%	57	7.97%
Access to (Access from Origin)	30	5.93%	48	6.64%
Access by (Access to Destination)	30	6.14%	49	6.70%
Proximity	4	2.99%	27	3.78%
<b>Corporate Social Responsibility</b>	388	50.92%	453	44.79%
Environmental Stewardship	251	36.92%	116	11.41%
Stakeholder Engagement	107	16.32%	230	23.81%
Accountability and Transparency	68	8.92%	174	18.56%
Self Evaluation	86	8.26%	96	10.38%
Statistical Improvement	13	1.38%	52	5.42%

***Deductive Subthemes: Affordability and Proximity***

Interestingly and contrary to what the academic literature would suggest, each of the deductive subthemes used, namely affordability and proximity, did not frequently appear in either of the analysed documents. As stated prior, these concepts are subthemes, and are under the accessibility of services and spatial access to public transit main themes respectively.

Regarding the Metrolinx document (n.d.), 36 references were made to affordability, covering 6.91% of the document. As for proximity, only 4 references were made to this theme throughout the document, covering 2.99%. Both of these figures are well below several of the inductive codes revealed during analysis. This pattern is largely repeated within the TTC document, in which there were 63 references to affordability, accounting for 5.39% of the document in coverage. While this figure is slightly lower than that of Metrolinx in terms of coverage, the TTC

edges out Metrolinx in terms of references to proximity, with 27 references throughout the document accounting for 3.78% coverage. Interestingly, proximity was found to be the second least prominent subtheme overall (with just one more mention than access for those with disabilities), despite the initial expectation that each document would make ample reference to it.

## Discussion

The transportation industry contributes to climate change through the emission of greenhouse gasses (Griswold et al., 2017). Public transportation holds the potential to alleviate some of the GHG emissions associated with the transportation industry, as it can transport a large number of people at once with high capacity vehicles, reducing the need for personal vehicles that create road congestion and emit far more GHGs per rider (Mathez et al., 2013; Pasha et al., 2016). Resultantly, as the ridership of public transportation increases, the more sustainable it becomes as the emissions released per rider drops (Griswold et al., 2014). One way to increase the ridership of public transportation is to increase accessibility (Chakour & Eluru, 2016). According to the literature, increasing accessibility may be achieved by ensuring that public transportation options are affordable and in close proximity to potential riders (Cats et al., 2017; El-Amine et al., 2018; Liu et al., 2019; Djurhuus et al., 2014; Lachapelle & Pinto, 2016; Boulange et al., 2017). In order to identify the extent to which Toronto's transit providers adhere to the principles of accessibility (namely, affordability and proximity), this MRP analysed the sustainability strategies of Metrolinx and the TTC. The MRP produced four key findings, which are discussed below.

*Key Finding 1 – The importance of accessibility, as a means of increasing the sustainability of public transportation, is reflected in the sustainability strategies of Metrolinx and the TTC*

To answer the first research question posed by this MRP, the importance of accessibility was reflected in the sustainability strategies of both Metrolinx and the TTC. Indeed, accessibility of public transit services was the second most prominent theme in both documents. This finding is in line with previous literature that has found accessibility to be a common theme in transit planning documents. For example, in an analysis of 25 American regional transportation plans for their considerations of health for instance, Singleton and Clifton (2017) note that

“accessibility was the most frequent health component in guidance statements and was found in all plans” (p. 84). While it is acknowledged that this measure is only tangentially related to health, no specific distinction is made between accessibility of services and spatial accessibility in Singleton and Clifton’s (2017) analysis, and thus both are categorized as the same variable. As noted above, accessibility of services refers to any operational measure promoting ease of use such as vehicle punctuality, fare machines, and comfortable seating (Steinfeld et al., 2012) while spatial accessibility refers to a potential rider’s physical ability to reach the transit network and utilize it to effectively reach their destination (Mamun, Lownes, Osleeb, & Bertolaccini, 2013; Ashik, Mim, & Neema, 2020). As such, it is problematic when transit documents conflate these variables, as they are distinct factors that separately contribute to public transportation access. Further, Proffitt, Bartholomew, Ewing, and Miller (2019) note that while many American transportation plans make ample reference to accessibility, they do not explicitly define the capacity (accessibility of services or spatial access) that they use it in. While these findings align with the prominence of the accessibility of services theme in this MRP, they would also suggest that the spatial access to public transit theme would be similarly represented. Perhaps this is indicative of a lack of distinction between service accessibility and spatial accessibility within public facing documents produced by North American transit agencies (Proffitt et al., 2019), with their lack of distinction leading to the muted prominence of the latter theme in this study.

*Key Finding 2 – The importance of affordability is not well reflected in the sustainability documents of Metrolinx and the TTC*

Affordability was lacking in the sustainability documents of both agencies, relative to other subthemes. As such, and to answer the second research question of this MRP, the sustainability documents of both Metrolinx and the TTC do not indicate that affordability is among the most important factors in their sustainability planning. While this suggests that both

Metrolinx and the TTC should direct greater attention to the affordability of their services in such documents, this finding is nonetheless consistent with what has been found in the literature. For instance, in an analysis of 32 North American transit planning documents, Boisjoly and El-Geneidy (2017) found that despite being a vital aspect of public transportation accessibility, affordability was not among the “main aspects of accessibility objectives” (p. 47). Reviews of recent public transportation initiatives also indicate that the lack of attention to affordability is common in transit planning. For instance, in a review of sustainable transportation initiatives in Montevideo, Uruguay, Hipogrosso and Nesmachnow (2020) recommend that the city implement more affordable services to bolster the accessibility of recent sustainable transit implements, which could be achieved by integrating different transit modes. In a context closer to the cases analysed in this MRP, Joy and Vogel (2015) note that Toronto’s “piecemeal approach to neighbourhood planning” has failed to address affordable transit access, among other issues at the municipal scale (p. 46). As such, the findings of this MRP support previous studies that show that not all public transit agencies utilize strategies that promote affordability in their efforts to become sustainable.

The most common subtheme (under the accessibility of public transit services theme) in the TTC document was service extensions, which included references to measures that are aimed at extending service to more patrons through transit operations. In particular, this subtheme had 31.23% coverage in the TTC document. This theme had similar coverage in the Metrolinx document (28.36%). Glover (2011) notes that an advantage of government run transportation systems is their propensity to integrate with one another, especially for planning systems and extending services, whereas private corporations have historically struggled to do so. This is congruent with the finding that Metrolinx and the TTC appear to place similar value on service

extensions in their sustainability documents. While the relatively high prevalence of the service extensions subtheme is indicative of a broad commitment to increasing accessibility by each transit agency, this subtheme is not explicitly tied to affordability or proximity, in that these factors are not specifically discussed in relation to expanded services. As such, these transit agencies may have a commitment to accessibility in their pursuit of sustainability, but not through the channels deemed important in the literature. It is also possible that improvements to accessibility that fall under service extensions (e.g. route extensions, signage, the construction of new station amenities, etc.) are not made with the intention of providing more affordable services, or services that are closer to potential riders. Instead such projects may provide greater transit access to populations that are already adequately served, and thereby increase ridership for the purpose of bolstering revenue regardless of location or fare prices. In line with this, Wei et al. (2017) note that transit agencies often have competing goals, and improving operational efficiency by aiming “to achieve the highest ridership possible with the least operational costs” may conflict with the provision of equitable access, which is denoted by affordability and proximity in this case (p. 70).

*Key Finding 3 – The importance of proximity is not well reflected in the sustainability documents of Metrolinx and the TTC*

Similar to affordability, proximity was not reflected in the Metrolinx or TTC’s sustainability strategies. Therefore, the answer to the third research question is no, proximity is not featured prominently in the sustainability strategies of Toronto’s transit authorities. In fact, only a single subtheme (access for those with disabilities) appeared less frequently in terms of raw total instances than proximity. This held true for proportional coverage as well. This is noteworthy considering that a lack of proximal access to public transportation is identified in the academic literature as one of the major barriers of public transit use, particularly due to the first

and last mile problem (Zuo, Wei, Chen, & Zhang, 2020). In essence, the first and last mile problem refers to the distance between one's trip origin and the nearest transit station, and the distance between one's final destination and the nearest transit station they may depart from (Rahat et al., 2019). Potential passengers may opt to drive rather than use public transit "due to poor local public transport coverage or long walking distances" in such instances, thus hindering ridership and sustainability by extension (Rahat et al., 2019, p. 397). Resultantly, it was expected that Toronto's two transit agencies would make greater reference to this concept, and proximity would appear as a goal of their operations at large.

The lack of attention to proximity reflect in the results of this MRP and in the published literature may indicate that regardless of the known benefits of ensuring proximal access to public transportation outlets, overcoming the challenges associated with increasing proximity may be difficult to resolve. To address the third research question of this MRP therefore, the sustainability documents of both Metrolinx and the TTC do not indicate that these transit agencies give adequate attention to proximity, despite the fact that addressing this challenge can bolster each agency's accessibility, and sustainability by extension.

*Key Finding 4 – Accessibility and sustainability are primarily addressed through the theme of corporate social responsibility in the sustainability documents of Metrolinx and the TTC*

The findings of this MRP suggest that the main accessibility or sustainability-related theme of both the Metrolinx Sustainability Strategy 2015-2020 (n.d.) and the TTC Sustainability Report (2013) is corporate social responsibility. This finding is in line with other studies that have identified public transit authorities' focus on corporate social responsibility as a way to address sustainability. For example, Sodhi and Tang (2018) state that "sustainability has become a catch-all phrase for large companies to subsume diverse initiatives pertaining to CSR [i.e. corporate social responsibility], environment and profitability" (p. 883). As such, the prominence

of the corporate social responsibility theme in these documents may stem from the conflation of this business management concept with sustainability itself. This may suggest that the main purpose of the documents studied is to provide consumers with a document showcasing the efforts of each respective transit agency's efforts to operate responsibly. Actions illustrating a commitment to sustainability may simply be in support of achieving this goal, rather being the reason for the document's publication in and of itself.

Within the overarching theme of corporate social responsibility is the environmental stewardship subtheme. This subtheme was one of the most unevenly distributed subthemes between the two documents. Although the Metrolinx document (n.d.) was approximately half the length of the TTC document (2013), it contained more than double the amount of references to environmental stewardship. Proportionally, this gap was found to be even wider, with the proportional coverage of this subtheme in the Metrolinx document reaching 36.92% versus 11.41% in the TTC document. Ramani, Zietsman, and Pryn (2018) note that in the United States, there are differences in policy and attitudes toward environmental stewardship that manifest in transportation planning due to political differences. In the context of Toronto, the TTC is an agency of the city, while Metrolinx is a provincial crown corporation, and the two organizations have had disagreements over issues such as fare collection infrastructure and the honouring of contracts in the past (Spurr, 2020). Due to the fact that a different level of government oversees each agency, political differences may impact approaches to environmental stewardship, as observed by Ramani et al. (2018) in the United States. Further, it is noted that at the federal level, the social dimension of sustainability is not as well defined as environmental stewardship, and sustainability tends to be "implicitly addressed" rather than explicitly (Ramani et al., 2018, p. 290). Perhaps this observation can explain the prominence of environmental stewardship over

social measures of sustainability (e.g. affordability and proximity) in the documents analysed in this study.

## **Limitations**

This MRP contributes to the literature on the accessibility and sustainability of public transportation. Nevertheless, there are several limitations that I would like to highlight here. As stated in the literature review, there is ambiguity in the public transportation literature on what are considered to be the foremost variables in determining accessibility (Carleton & Porter, 2018; Carpentieri et al., 2020). As such, the focus on this MRP was limited to affordability and proximity due to their apparent prominence over other variables in the literature. Further, this study focuses on only two sustainability documents of public transportation agencies. Due to the timeframe of this study, two public transportation agencies are represented, both of which provide service to the Greater Toronto Area. With more time for assessment and data collection, it would be beneficial to collect data on the sustainability documents of transit agencies in Canada's other large metropolitan areas, such as Montreal, Vancouver, and Calgary due to the relative dearth of research in this area. It would also be beneficial for future research to conduct a longitudinal study of public transportation sustainability, in an effort to uncover whether or not public transportation sustainability documents change to better reflect what the academic literature deems to be important in ensuring sustainability in practice. It is recommended that future research focus on studying this topic at this increased scale to further our understanding of public transportation performance in Canada, and the relationship between public transit sustainability research and practice.

## **Implications**

The purpose of this research is to evaluate the degree to which the best practices for accessible, affordable, and proximal public transportation are reflected in the sustainability documents of Metrolinx and the TTC. The findings of the document analysis indicate that while accessibility is a prominent theme within the documents, best practices for increasing the affordability and proximity of public transit are not well reflected in the sustainability strategies of Toronto's two main transit authorities. While others have noted that transit agencies often neglect to give prominence to affordability in such documents, the literature also suggests that these agencies would be well advised to discuss this topic at more length in future iterations of these sustainability documents, due to the importance of affordability to accessibility (and ultimately sustainability). In addition, neither document featured proximity, a finding that is in line with the prominence of the unresolved first and last mile problem in the literature.

The results of this study indicate that Metrolinx and the TTC (and any other transit agency that has published similar documents) could strengthen their future sustainability plans by making greater reference to the themes of affordability and proximity, in the interest of accessibility. However, the prevalence of the service extensions subtheme, which represents accessibility in a general sense, is relatively high in both documents. This suggests that the transit agencies do demonstrate a commitment to accessibility, but not in the specific ways deemed to be important in the literature. Reporting on a greater breadth of themes related to accessibility rather than a narrow, yet deep focus on the subthemes of service extensions and environmental stewardship, along with the main theme of corporate social responsibility may lead to the development of more academically informed sustainability documents in the future.

## Conclusion

This major research paper (MRP) explored the extent to which the sustainability strategies of Toronto's two main transit authorities (Metrolinx and the TTC) reflect the established importance of making public transportation services more accessible in order to increase their sustainability. Accessibility can produce gains to public transportation ridership, as it allows more potential riders to utilize the service. With increased ridership, public transportation becomes more sustainable, as it limits GHG emissions per person by filling transit vehicles to capacity, while also reducing the number of people using private transportation options. While the COVID-19 pandemic has limited the current ability of public transportation agencies to responsibly fill public transportation vehicles to their highest capacity, this ideal can be used as a way to reduce the overall emissions produced in any given city once the health crisis is controlled.

This MRP also analysed the extent to which the themes of affordability and proximity were given prominence in the sustainability documents of each transit agency. These variables were chosen due to their prominence in the academic literature as important drivers of accessible, and therefore sustainable, public transportation in several contexts, including cities in Europe and Oceania. By comparison, research on the themes of affordability and proximity in Canadian contexts is limited.

Contrary to the established importance of these two themes, affordability and proximity were among the least prominent subthemes in the sustainability documents of Metrolinx and the TTC. Instead, the subtheme of service extensions was the most common subtheme in the TTC document. While this subtheme does portray a commitment to accessibility in a general sense, it does not necessarily denote commitment to affordability and proximity. Nonetheless, the

connection between accessibility and sustainability is clearer in this document than that of Metrolinx. In contrast, the environmental stewardship subtheme was most prominently featured in the Metrolinx document. This suggests that Metrolinx is more focused on direct pathways to addressing sustainability, such as outright reducing construction emissions, and contributing to local conservation efforts. However, it is apparent that this comes at the expense of addressing sustainability via accessibility, which arguably better represents the social and economic pillars of sustainability, rather than the environmental pillar alone. While the service extensions subtheme is second most prominent in the Metrolinx document, indicating that general accessibility is still given importance, it is still not the foremost subtheme as it is in the TTC document.

As stated prior, a commitment to accessibility in and of itself is not indicative of a commitment to affordability and proximity, though it is nonetheless preferable to an omission of this theme entirely. While affordability and proximity are not featured prominently in either document, it is noted in the literature that this is not atypical in North American public transportation planning documents, suggesting that Metrolinx and the TTC have not likely fallen behind in this regard relative to similar agencies.

Regardless, it would be prudent for future iterations of these documents to specifically engage with the notions of affordability and proximity as effective pathways to accessibility, and sustainability by extension. In doing so, the opportunity to apply some of the best practices for public transit sustainability according to the literature may be taken, paving the way for other transit agencies to follow. While the transportation industry represents a large part of the economy that will need to adapt to mitigate the scope of climate change, the opportunity awarded to public transportation agencies to lead this charge is a responsibility and challenge that can be

met by increasing rather than decreasing service levels. In this fairly unique position, the social, economic, and environmental sustainability of the urban sphere can be greatly improved by such agencies, prompting one to ponder whether or not accessibility will soon come to the forefront of the operational goals set by transit agencies.

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