SCHOLARLY REVIEW

Enhancing Inclusive Design by Balancing Digital Innovation and Physical Accessibility

By Emily Rong

Author Biography

Emily Rong is a senior studying at the University of Toronto Schools in Canada. Interested in interdisciplinary approaches to traditional disciplines, she is passionate about the intersection of neuroscience, urban design, and user experience design. She is especially intrigued by avenues to enhance the quality of life for individuals with cognitive diseases.

Abstract

Even with recent advancements, significant challenges persist in the majority of subway systems globally, ranging from physical barriers to information accessibility and poor overall user experience. This paper contributes to the conversation surrounding inclusivity in urban planning by investigating how infrastructure development, technology integration, and policy changes affect the accessibility of Line 1 of the Toronto Transit Commission (TTC). Using a comprehensive literature review, this study contextualizes the concept of accessibility within the broader framework of disability rights movements and social perceptions while examining Line 1's accessibility initiatives in the context of current global trends. Moreover, society should aim to guarantee that every individual experiences the highest level of freedom, irrespective of their characteristics, for everyone is susceptible to disability, whether due to aging or injuries. Ultimately, this paper concludes that the Toronto Transit Commission's current app development-focused initiatives fail to sufficiently address gaps in physical infrastructure, as evidenced by an analysis of other accessibility initiatives, layout practicality, and various implications. The study recommends prioritizing physical modifications, such as strategically placed elevators, clear signage, and designated wheelchair areas, to improve the efficacy of other initiatives. By laying a foundation for continued exploration, this study aims to inspire global efforts in improving public transportation accessibility, fostering greater economic participation and independence for individuals with disabilities, social integration, and ridership satisfaction for everyone.

Keywords: Accessibility, Disabilities, Social Model of Disability, User Experience, Public Transportation, Subway System, Urban Design, Universal Design

Introduction

Accessibility in public transportation is a critical aspect of urban infrastructure. It impacts the lives of millions of people daily, especially those with disabilities. However, there are still significant challenges that people with disabilities experience when using the subway, including issues related to physical accessibility, information accessibility, and overall user experience. This study delves into the accessibility of Toronto's subway system, focusing on the Toronto Transit Commission (TTC), to understand ways to improve accessibility in current stations and the new line through infrastructure development, technology integration, and policy changes. By using Toronto as a case study, this paper contributes to the growing discussion surrounding the inclusivity and accessibility of urban planning. It examines the TTC's current focus on app development and digital initiatives and argues that these efforts need to be implemented alongside physical modifications to reap long-term benefits. The paper highlights that while technology-based solutions can complement accessibility efforts, they cannot replace the necessity for fundamental physical improvements. This analysis underscores the importance of universal design principles and the social model of disability, advocating for comprehensive physical modifications to create a truly inclusive public transportation system. Through this case study, the paper aims to provide valuable insights for policymakers, urban planners, and transit authorities globally, emphasizing the need for balanced strategies that prioritize physical accessibility to achieve greater societal equity and inclusivity.

Background

Spanning 38.4 kilometers, Line 1, also known as the Yonge–University line, is the TTC's longest and busiest subway line, with a history dating back to 1954. Since its opening, Line 1 has expanded from 12 to 38 stations which connect Downtown Toronto to Vaughn and Markham. Transporting an average of over 670,000 riders each weekday, Line 1 is not only the busiest rapid transit line in Canada but also ranks third among the busiest in North America (TTC, 2024).

The ticket entrance consists of three to four doors that swing open with a tap of the ticket. Typically, one of these doors is wider and more accessible for wheelchairs. Figure 1 illustrates the lack of accessibility in the current state of the TTC. For example, although there are larger gates for individuals with wheelchairs, there are no elevators that follow, rendering the individual unable to access the subway after entry. Furthermore, after passing through the ticket gate, most stations have two escalators accompanied by sprawling stairs that lead to both ends of the platform and an elevator is found at one of the ends. The platform, shown in Figure 2, has wide yellow tactile strips that line the edge but no indication of where wheelchair-accessible seats are located within the train.

Figure 1
Entry Gates at York Mills Station

Figure 2
Images of the TTC platform at Bloor-Yonge Station

Current design guidelines in place in Toronto include regulations on access routes, entrances and exits, signage, platform height, and seating and waiting areas (Toronto, 2021). Access routes must be clear, unobstructed, and wide enough (Toronto, 2021). Entrance and exits must be accessible including the provision of automatic doors, ramps, and elevators (Toronto, 2021). Signage must be clear and accompanied by braille and tactile elements at appropriate heights to assist visually impaired users (Toronto, 2021). Platforms must align with vehicle floors to ensure level boarding and there must be easily reachable seating and waiting areas (Toronto, 2021).

Methods

This study employs a mixed-methods approach to analyze the current accessibility of Line 1 and the projected effectiveness of initiatives. The methods used include literature review, case study analysis, and comparative analysis. Firstly, a comprehensive literature review of academic articles and universal design principles was conducted to illustrate the current state of accessibility within public transit and also develop a framework for social perceptions. Secondly, Toronto's Line 1 was selected as a case study to provide a detailed examination of the TTC's current accessibility initiatives. Finally, a comparative analysis was conducted by reviewing the accessibility of other global urban centers such as New York City and Japan to compare the effectiveness of physical infrastructure improvements versus technological solutions in these systems–identifying the best practices and lessons learned.

Literature Review

Historical and Conceptual Foundations of Accessibility

The term "accessibility" has roots which can be traced back to broader movements for social inclusion and equality in access. The concept of accessibility gained prominence as part of the disability rights movements of the 20th century (Meldon, 2023). The focus of these movements was removing social and physical barriers that prevented individuals with disabilities from participating in society. Accessibility in urban design is the extent to which the building environment and transportation systems are meaningful and usable to the greatest extent of people possible, regardless of their physical abilities or disabilities (University of Washington, 2022). However, the concept of disability as defined by modern literature challenges common mainstream perceptions. Ultimately, these explore disability's intersection with accessibility in public transportation and illustrate the broader implications of how inadequate accessibility impacts all individuals and society.

Impact of Spatial-Structure Design on Train Station Accessibility

Train station spatial-structure network analysis–the systematic examination of how the physical layout and organization of train stations affect accessibility, efficiency, and user experience–reveals that the placement of elevators is another crucial aspect of accessibility (Arai et al., 2022). Currently, wheelchair users are often forced to take unnecessary detours, which increases the reachable time indices–a measure of how long it takes to board the train from the ticket gate (Arai et al., 2022). Currently, the elevators are situated in front of stairs or escalators, however, the findings indicate that placing an elevator in the center of a platform makes it harder for wheelchair users to get to various places on the platform promptly. Furthermore, the proximity of elevator doors to stairs or escalator entrances tends to increase the risk of collisions with pedestrians (Arai et al., 2022). The train's structure itself also affects accessibility. For instance, the current central location of vertical handrails affects the accessibility of wheelchair users as well as enabled users as it obstructs the route making it difficult for everyone to move (Seriani et al., 2022). The study revealed that placing the pole on one side of the train has positive effects on the accessibility of these users since it reduces boarding time by 34% (Seriani et al., 2022).

Misconceptions and Models of Disability in Accessibility

In analyzing accessibility, a couple of common misconceptions about the role of disability in our society must be considered. Historically, the common perception most aligns with the medical model of disability, ie, viewing disability as a defect

within the individual (Hogan, 2019), the social model of disability, in contrast, frames restrictions as imposed by society on an individual rather than inherent (Terzi, 2004). According to this model, disabilities are not solely the result of an individual's impairments but are also caused by environmental and societal constraints. To illustrate, if a woman using a wheelchair is unable to enter a building because of steps at the entrance, the medical model would define the issue as her inability to walk. On the other hand, the social model reframes this issue, instead saying the lack of a ramp prevents her, and others with strollers or mobility aids, from entering. This emphasizes the role of physical barriers perpetuating exclusionary societal norms. This distinction is significant in realizing the difference between digital accommodations and physical changes. Although apps are helpful, they focus on changing the person rather than the environment. Thereby following the medical instead of the social model. If the TTC's accessibility issues are approached from the medical model perspective through assistive technologies, they will stray away from comprehensive and systemic solutions that benefit all users rather than niche groups.

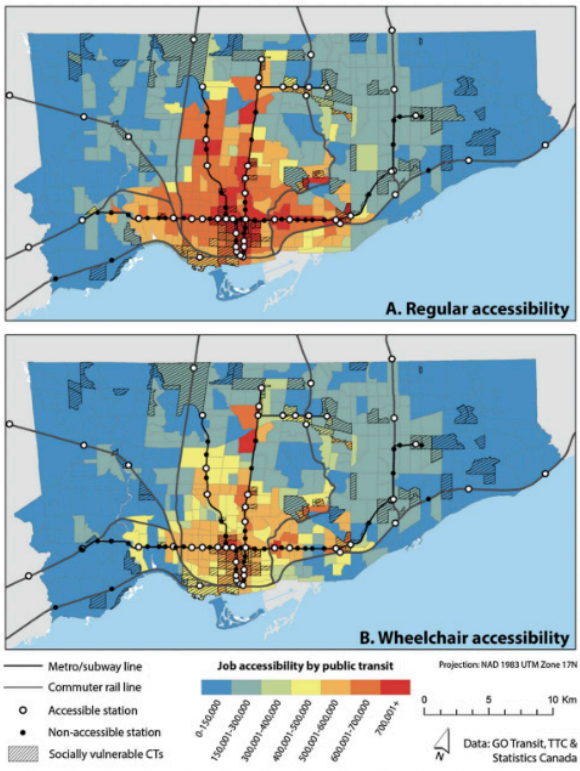
Evaluating Fairness and Design through the Veil of Ignorance

Moreover, the fairness of a public space's design should be examined through the veil of ignorance as it considers the moral foundations of our social systems free from personal biases and self-interest (Jark and Velasquez, 2023). Proposed by philosopher John Rawls, the ethical case study suggests that justice is impartial and when considering ethics and actions, individuals should imagine themselves behind a "veil of ignorance" (Wilburn, 2019). Behind the veil, individuals are unaware of their attributes–socioeconomic backgrounds, abilities, race, etc. (Wilburn, 2019). Society at large, per this concept, should strive to ensure that everyone enjoys the maximum liberty, regardless of their various attributes. In addition to the veil of ignorance, which encourages us to consider various life circumstances we could be in, it is crucial to recognize that almost everyone is likely to experience disability at some stage in their life, whether it be through a sprained ankle from playing a sport or age-related vision loss. Therefore, advocating for disability rights is not only a matter of societal concern and equality but also in one's self-interest as it could pertain to their future self. Furthermore, the universal nature of accommodations such as traffic lights to assist drivers, or pedestrian signals at crosswalks demonstrates that making aids more inclusive benefits everyone. When analyzing the accessibility of public transport, the social model of disability and Rawl's veil are critical guides for its improvement.

Comparative Analysis

Currently, accessibility is a serious issue in public transport in and out of Canada, and common structural designs severely hamper accessibility. Instead of viewing disabilities as individual burdens, disabilities should be framed as a result of societal barriers. When examining societal barriers in subway systems through the veil of ignorance, it becomes apparent that changes need to be made given that anyone could experience disability. Especially since public transportation is the gateway for people to engage in community activities, socialize, and gain independence (Carmein et al., 2005). Additionally, as many countries have aging populations, they are increasingly reliant on the universal design of public transportation, emphasizing the need for inclusive design and equal access for all. As shown in Figure 3, on average wheelchair users in Toronto have access to approximately 75% of jobs or 100,000 fewer jobs than people who are not in a wheelchair (Grisé et al., 2019). Similarly, in New York City, high-income communities are better served by accessible stations in the suburbs compared to those in low-income urban communities (Santiago et al., 2012). This is despite low-income urban communities having both larger disabled and elderly populations, emphasizing how public transport disproportionally contributes to the cycle of poverty for low-income communities that are not physically able to access the same job opportunities (Santiago et al., 2012). Besides physical barriers, wheelchair users feel reluctant to take public transport due to increased anxiety levels (Velho, 2019). A study in the United Kingdom found that disabled people are more likely to find public transport unreliable as their experience is filled with technical and spatial malfunctions (Velho, 2019). However, with changes to the physical environment such as increased maintenance, clear travel pathways, and strategically placed elevators, trust can gradually form between users and the space.

Figure 3
Subway maps of the TTC that compare job accessibility by public transport in the city of Toronto



Note. Adapted from "Elevating access: Comparing accessibility to jobs by public transport for individuals with and without a physical disability," by E. Grisé, G. Boisjoly, M. Maguire, and A. El-Geneidy, 2019, Transportation Research Part A: Policy and Practice, 125, Figure 2. (https://www.sciencedirect.com/science/article/pii/S096585641730705X). Copyright 2019 by Elsevier.

Comparison to Japan's Train System

Using Japan's train system as a case study provides valuable insights for improving wheelchair accessibility in Toronto. Japan's extensive train network acts as a benchmark for accessibility, thanks to continuous investment in infrastructure that ensures features are regularly upgraded. Compared to Japan's vast system, the TTC has a smaller network, yet faces significant accessibility gaps, particularly in older stations that lack sufficient features like elevators and ramps (Accessible Japan, 2024). Although the TTC is making ongoing improvements to enhance accessibility, progress is slower compared to Japan (PEACH Research Unit, 2022). In Japan, elevators and escalators are widely available in stations, often with multiple elevators to ensure access from street level to platforms. Tactile paving is extensively used to guide visually impaired passengers from station entrances to platforms rather than just lining the edges of platforms in the TTC, and clear audio announcements and visual displays in multiple languages are common. Furthermore, there are typically attendants who assure wheelchair users have a safe and smooth boarding onto the train (Accessible Japan, 2024). This comparison highlights that while both Japan and Toronto are committed to improving train system accessibility, Toronto's TTC, though making significant strides, still faces challenges, particularly in older stations and technology integration. Understanding these differences is crucial for identifying areas of improvement and implementing effective strategies to enhance accessibility in public transportation systems globally.

Current Solutions

To further step away from the medical model of disability–that the disability is intrinsic to the individual–the TTC should reframe with the social model of disability and implement more physical aids that break down the restrictions imposed by the physical environment rather than the individual (Terzi, 2004). Because construction of large-scale physical features such as elevators typically have vague timelines, are costly, and filled with delays (as seen with the construction of the Eglington line), the TTC should prioritize not only large-scale projects but also smaller, targeted improvements such as adding large service information displays and announcements and Wayfinding strips.

As of June 23, 2022, the TTC has listed three major initiatives they plan on adding (TTC Chief Strategy and Customer Officer, 2022). First, the York Mills Tactile Wayfind Pilot Project is intended to improve access for individuals with vision loss or limited mobility (TTC Chief Strategy and Customer Officer, 2022). This project includes adding tactile wayfinding paths to each of the nine bus bays for

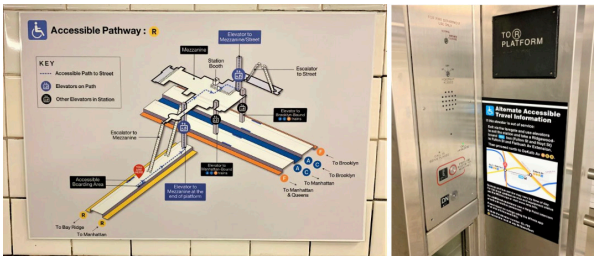
the blind, stop poles with tactile route information modules catering to the blind, and floor labels indicating "first on, last off" accessible waiting areas for individuals with mobility devices. To expand on this, there should be more Wayfinding floor strips implemented throughout the station as shown in Figure 4. Even smaller projects such as adding floor markings to indicate where the train doors open and clear color-coded Wayfinding Floor Strips for directions can have a profound impact. The precise markings on the floor provide visual clarity, clear paths, and designated waiting areas that optimize subway spaces for everyone, including the neurodivergent.

Figure 4
Wayfinding Floor Strips

Note. The directional floor wayfinding tape was designed by the Systemwide Accessibility Team and produced by Color Reflections. Similar floor markings have been used at airports (The MTA, 2024). Adapted from Project Subway, by MTA, 2020, MTA, https://new.mta.info/accessibility/stationlab/floorwayfinding.

Furthermore, the TTC is planning on implementing a pilot project of contactless elevator controls (TTC Chief Strategy and Customer Officer, 2022). These five elevators will provide customers with the option to call and select floors on these elevators from an app on their phone. While it has some benefits such as potentially reducing wait times, rather than creating more apps and thus a dependency on phones, it would be more effective for the TTC to ensure that all of its elevators function. Additionally, to make the elevators more impactful, the platform surrounding the elevator should be wheelchair designated as the narrow paths make it extremely difficult for people to travel down platforms (Arai et al., 2022). The placement of wheelchair-accessible exits which include at least one wide ticket fare entrance, and an easily visible elevator should be indicated on a map at each station. One way to implement this would be through the implementation of accessible pathway maps shown in Figure 5 taken from the MTA Accessibility Station Lab.

Figure 5
Accessible Pathway and Alternate Route Maps



Note. The map on the right details the path individuals with wheelchairs should take. The map on the right shows an alternate route map which should be placed at each elevator with clear instructions on how to continue your trip if that elevator is down. By having a backup plan in case the elevator is out of service, anxiety levels due to transportation can be decreased (Velho 2019). Adapted from Project Subway NYC, by MTA, 2020, MTA, https://new.mta.info/accessibility/stationlab/projectsubwayNYC.

Finally, the TTC has partnered with Magnusmode to create MagnusCards, tailored toward neurodiverse communities (TTC Chief Strategy and Customer Officer, 2022). The app, MagnusCards, is designed to guide autistic and neurodiverse individuals using visual cues, step-by-step instructions, and audio through entering the station, boarding and exiting buses, streetcars or subways, paying a transit fare, planning a transit trip and navigating the TTC website. Though apps such as Magnusmode are steps in the right direction as they provide reassurance and independence, addressing the physical barriers that are still prevalent would be far more effective, it can be developed as a highly personalized to complement physical developments--rather than act as an alternative. Additionally, greater public outreach is necessary to reach a wider audience.

Conclusion

The accessibility of public transportation is a crucial component of urban infrastructure that significantly affects the daily lives of millions, particularly those with disabilities. Although the TTC is striving to provide more accessible services, it should not neglect the physical environment and focus solely on developing more apps. Especially with the ongoing construction of the Eglinton Line, the TTC should emphasize accessible infrastructure for individuals who use wheelchairs, are blind, deaf, or neurodivergent by changing physical infrastructure in addition to current initiatives.

This research was conducted under a limited scope due to constraints on access to research materials and funding. Despite these limitations, the findings provide insights into the current state of accessibility in Line 1 of the TTC and ways it can continue to improve. Looking ahead, I am keenly interested in furthering my research in the future. With access to resources and more support, I would like to conduct my research to delve deeper into how to improve the accessibility of public transport for individuals with cognitive disabilities. This study lays a foundation for continued exploration in this field, hoping to contribute significantly to increasing the accessibility of public transport globally.

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