TOWARDS AN ENABLED JOURNEY: AN INVESTIGATION OF THE WHOLE JOURNEY CHAIN FOR PUBLIC TRANSPORT JOURNEYS BY PEOPLE WITH DISABILITIES

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Abstract

The ability to travel freely and independently to participate in society is essential for an individual's well-being and quality of life. However, the inability to access public transport (PT) due to barriers in the urban environment and PT systems is one of the driving forces that lead to social exclusion for people with disabilities. The aim of this research is to attain a comprehensive insight into the travel behaviour of people with disabilities. It has two objectives. The primary objective is to examine the root cause of the difficulties faced by independent riders, with disabilities, when using PT. The secondary objective is to highlight the importance of the "bottom-up" approach for policy implementation and engagement with the disabled community. This research employed both quantitative and qualitative methods to assist decision-makers and practitioners in designing inclusive PT systems. Data was collected through a series of semi-structured interviews and stated preference surveys around various cities of New Zealand between 2017 and 2019. The thesis consists of two parts, each addressing a specific research question.

The first part consists of three studies. The first two adopts the "whole journey chain" concept to identify and prioritise the critical barriers which impede the ability of physically and visually impaired users to travel in a PT journey chain, from origin to destination. Further, the similarities and differences between these barriers are investigated. The findings showed that prioritising the improvement of bus driver training, more strategically placed pedestrian crossings and better presentation of information would bring the most significant mobility benefits. Bus driver's attitude and unawareness of disabled users' needs was a common concern. The main barriers for physically impaired users were related to the urban environment, stations and stops, services, and quality of footpaths. In comparison, the main barriers for visually impaired users were the poor presentation of information and obstructions on footpaths. Decision-makers are encouraged to adopt the "accessible journey chain" to eliminate and minimise barriers. For people with disabilities, this means improving the ability to interact more fully in society.

To further understand the discrepancies between practitioners and users, a multi-criteria decision-making method "Analytic Hierarchy Process" (AHP), is adopted to determine any differences in the users' needs and practitioners' prioritisation of accessibility features for a PT

journey chain. The study revealed discrepancies between the prioritisation by practitioners and users. In particular, bus driver attitude accounted for the largest disparity between the two groups. The most important factors perceived by practitioners are crossing facilities, followed by access to stops/stations and quality of footpaths. Practitioners value the built environment component of the journey chain more than the PT component by users. The study highlights the need for practitioners to shift their prioritisation closer to the needs of people with disabilities to eliminate existing barriers. This first part of the study revealed the level of disappointment, mistrust, and frustration felt by the disabled community. Their ability and willingness to participate more fully in society is obstructed by barriers that can be resolved through consultation and prioritisation in design.

The second part of the thesis investigates the operational aspect of transfer-making in an integrated PT system. The two studies examine the trip attributes which influence the decisions of people with disabilities to use PT routes involving a transfer. Transfer waiting time was revealed to have the most significant effect on non-PT user's willingness to ride transfer routes. In contrast, personal safety was the most significant factor for current PT users', on the condition that infrastructure facilitating transfers are accessible. This reinforces the importance of having stringent regulations to ensure that PT infrastructure is compliant with accessibility design standards to allow disabled users to ride PT independently.

A psychological model, Weber's Law "Just Noticeable Difference" (JND), is adopted to determine the least travel and transfer time required for disabled PT users to perceive integrated routes with transfers as a feasible option. Disabled PT users desired a reduction in their current travel times by at least 31%. It also includes the examination of the effects of quality of accessibility features on transfer waiting and walking time. There was minimal effect on the desired travel time savings given an interchange with better quality accessibility features. However, participants desired a higher transfer waiting time for complex interchanges compared to simple stations. These values can be used to assist transport planners to reconsider how they design integrated systems to improve their attractiveness for the disabled community.

This research provides a comprehensive insight into the perspective of disabled travellers. By adopting a more holistic view of the PT journey chain, decision-makers and practitioners can develop a better understanding of the needs of people with disabilities, and thereby, incorporate approaches towards achieving a more inclusive transportation network. In summary, the following main contributions of this thesis are:

a) The adoption of the "accessible journey chain" concept to identify critical issues relative to the whole PT journey chain.
b) Investigating the similarities and differences in the perceived barriers between two common disability types, physical and visual impairment.
c) The quantification of the relative weightings perceived by practitioners and disabled PT users in the prioritisation of common accessibility features using AHP.
d) Determining the average values of the JND constant, *k*, for the relationship between travel time and transfer time.

Dedication

To my loving family

Grandpa, Grandma, Mum, Dad, and my beautiful Sister

Joong Ho Ahn

Ok Soon Seol

Hee Su Park

Hey Jung Ahn

Kyung Min Park

Publications

Some of the chapters in this thesis are based on conference and journal publications. Apart from changes to the formatting of the text and figures, the chapters appear as they have been published or submitted for publication.

Chapter 3

Park, J., Bamford, J., Byun, H., & Chowdhury, S. (2017, November). *Journey by Visually Impaired Public Transport Users: Barriers and Consequences.* Paper presented at the 39th Australasian Transport Research Forum (ATRF), Auckland, New Zealand.

Chapter 4

Park, J., & Chowdhury, S. (2018). Investigating the barriers in a typical journey by public transport users with disabilities. *Journal of Transport & Health*, *10*, 361-368.

Chapter 5

Park, J., Chowdhury, S., & Wilson, D. (2020). Gap between Policymakers' Priorities and Users' Needs in Planning for Accessible Public Transit System. *Journal of Transportation Engineering, Part A: Systems, 146*(4), 04020020.

Chapter 6

Park, J., Chowdhury, S., & Wilson, D. J. (2019, August). *An examination of people with disabilities' willingness to make transfers in an integrated public transport network.* Paper presented at the 16th International Conference on Competition and Ownership in Land Passenger Transport (Thredbo), Singapore.

Chapter 7

Park, J., Chowdhury, S., & Wilson, D. J. Investigating the time and facilities required by people with disabilities to ride public transport routes involving transfer. *Journal of Transport Geography,* (submitted 2020).

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Chapter One

Introduction

1.1 Research Motivation

- *"There is no greater disability in society, than the inability to see a person as more".*
    - *Robert M. Hensel, author of Writings on the Wall: Inspirational Poems & Quotes*

The public transport (PT) system should provide access to opportunities and mobility for anyone who wishes to use it. However, many PT systems are usually designed for able-bodied passengers. This presents many challenges for people with disabilities who have unique barriers. Disability is defined as "any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner of within the range considered normal for a human being" (World Health Organization, 1980). Currently, around 15% of the world's population is estimated to be living with some form of disability, and this is predicted to increase due to an ageing population (World Health Organization, 2011). Given the type and severity of the disability, and whether they have access to private vehicles will dictate their travel modes. Due to the variability in these factors, people with disabilities cannot be categorised into a homogenous group. Those whose disability restricts them from being able to drive (for example, being legally blind) become captive PT users, which puts them at the mercy of the built environment and the PT system. For this reason, there is a high dependency on PT services by people with disabilities to gain independence in mobility (Human Rights Commission, 2005; Jolly, Priestley, & Matthews, 2006).

In addition, the majority of disabled PT users are from the low to the middle-income group. It has been well documented that people with disabilities tend to experience higher unemployment and lower earnings than able-bodied people (International Labour Organization, 2007). Less than a quarter of people with disabilities were in employment in New Zealand (Statistics New Zealand, 2019). They are often either segregated from the mainstream labour market wholly or are relegated to low-level, low-paid jobs with little job or social security. As such, being able to access mobility by PT provides people with disabilities to opportunities and independence.

Literature has documented many barriers faced by this group of PT users. These barriers are discussed in detail in Chapter 2. Their inability to travel freely is mainly associated with the urban environment to access PT stations and stops along with the services provided. As such, this group of individuals make fewer journeys on average, travel shorter distances, and by a more limited number of modes (Deka, 2014). The "social model of disability" (Barnes, 1991) conceptualises that one's disability is contingent upon an inaccessible environment, not an impairment.

"The disability is not the problem. Accessibility is the problem".

-Mohamed Jemni via TEDxMelbourne

The decision for disabled users to travel is influenced by whether their journeys are accessible and barrier-free to, from, and within PT systems (Maynard, 2009). For this reason, their journey starts with meticulous planning of the routes and arranging appropriate transportation options to ensure they are confidently able to reach their destination. Unlike able-bodied people who have the ability to adapt and bypass unexpected barriers quickly, and so, are confidently able to make spontaneous trips; people with disabilities, on the other hand, have little opportunity to alter their planned journeys. When their only option of transport is inaccessible, it presents a range of implications. In the worst case, should an unexpected barrier appear, such as the sudden unexpected cancellation of PT services or construction activity with no accessible detour routes, can potentially strand them in the middle of their journey. This can result in the development of transport anxiety in using the PT service. Being unable to access the limited available opportunities, means every day becomes a constant struggle both financially, mentally and socially. Consequently, the restricted mobility faced by people with disability in using PT can lead to further isolation and dependency on friends and family (Church, Frost, & Sullivan, 2000). The feeling of being isolated, unheard and unseen has a strong negative effect on their mental health and well-being (Currie et al., 2010; Lindqvist & Lundälv, 2012; Titheridge, Achuthan, Mackett, & Solomon, 2009). They lose the opportunity to live a diverse and healthy life.

Accessibility to reliable and barrier-free PT systems can significantly improve the lives of people with disabilities by providing independence and access to opportunities offered by society (Hine & Mitchell, 2001). Their lives can be transformed from one of isolation and dependency to one of social integration and independence; thereby increasing the chance of not feeling limited in social, leisure, daily living and work role activities (Asplund, Wallin, & Jonsson, 2012; United Nations, 2007). It is a mode that can provide the ability to perform day-to-day journeys independently and a pivotal determinant to positive well-being.

A reliable and seamless PT journey relies on all legs of a journey. The "accessible journey chain" concept shows the interaction of all the segments and linkages in a PT journey. This is discussed further in detail in Chapter 2. Previous literature has mainly focused on segments of a journey when investigating the barriers faced by people with disabilities. A limited number of published literature examined barriers in respect to the whole PT journey (Ahmad, 2015; Carlsson, 2004; Gallagher, Hart, O'Brien, Stevenson, & Jackson, 2011; Sundling, Berglund, Nilsson, Emardson, & Pendrill, 2014). Broadly, they were either on the built environment (Jenkins, Yuen, & Vogtle, 2015; Rosenberg, Huang, Simonovich, & Belza, 2013) or access to PT (Soltani, Sham, Awang, & Yaman, 2012; Velho, Holloway, Symonds, & Balmer, 2016). For people with disabilities, any barriers in the built environment can prevent them from using PT in the first place. Unless every segment is seamless, there are going to be barriers for people with disabilities. However, the barriers are segregated, and there is limited knowledge about their importance relative to the whole journey. Therefore, it is imperative to examine the PT journey as a whole from an origin to a destination, and from the users' perspective. This allows critical aspects of the journey chain, which can prevent or discourage an individual from using PT, to be examined for those with physical and visual impairments.

Globally, PT networks are moving towards an integrated multi-modal system, relying on users to make transfers (Chowdhury & Ceder, 2016). It has been widely recognised that there is a negative perception toward transfers. Many of the barriers that exist with PT use is associated with the urban environment. To make a transfer, riders need to egress and board another vehicle. For people with disabilities, unless proper facilities are in place, the physical movement to make a transfer will become the greatest barrier for independent travel. Chowdhury and Ceder (2013) discussed that transfers need to be planned in the early stages of design in order to make them efficient and attractive. The study argued that delaying the designs of transfers to later stages, which is the common practice, makes it difficult for practitioners to make them seamless. Therefore, in the development of integrated systems, transport planners need to understand the transfer time and facilities required by people with disabilities to make transfers easily and to ensure significant additional transfer penalties are not forced on people with disabilities.

Numerous travel behaviour studies (Chowdhury & Ceder, 2013; Eboli & Mazzulla, 2012; Zhou, Yang, & Lao, 2007) have investigated the factors that influence PT users' willingness to use routes involving transfers. Trip attributes, such as travel time, transfer waiting and walking time were found to significantly influence users' perception of using PT routes involving transfers (Chowdhury & Ceder, 2013; Eboli & Mazzulla, 2012; Zhou et al., 2007). In particular, travel time can be considered the governing factor that induces ridership to most PT systems. A shorter transfer waiting and walking time relieves the perceived burden of the process of making transfers, especially in unpleasant and insecure waiting conditions (Iseki & Taylor, 2009). Other trip attributes such as personal safety (Singleton & Wang, 2014) and weather protection (Chowdhury, Ceder, & Sachdeva, 2014) were also found to influence users' willingness to make transfers. Personal safety at terminals was found to be the most sensitive factor that influences the decision to use PT (Eboli & Mazzulla, 2012). For people with disabilities, this trip attribute is more significant as they are likely to feel extremely unsafe due to their perceived vulnerability and the inability to protect themselves (Marston, Golledge, & Costanzo, 1997; Yavuz & Welch, 2010).

It is evident from previous literature that travel behaviour studies primarily revolves around the standards of able-bodied people. On the other hand, similar travel behaviour research is scarce for people with disabilities. A few studies that were conducted on the needs of disabled PT users have highlighted the importance of removing barriers in the urban environment. An integrated system means that a disabled PT user will need to interact more with the urban environment. This is a significant knowledge gap as people with disabilities have varying needs and level of ability for movement. If the designs of the transfer stations do not meet the requirements of this group of users, it will discourage them from receiving the benefits of the new integrated system. Incorrect optimisation of the transfer time can create further challenges for people with disabilities to ride PT, as certain groups of disabled users may need more time to make a transfer.

There is also added pressure to increase the attractiveness of PT and reduce reliance on car travel with a global trend towards the desired future for a more sustainable transport system. For people with disabilities who can drive and own a car, this raises additional challenges given the flexibility offered by driving because their threshold of perceiving PT as being an attractive and viable travel mode will be much higher than those who are captive travellers (Stradling, 2002).

Additionally, a radical change in the approach of urban design by shifting its priority to place-making as opposed to movement has impacted the PT journey chain by replacing some conventional roads along typical pedestrian routes and surrounding areas of PT terminals. This comes predominantly in the form of shared spaces, also called “shared streets” or “shared zones” that promote social interaction by integrating multiple modes of transport (pedestrians, cyclists, and motorists) to have equal rights to the same road space (Hamilton-Baillie, 2008a; Karndacharuk, Wilson, & Dunn, 2014). The popularity of shared spaces continues to increase in many countries because it enriches the areas undergoing economic revitalisation and meets the desires of the public (Hamilton-Baillie, 2008a; Imrie & Kumar, 2011; Karndacharuk, Vasisht, & Prasad, 2015). Concerns for shared space accessibility has been highlighted because social behaviour and navigation in this environment is dependent on skills to pick up visual cues and to process that information to negotiate the space safely due to the absence of signs and traffic signals and the removal of clearly delineated kerb lines (Earl et al., 2016; Havik, Melis-Dankers, Steyvers, & Kooijman, 2012; Imrie, 2012). Additionally, adjacent land use activities like cafés often crowd the shared space zones with furniture that makes it more challenging to navigate around. These are often the skills that people with disabilities have lower competency in; thus, this type of urban environment puts them at a disadvantage as they cannot easily adapt to changes.

Overall, there are a number of research gaps in regard to understanding the PT needs of people with disabilities. Journeys are becoming increasingly complex as the urban form and PT systems become more sophisticated and streamlined. Although it provides more efficiency, at the same time, it also introduces additional barriers, especially to those with lower levels of abilities. Therefore, it is imperative that research is conducted in this area to minimise the negative effects of this change to ensure people with disabilities and their travel journeys are not further adversely disadvantaged.

1.2 Policies and Acts

Despite all the accomplishments from laws such as Australia's Disability Discrimination Act 1992, New Zealand's Human Rights Act 1993, UK's Disability Discrimination Act (DDA) 1995, and most notably, the Americans with Disabilities Act (ADA) in 1990 which have been enacted to increase participation, facilitate independence and improve access for people with disabilities, significant barriers still exist to this day.

Disability is increasingly understood as a human rights issue (Mégret, 2008). The United Nations Convention on the Rights of Persons with Disabilities (CRPD) is an international human rights treaty that was adopted in 2006 to change the attitudes and approaches to people with disabilities as having the same human rights as able-bodied people. Since then the convention has been signed by 163 countries, with the goal of existing legislation and policies around the world to align and stay consistent with the CRPD. In other words, it sets out a guideline for actions government agencies need to implement to ensure that people with disabilities have the same rights as everyone else. Germany, the United Kingdom, Spain, Sweden, Malta and New Zealand have mechanisms in place to ensure that people with disabilities are being treated equally through the establishment of an independent body or group (Irish Human Rights and Equality Commission, 2016).

"People with disabilities should not be considered as *objects* to be managed, but as subjects deserving of equal respect and enjoyment of human rights"

-World Health Organization (2011)

The disability community often voice their concerns that their needs are neglected. There is still immense distress and frustration in the community. The needs of people with disabilities are not included as a requirement in planning, funding, and implementation, but are often considered after key decisions have been made making it more challenging to include best practice provisions (Human Rights Commission, 2005). The issue is further exacerbated as it has been suggested that standards for inclusive design are inflexible and lack comprehensive guidance for practitioners, especially for complex or uncommon situations (Tennoy, Oksenholt, Fearnley, & Matthews, 2015). Issues arise when designs cannot support the minimum accessibility requirements (Rosenberg et al., 2013). This is a growing problem that contributes to this cycle of mistrust with the disability community. Practitioners develop their understanding of the transport needs of people with disabilities from primarily these documents, with guidance from the experts in the disability field to conduct audits. Without this liaison, discrepancies will exist as the issues can only truly be identified by experience.

Practitioners have the added pressure of budgetary and resource constraints. This necessitates the need to prioritise accessibility features that will have the most impact. It is well-known that people with disabilities face a myriad of barriers in a typical PT journey. These barriers are mainly cited from the users' perspective. On the other hand, there is limited knowledge and mobility design skills at the level of detail required, nor the understanding of the relative importance of these barriers from the perspective of transportation practitioners who can address these issues. Budgetary constraints mean that it is not feasible to address every barrier, resulting in the need to prioritise. The discrepancies in the perceived importance of these barriers between users and practitioners is a possible reason as to why issues of mobility continue to exist for people with disabilities. Highlighting the disparities and similarities between the importance of accessibility features from the users' and the decision-makers' perception can better inform policies and designs to reduce/eliminate mobility issues for people with disabilities.

1.3 Scope of research study

People with disabilities are a diverse group with different and varying needs and abilities. As discussed in Section 1.1 and 1.2, despite changes in policy and improvement in accessibility features, they continue to face challenges to ride PT for their day-to-day activities. A possible reason for this on-going issue is that there is a limited number of studies which have examined the barriers in the whole journey chain from a holistic viewpoint. As a result, there are gaps in the overall system leading to inefficient allocation of budget and resources. This research focuses on:

a) The needs of people with disabilities from existing PT services and infrastructure and adopts the concept of the whole journey chain.
b) Independent PT users with a disability who can undertake journeys on their own without assistance, which comprised mainly of those with physical or visual impairments. Participants were aged 16 or more as they do not require parental consent in New Zealand, and therefore, can be considered independent.
c) The barriers encountered within existing PT journeys made by people with disabilities. The purpose and origin-destination of the journey are not examined.

The findings from this research aim to bridge the gap between decision-makers/practitioners and people with disabilities to reduce the barriers faced by this group of riders. This research utilises both qualitative and quantitative approaches, with a higher emphasis on the former, in order to delve deeper into the critical issues and to identify discrepancies in the system. Two main data collection methods comprising of a series of semi-structured interviews and online user preference surveys were employed throughout the study to gather qualitative and quantitative data. As a result, a broad spectrum of participants from around the country of New Zealand with varying disabilities could be reached in both urban and rural communities. Thus, providing a vast set of viewpoints from different perspectives on the issues to accessibility.

1.4 Ethics

Given that this research involved human participants, the design of the semi-structured interview process and stated preference surveys was reviewed and approved by the University of Auckland Human Participants Ethics Committee. The relevant documents incorporated in the ethics approval for each study in this thesis such as the Participant Information Sheet (PIS), Consent Form (CF) and the interview/survey questionnaires can be found in the appendices.

1.5 Research aim and objectives

The main questions that this research investigates are:

(a) What are the barriers faced by people with disabilities from a whole journey perspective due to current public transport systems' operations and policymaking?

(b) What are the potential barriers from the current designs of integrated systems, and how can they be addressed for people with disabilities?

Research question (a) comprised of objectives 1 and 2.

Objective 1: Examine the key barriers in typical public transport (PT) journeys which would bring the greatest mobility benefits, when addressed, by focusing on the two most common types, physical and visual impairment, by adopting the "accessible journey chain" concept.

Objective 2: Determine the prioritisation of accessibility features in a typical PT journey from the practitioners' perspective.

Research question (b) comprised of objectives 3 and 4.

Objective 3: Investigate the influence of trip attributes on the willingness of disabled PT users (captive and non-captive) to use an integrated PT route involving transfers.

Objective 4: Determine the least travel time and transfer time (walking and waiting) savings for an integrated PT route involving a transfer that will be attractive to disabled PT users.

1.6 Thesis structure

Following this introductory chapter, Chapter 2 provides a summary of the relevant literature on people with disabilities and their use of PT. It concludes with the knowledge gaps that will be investigated in this study. Chapters 3,4,5,6 and 7 are grouped under three main categories: the overall journey chain, policy and integrated PT systems. Chapters 3, 5 and 7 are journal papers, and Chapter 4 and 6 are international conference papers. Chapters 3, 5 and 6 appear in the form they were accepted for publication with some minor format changes. Chapters 4 and 7 are also presented with minor changes.

1.6.1 Overall Journey Chain

Chapters 3 and 4 - Discusses the barriers perceived by people with disabilities in the whole journey chain (from origin to destination).

Chapter 3: Journey by visually impaired public transport users: barriers and consequences

The aim of this aspect of the study presented in Chapter 3 is to examine the key issues that will bring the most mobility benefits, when addressed, for people with visual impairments. Further, the consequences of these issues on their wellbeing and experienced social exclusion is explored. The study is based on semi-structured interviews which explore the barriers and the consequences on their wellbeing in depth. NVivo (Version 11) was used to analyse the data thematically. The study revealed that these travellers experience intense frustration and isolation on a regular basis due to these issues in the network, in particular, due to neglect. Objective 1 in Section 1.5 is addressed in this study. The approach used in this study forms the foundation for Chapter 4, which explores the issues in more detail as well as involving an additional disability group.

Link 1: Studies conducted within the Overall Journey Chain (Chapters 3 and 4)

The study conducted in Chapter 3 sheds light on the many barriers in a PT journey faced by people with visual impairments and its impact on their wellbeing. There is a range of people with different types of disabilities who use the PT network. Although different disabilities have their own associated barriers and challenges, there are also overlaps in the issues they face. Addressing the common barriers between different disability types brings mobility benefits to a wider number of users. The next study presented in Chapter 4 was conducted to explore the similarities and differences in the perception of barriers with the most common disability type in New Zealand being physically impaired users (Statistics New Zealand, 2014c) to further address Objective 1 in Section 1.5.

Chapter 4: Investigating the barriers in a typical journey by public transport users with disabilities

The main purpose of the study presented in Chapter 4 is to determine the prioritisation of the key barriers in a typical PT journey chain from the perspective of people with physical and visual impairments and comparing the similarities and differences of their needs. Similarly, to Chapter 3, the study utilised semi-structured interviews to explore their needs in-depth. NVivo (Version 11) was used to analyse the data thematically. The results highlight the importance of investigating the whole journey in identifying the common barriers to improve the experience for the wider group. The findings are used to explore the gaps in the prioritisation of accessibility between users' and decision-makers' in Chapter 5.

Link 2: Studies conducted in the Overall Journey Chain (Chapters 3 and 4) and Policy (Chapter 5)

The results of the studies discussed in Chapters 3 and 4 highlights the myriad of barriers faced by people with disabilities in their PT journeys, and the priority in which these barriers should be addressed. Transportation practitioners are responsible for designing and implementing transport infrastructure to enable the efficient movement of all users around the network. However, it has been acknowledged that budgetary constraints force decision-makers to prioritise their resources when addressing the vast issues on the network. To ensure users receive the greatest mobility benefits, the viewpoints of both providers and users must be aligned so that focus is placed in the right areas. The next study presented in Chapter 5 explores the viewpoints of practitioners responsible for making changes in the transport network to address Objective 2 in Section 1.5.

1.6.2 Policy

Chapter 5 - Discusses the gaps in the accessibility features prioritised by policymakers and the needs of disabled PT users.

Chapter 5: Gap between policymakers' priorities and users' needs in planning for accessible public transit system

The main purpose of the study presented in Chapter 5 is to determine the prioritisation of accessibility features in a typical PT journey from the perspective of practitioners. The study included senior practitioners in decision making roles who have multiple years of experience (more than 10). A survey comprising of pairwise comparisons was used to determine the relative weight of accessibility features identified in Chapter 4. This was achieved by using a multi-criteria decision-making method "Analytic Hierarchy Process" to determine the prioritisation within a set of common accessibility features. The results identified the gaps between the users' needs (from Chapter 4) and practitioners' prioritisation of accessibility features. To the author's knowledge, this study is the first in published literature to provide a comparison between the two groups.

Link 3: Studies between Overall Journey Chain and Policy (Chapters 3, 4 and 5) and Public Transport (Chapters 6 and 7)

The studies investigating the "Overall Journey Chain" in Chapters 3 and 4, and the "Policy" aspect in Chapter 5 shed light on the myriad of barriers that impede people with disabilities' ability to travel in a PT journey, from origin to destination from a holistic perspective. The results of these studies indicated that the PT component of the journey chain requires further focus. The vast benefits offered by an integrated transport system provides PT users with more affordable, comfortable, quicker and flexible destination choices; thus, PT networks are becoming increasingly complex as there is a shift towards integrated multi-modal systems (Chowdhury & Ceder, 2016). To fill the knowledge gap in this field, the next two studies narrows to focus on the transfer aspect of PT systems and the effect it has on disabled PT users' perception of transfers. The studies presented in Chapters 6 and 7 were conducted to address Objectives 3 and 4 in Section 1.5, respectively.

1.6.3 Public Transport

Chapters 6 and 7 - Discusses the needs of people with disabilities when making transfers in an integrated network.

Chapter 6: An examination of people with disabilities' willingness to make transfers in an integrated public transport network

The aim of this study presented in Chapter 6 is to investigate the influence of trip attributes (transfer time, physical and information integration, and security) on the willingness of people with disabilities to ride integrated PT routes involving transfers. Hypothetical scenarios with varying levels of transfer time (walking and waiting), physical and information integration, and security were presented to participants. Binary logistic regression models, using the Statistical Package for Social Sciences (SPSS) version 26, was used to analyse the survey data. The results revealed a shorter transfer time, and the presence of physical, information and security provisions improved the willingness to shift from private vehicle users to PT routes involving transfers.

Link 4: Studies conducted within Public Transport (Chapters 6 and 7)

The results of the study discussed in Chapter 6 show that trip attributes associated with the out-of-vehicle phase during transfers affect people with disabilities' decision to use PT routes involving transfers. The findings, to a certain extent, are in line with previous studies conducted for able-bodied PT users (Chowdhury & Ceder, 2013; Eboli & Mazzulla, 2012; Iseki & Taylor, 2009; Zhou et al., 2007). Although the correlation of the responses is similar between the two groups; for people with disabilities, however, accessibility is the governing factor before the aforementioned trip attributes are considered in their decision to travel. The next study builds on Chapter 6 by investigating the effects on transfer time when this precondition has been met and improved.

Chapter 7: Investigating the time and facilities required by people with disabilities to ride public transport routes involving transfers

The objective of this aspect of the research was to determine the desired travel time and transfer time (walking and waiting) that influences disabled PT users to use routes involving transfers. A user preference survey is conducted to determine the distribution and different threshold values of travel time, transfer time, and the level of accessibility features which will reduce barriers for PT users' when riding routes with transfers in an integrated system. Availability of accessibility features was seen to have a marginal effect in reducing the average Just Noticeable Difference (JND) constant, k, for transfer time.

Figure 1.1 illustrates how the chapters are linked to each other and the research aims. Finally, the summary of the main findings, contributions, conclusion and recommendation and proposed future research are presented in Chapter 8. Hereafter, Chapter 2 provides a summary of the relevant literature for people with disabilities and their use of PT.

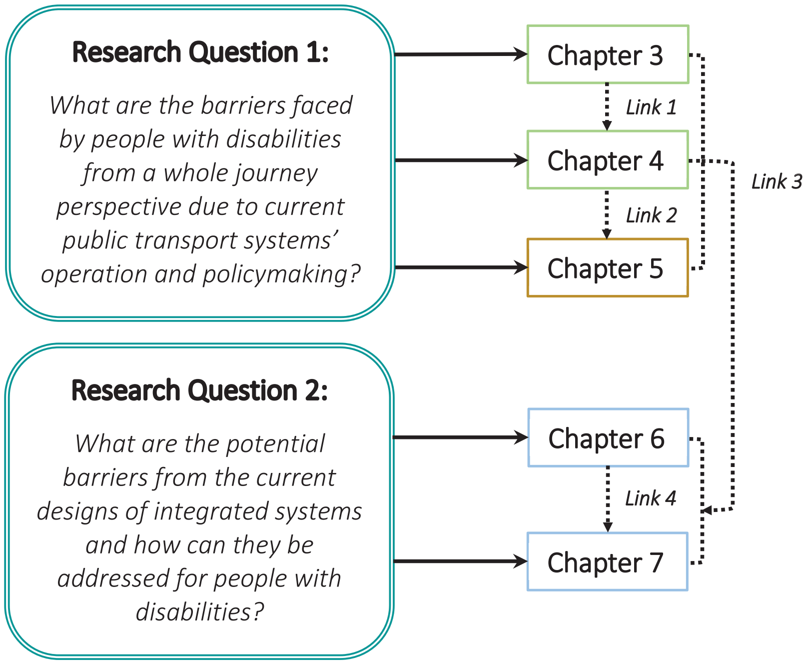

Figure 1.1: Link between the chapters and aims of the research

Chapter Two

Literature Review

2.1 Introduction

The nature of public transport (PT) has become considerably more complex as globally PT networks are moving towards an integrated multi-modal system (Chowdhury & Ceder, 2016; Luk & Olszewski, 2003). There is a negative perception towards making transfers and the increase in out-of-vehicle times during this process is perceived to be more cumbersome than in-vehicle times (Guo & Wilson, 2004; Iseki & Taylor, 2009). Moreover, the increasing complexity of the built environment with the rising popularity of pedestrian-oriented urban designs, such as shared spaces exacerbates this issue as they become a typical part of a PT journey. Literature has shown that shared spaces present specific issues for people with disabilities (Havik, Steyvers, Kooijman, & Melis-Dankers, 2015; Imrie, 2012; Parkin & Smithies, 2012). The fact that the same level of accessibility analysis has not been undertaken for more complex pedestrian journeys (Evans, 2009), coupled with the limited knowledge on how the needs of people with disabilities are aligned with policy-making (Imrie, 2000) has consequently resulted in accessibility issues continuing to persist for disadvantaged travellers.

To discuss the key themes in each journey aspect that make up the whole travel chain, the literature on how disabled PT users' mobility is addressed can be grouped into three main categories: policies, regulations and standards; built environment; and public transport. An ideal environment is created for people with disabilities to carry out their journeys successfully when there is an overlap between all three components. Figure 2.1 illustrates this interaction.

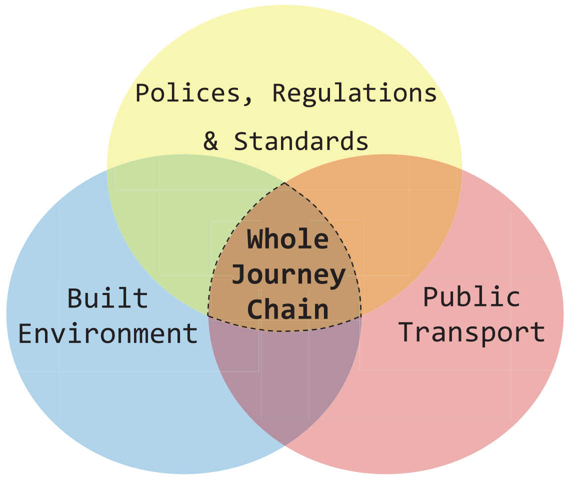

Figure 2.1: The three components of a journey which are necessary to create the ideal environment for people with disabilities

2.2 Review methodology

2.2.1 Search strategy and databases used

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, Altman, & Prisma Group, 2009) was adopted, shown in Figure 2.2, to determine the literature for the review. The main search engines used to obtain full-text literature materials for this review consisted of Scopus, Science Direct and Web of Science. Relevant studies were identified based on the following search terms or phrases and its equivalent synonyms in various combinations within the abstract, title or keywords: “disability” with “accessibility”, “inclusive design”, “transport disadvantage”, “transport needs” with “built environment”, “public transport”, “shared spaces”, “travel chain”, “journeys”. The references in the retrieved articles were also checked to find any additional studies for consideration.

2.2.2 Selection procedure

The review materials for this research primarily consists of international, peer-reviewed journal papers as well as key conference papers and only articles written in English were selected from the electronic database. The literature was initially screened by reading the title and abstract sections, where articles involving accessibility issues relating to the journey of disadvantaged pedestrians were considered. Approaches to disability design were radically revised since the passage of Americans with Disability Act in 1990 (ADA, 1990), which resulted in increased awareness for the needs of people with disabilities. Therefore, published research from 2000 onwards was the main focus to examine recent advances in this topic area. Studies that either focused extensively on policies or those that focused on mathematical models to measure accessibility are outside the scope of this review.

2.2.3 Identification of literature

The initial search regarding the whole PT journey resulted in a total of 279 articles (Scopus: 109, Web of Science: 53 and Science Direct: 117). After deleting duplicates and irrelevant studies by title, abstract, introduction and conclusion review resulted in 4 articles for inclusion. Due to the lack of suitable articles concerning the accessibility issues of the whole PT journey chain for disadvantaged travellers, the search was broadened by searching the aspects that make up the journey separately.

The two main legs of the journey that broadly make up a travel chain were identified as the 'built environment' and 'PT'. Shared spaces are a specific built environment design, so it was searched separately. Subsequently, the next set of searches involved keywords concerning these journey aspects. The initial search resulted in a total of 771 (Scopus: 341, Web of Science: 210 and Science Direct: 220) articles relating to the physical built environment; 162 (Scopus: 87, Web of Science: 50 and Science Direct: 25) articles relating to shared spaces; and 925 (Scopus: 458, Web of Science: 247 and Science Direct: 220) articles relating to PT. In total, the initial search identified 995 articles in Scopus, 560 articles in Web of Science and 582 articles in Science Direct. After the screening process, 10 articles concerning the physical built environment, 6 for shared spaces and 21 for PT were deemed appropriate for inclusion in the review.

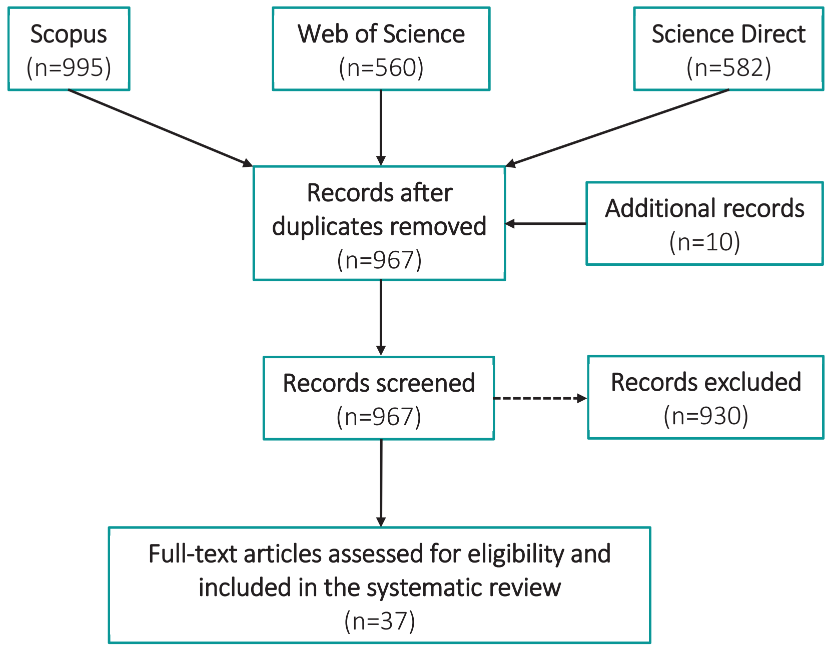

Figure 2.2: Flowchart of the article selection process

2.3 Policies, regulations and standards

2.3.1 Shortcomings of policies

A number of laws such as Australia's Disability Discrimination Act 1992, UK's Disability Discrimination Act (DDA) 1995, and most notably, The Americans with Disabilities Act (ADA) of 1990 have been enacted to increase participation, facilitate independence and improve access for people with disabilities. Despite having policies and standards in place to help realise these ideals, barriers to participation still persist, constituting to ongoing social exclusion. The current top-down approach for the development of accessibility regulations does not necessarily translate into measures that adequately address the issues of people with disabilities (Velho et al., 2016).

Studies suggest standards for inclusive design are inflexible and lack comprehensive guidance for practitioners, especially for complex or uncommon situations (Tennoy et al., 2015). To make matters worse, standards across various countries appear to address the high-level needs of disability that do not consider the detailed features of the environment (Rosenberg et al., 2013), which then translates into designs that barely meet the minimum accessibility requirements. For standards to be truly effective in addressing accessibility issues, design specifications should cater to the least capable person. The issue is further exacerbated by ambiguous terms used in standards such as '*reasonable*' access, which is not defined, and values are often decided by providers rather than users (Evans, 2009). Therefore, a bottom-up approach is needed to capture the subtleties that constitute to the persisting barriers for people with disabilities.

2.3.2 Vulnerable users are not homogenous

The need for policies to take into account of the variation in health and physical abilities of elderly has been highlighted by Kim et al. (2014), and the need to change the assumption towards elderly above the age of 65 being homogenous. This statement is supported by many studies which recognised the differences in needs, and thus, categorised elderly as young (65-75) and old (over 75) years of age (Alsnih & Hensher, 2003; Kim et al., 2014; Waara, Risser, & Ståhl, 2013). Conversely, studies focusing on disabilities appear to assume the needs of disabilities within the same category are homogenous and does not differentiate them as evident in studies examining the elderly. The elderly, based on age, can display varying functional limitations. Similarly, people with disabilities will exhibit a range of different functional limitations depending on the type and severity of the disability (Tyler, 2006).

2.3.3 Universal design

The Anti-Discrimination and Accessibility Act 2008 in Norway has made it mandatory to include universal design (UD) measures. The definition of UD varies across different countries and disciplines. It can be defined broadly as the design of infrastructure, in particular, the transport systems in place to provide mobility that is usable to the greatest extent possible by users' of all abilities (Odeck, Hagen, & Fearnley, 2010; Story, Mueller, & Mace, 1998). However, Fearnley (2011) notes that there are some distinct implications with the Norwegian Anti-Discrimination and Accessibility Act definition of UD, which they defined as *"designing or accommodating the main solution as regards to physical conditions so that [the facility] can be used by as many people as possible"*. Most notably, the primary intention of UD measures is to benefit as many passengers as possible but does not necessarily consider the needs of disabled people.

Therefore, the definition of UD does not mean “accessibility for all” as specific provisions to accommodate people with disabilities are still absent (Visnes Øksenholt & Aarhaug, 2018).

Given that people with disabilities form the minority, there is a notion by planners that UD projects that address accessibility issues for transport will be unprofitable from a socio-economic point of view (Imrie, 2000). This concept can be illustrated in the form of a skewed distribution curve for the level of mobility and the benefit/cost ratio, shown in Figure 2.3. Given that people with disabilities form a minority in the population, the benefit/cost ratio will naturally be scored lower for accessibility projects that are catered for them as opposed to non-disabled individuals. For those sitting on the extreme ends of the spectrum, it is too impractical to accommodate them. In these cases, other alternatives such as more personalised solutions will be required to cater for them.

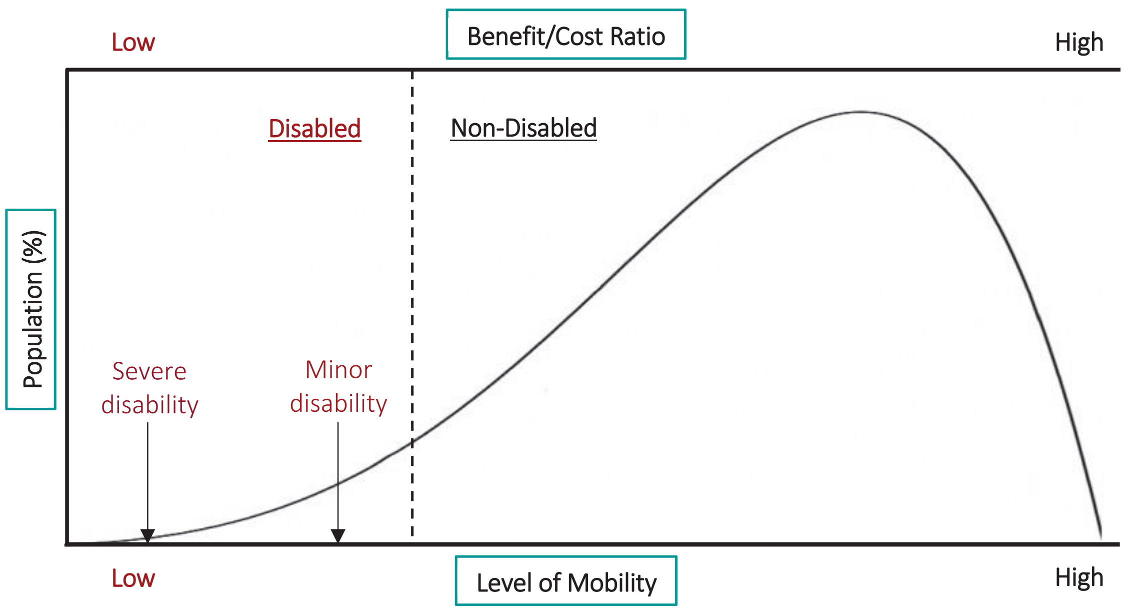

Figure 2.3: Distribution of the level of mobility and benefit/cost ratio for disabled and able-bodied people

However, a study by Odeck et al. (2010) challenged this notion, which conducted an economic appraisal of UD projects in transport using the Benefit-Cost Analysis (BCA). The findings revealed that UD projects provide benefits greater than investment costs due to the improved ease of usage and time savings for all users of the system, including those without disabilities. Maynard (2007) showed that the benefits of disabled access in PT, specifically trams, can be economically appraised using BCA. Accessibility elements such as audio-visual information at bus stops, the elevation of stops and buses' access ramps were valuated for varying types of people with reduced mobility (Cepeda, Galilea, & Raveau, 2018). Fearnley (2011) established a robust set of valuation of measure for improved 'accessibility for all' in PT in Norway. However, their study excluded inclusive design measures that target passengers with specific needs and focused on measures that benefit as many passengers as possible.

Furthermore, studies have highlighted the challenges of implementing universal/inclusive design solutions to be fully accessible due to financial and organisational constraints (Kántor-Forgách, 2010; Rosenberg et al., 2013), and physical constraints from existing infrastructure (Chin & Menon, 2015). Barrier-free measures can be incorporated in new pedestrian facilities but retrofitting older facilities are difficult as modifications are costly and difficult to implement due to limited space. Therefore, the lack of retrofitting due to these limitations constitutes to the ongoing transportation issues in the network (Larkins, Dunning, & Ridout, 2011).

2.4 Physical built environment

2.4.1 Key issues

A typical PT journey requires walking at the start, end, and when making a transfer. This is when considerable interaction with the physical built environment takes place (Litman, 2003; Woldeamanuel & Kent, 2015). In this thesis, the term "built environment" refers to human-made structures, notably footpaths and recreational structures to facilitate an individual's mobility (Handy, Boarnet, Ewing, & Killingsworth, 2002; McCormack et al., 2004).

Barriers in the physical built environment have been highlighted as a constant issue for disabled pedestrians. The challenges of accessibility in a PT journey start as soon as the user leaves their home, making it difficult to use the mode in the first place. The lack of sidewalks and poor quality footpaths such as uneven surfaces due to cracks and potholes were identified as an issue for the mobility impaired, visually impaired and the elderly (Ahmad, 2015; Gallagher et al., 2011; Jenkins et al., 2015; Phillips, Walford, Hockey, Foreman, & Lewis, 2013; Rosenberg et al., 2013). It creates a risk for falling for those with visual impairment and makes manoeuvring difficult for those with physical impairments, especially those relying on walkers and wheelchairs. Further, steep gradients, poor quality or the absence of kerb ramps mean they cannot leave the footpath to cross the road (Bromley, Matthews, & Thomas, 2007; Meyers, Anderson, Miller, Shipp, & Hoenig, 2002; Rosenberg et al., 2013). The lack of amenities such as shelter and resting spots (Rosenberg et al., 2013), lack of lighting, which can hide potential trip hazards to travel safely and makes reading signs difficult for those with low vision (Rosenberg et al., 2013) and to a lesser extent, noise that masks audible information for visual impaired (Jenkins et al., 2015) were also found to be issues.

Unexpected obstacles on footpaths can have a deterring effect on journey experiences, to the extent that some are unable to complete their journey. Construction blocking footpaths and causing uneven surfaces were highlighted to be one of the significant issues, ranging from the placement of signage and cones to the total blockage of a footpath. This causes some travellers to return home if accessible detours are not available (Burdett & Pomeroy, 2011; Gallagher et al., 2011). Other barriers include the lack of crossings, especially on busy roads and the lack of audio announcements (Bromley et al., 2007; Wu, Li, & Li, 2017). For wheelchair users, street crossings posed difficulties but surprisingly did not affect those with hearing impairments. In unsignalised crosswalks, Pecchini and Giuliani (2015) stressed that it is fundamental to examine the interaction between drivers and pedestrians, but studies tend only to examine the physical aspects. Around 56% of older people were found to feel more unsafe during their movements on pavements (Basbas, Konstantinidou, & Gogou, 2010). Conversely, Rosenberg et al. (2013) found that most disabled people, including the elderly, felt safe. Chin and Menon (2015) described the physical measures used in Singapore for barrier-free travel by taking into account existing issues in the built environment. Table 2.1 shows some of the key issues found in the built environment aspect.

Table 2.1: Findings in the physical built environment aspect

Reference	Method type	Country	Study Focus	Key findings
(Gallagher et al., 2011)	Focus group	Ireland	Vision impairments	Inconsistent footpaths and roadworks.
(Lamont, Kenyon, & Lyons, 2013)	Focus group	UK	Dyslexia	Poor presentation of travel information.
(Phillips et al., 2013)	Observational	Wales	Elderly	Poor signage, confusing spaces, poor paving, sensory overload.
(Tennoy et al., 2015)	Interview, Seminars	Norway, UK, Europe	Vision impairments & practitioners	Lack of detailed guidance in standards (for example, simple recommendations that do not consider complex situations). Inconsistent tactile paving usage.
(Ahmad, 2015)	Interview	Pakistan	Mobility impairments	Poor footpaths hindering smooth movement, crowded side roads/walkways.
(Rosenberg et al., 2013)	GPS mapping, Interview	US	Mobility and vision impairments	Kerb ramp availability and condition, hills, aesthetics, lighting, ramp availability, weather, presence and features of crosswalks, availability of resting places and shelter on streets, paved or smooth walking paths, safety and traffic on roads.

2.4.2 Approaches for data collection

Numerous studies employed qualitative and quantitative methods, including focus groups, interviews, surveys and observations to identify accessibility and mobility issues of the physical built environment and to gain a deeper understanding of the needs of disabled people. Gallagher et al. (2011) involved participants with a range of visual impairments to explore issues, but the association of issues with visual levels are not examined. Jenkins et al. (2015) emphasised that studies lack information on the severity of the visual impairment of the participants. Tennoy et al. (2015) also highlighted that there is a lack of systematic and research-based knowledge on how visually impaired people actually orient and find their way in complex pedestrian environments. Further, there is a lack of empirical evidence published about how to help and address the needs of older pedestrians travelling on foot, especially in terms of safety (Tournier, Dommes, & Cavallo, 2016). Studies employing these qualitative/quantitative methods were primarily based in the European context.

Audit-based assessments were employed on the basis of the requirements found in guidelines and regulations against various aspects of the physical built environment. Faruk et al. (2010) measured accessibility of pedestrian crossings while taking into account of important features of the walking environment against established design guidelines. Larkins (2011) evaluated bus stop accessibility of a university bus system in American College Campuses. However, university and work-related sites were observed to have the lowest proportion of elderly and people with disabilities and trips made to these areas (Burdett, 2015; Titheridge et al., 2009). Burdett (2015) showed that accessibility could be measured objectively through pedestrian counting as an indirect way of measuring accessibility performance against guidelines. However, this objective measure does not capture the underlying issues to why an individual does not travel, and it is biased towards people that travel. Unlike qualitative studies which explore the perception of accessibility issues in-depth, objective-based studies only consider the high-level issues in the environment. Studies that rely on guidelines to conduct an audit-based approach are limited to the quality of the standards, which were found not to be comprehensive enough (Tennoy et al., 2015). There is a lack of comprehensive guidance regarding temporary traffic management which was found to be a frequent barrier to access for disabled people and highlights the limitations of the current guidelines (Burdett & Pomeroy, 2011).

2.5 Shared spaces

2.5.1 Role of shared spaces in the travel chain

Shared spaces, also called “shared streets” or “shared zones” is a pedestrian-friendly urban design in the built environment that promotes equality and social interaction by integrating multiple modes of transport (pedestrians, cyclists, and motorists) to have equal rights in the same road space (Hamilton-Baillie, 2008a). Shared spaces are different from conventional roads in the sense that it lacks separation between footpaths and traffic lanes (Hamilton-Baillie, 2008b). The concept of shared spaces places more emphasis on the place rather than mobility function as that of a conventional street (Karndacharuk, Wilson, & Dunn, 2013).

The popularity of shared spaces continues to increase in many countries because it enriches the areas undergoing economic revitalisation and meets the desires of the public (Hamilton-Baillie, 2008a; Imrie & Kumar, 2011). Due to these benefits, shared space concepts are now becoming a larger part of PT journeys by replacing some conventional roads along typical pedestrian routes and surrounding areas of PT terminals. Figure 2.4 depicts the interaction between these journey aspects.

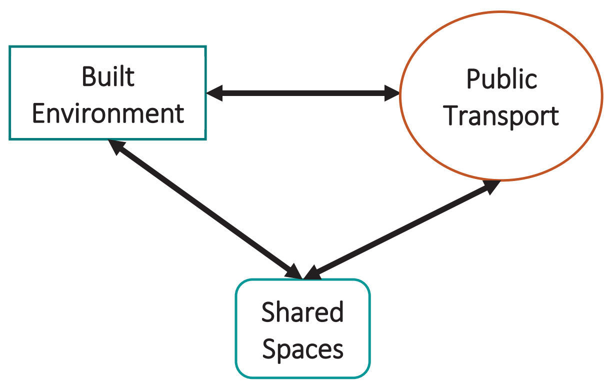

Figure 2.4: Interaction of shared spaces between the built environment and public transport in a journey

2.5.2 Perception of accessibility in shared spaces

Concerns for shared space accessibility has been highlighted in many studies because social behaviour and navigation in the shared space environment is dependent on skills to pick up visual cues and to process that information to negotiate a shared space safely due to the absence of signs and traffic signals (Earl et al., 2016; Havik et al., 2012; Imrie, 2012). Perception studies explored how vulnerable pedestrians, namely visually impaired, navigated around shared spaces in order to understand the challenges they face. Generally, the key issues that were highlighted were regarding safety from traffic and cyclists (Havik et al., 2012; Imrie, 2012), inconsistent kerb heights throughout the space (Hammond & Musselwhite, 2013; Parkin & Smithies, 2012) and non-optimal placement of tactile pavings (Havik et al., 2012; Parkin & Smithies, 2012). Orientation issues due to a lack of demarcation between carriageway and footpaths (Havik et al., 2012; Havik et al., 2015; Imrie, 2012) and obstacles such as street furniture and randomly parked cars affected the users' confidence and navigation capabilities

(Havik et al., 2012; Parkin & Smithies, 2012). Table 2.2 highlights the key issues found in shared space environments. Havik et al. (2015) concluded that shared spaces were perceived more negatively than conventional streets. On the contrary, Hammond and Musselwhite (2013) found that the majority of participants were not concerned and preferred shared spaces.

Studies exclusively examined shared space perception in mid-block areas but did not include user perceptions at the entrances and exits (intersections) (Hammond & Musselwhite, 2013). The only exception to this statement is a study by Havik et al. (2012), who highlighted that entrances/exits of shared spaces had low detectability. It is important to note that shared spaces at intersections, in general, are prioritised for vehicle movement, which compromises safety and the place function (Karndacharuk et al., 2014).

Table 2.2: Findings in the shared spaces aspect

Reference	Method type	Country	Study Focus	Key findings
(Curl, Ward Thompson, & Aspinall, 2015)	Interview & survey questionnaire	UK	Elderly	Street interventions involving shared space concepts improved the perceptions of how easy it is to walk on the street and increased activeness.
(Earl et al., 2016)	Field study	Sweden	Intellectual impairments	Lower traffic speeds are necessary to provide vulnerable users more time to process safety information.
(Hammond & Musselwhite, 2013)	Street Audit, Focus Group, On-street questionnaires	UK	Mobility impairments, vision impairments & elderly	Inconsistent kerb heights, vehicles inhibit social interaction. Insufficient consultation.
(Havik et al., 2012)	Expert judgement review panel survey	Netherlands	Vision impairments	Absence of demarcation, Cyclists, insufficient brightness contrast markings, Absence of tactile warnings, absence of guidance paths and designated parking places.
(Havik et al., 2015)	Observations & interviews	Netherlands	Vision impairments	Orientation issues and navigation around shared spaces is more difficult than conventional streets.
(Parkin & Smithies, 2012)	Questionnaires, interviews & observations	UK	Vision impairments	Unexpected obstacles, issues surrounding the use and interpretation of tactile pavings.

Studies exploring the perceptions of vulnerable users regarding the accessibility of shared spaces were predominately cross-sectional in nature. On the other hand, Curl et al. (2015) undertook a longitudinal based study to explore the changes in perception of the ease of walkability for elderly towards various streets before and after shared space intervention. Overall, shared spaces were shown to have improved the perceived walkability. However, which particular aspect of the intervention resulted in this positive perception is unclear.

2.5.3 Non-homogenous effect of shared spaces

Havik (2012) extracted characteristics from the Dutch accessibility manual that applied to visually impaired users, which were compared against existing shared spaces. It was found that none of the locations met all of the accessibility guidelines, while some locations met it more than others. Of particular interest were the design characteristics of shared spaces, which appear to vary across different countries and contexts, such as narrow, one-way street, two-way, presence of a roundabout, and the types of amenities, which have an impact on the shared space environment and in turn present different issues for different types of vulnerable users.

Results from a controlled laboratory experiment showed that the requirements for shared space surfaces (delineators) are different for people with visual impairments from those with mobility impairments (Childs, Thomas, Sharp, & Tyler, 2010). Hammond and Musselwhite (2013) explored the perceptions and attitudes towards shared spaces for people with mobility impairments, visual impairments and the elderly. Participants were further subcategorised according to the extent of their disabilities. This also differentiated individuals within the same categories of disabilities. Despite sample sizes being too small to make a conclusive statement, the results indicated common issues that applied to different groups. Imrie (2012) concluded shared spaces are a flawed design in the sense that the “underlying conceptions of shared space do not differentiate sufficiently between different categories of disabled people”, but also does not identify, in enough detail, of the various ways that different types of impairments interact within this environment.

2.6 Public transport

2.6.1 Key issues of accessibility

Issues relating to PT facilities included the lack of shelter, poor lighting and safety (Ahmad, 2015; Crudden, McDonnall, & Hierholzer, 2015), long distances to PT stops (Jansuwan, Christensen, & Chen, 2013; Jensen, Iwarsson, & Stahl, 2002) and inaccessible transport vehicles (Jensen et al., 2002; Lindqvist & Lundälv, 2012). The location of priority seats in the vehicle, close to both the driver and door is very important (Gallagher et al., 2011). Variations in the internal layout of buses can make it very difficult for the visually impaired to find a seat, as they rely on memory to navigate (Gallagher et al., 2011). Asplund et al. (2012) indicated that with all means of transport, physical constraints when boarding, moving around on-board and disembarking have been perceived as the most common barriers, correlating to a higher chance of an accident due to inadequate design, and especially steps in buses (Gallagher et al., 2011). The physical aspect of accessibility is often examined, but this applied mainly for physical and sensory disabled persons. The platform infrastructure, such as gaps and/or non-level access between platforms and buses/trains was highlighted as a common barrier for those with physical impairment as wheelchairs and walkers cannot access the vehicle (Karekla, Fujiyama, & Tyler, 2011; Soltani et al., 2012).

Studies investigating the needs of intellectual disability and other non-physical disabilities revealed communicative issues, especially traveller information (Ashton et al., 2008; Waara et al., 2013). Key issues for this aspect of disability included difficulty obtaining information due to the unavailability of audio announcements and suitable timetables (Ahmad, 2015; Lamont et al., 2013; Risser, Iwarsson, & Ståhl, 2012) and unhelpful attitude from PT staff (McEvoy & Keenan, 2014; Risser et al., 2012). In particular, poor drivers' attitude was found to be the greatest barrier to PT use in a previous study by Park and Chowdhury (2018). Visually impaired travellers rely on drivers to announce the stops for them where audio announcements are not available. Generally, these accessibility issues tend to be superficial and does not consider the user's experience. Table 2.3 shows the key findings from studies in the PT let of the journey.

Table 2.3: Findings in the PT leg of the journey

Reference	Method type	Country	Study Focus	Key findings
(Ahmad, 2015)	Interview	Pakistan	Mobility impairments	Poor terminal facilities: inadequate shelter, insufficient lighting, timetable unavailability, inappropriate entrance-exit, poor security arrangements, uncomfortable seats and inadequate toilets.
(Ashton et al., 2008)	Interviews + observations	Australia	Aphasia	Importance of addressing communicative aspects of accessibility within PT systems.
(Crudden et al., 2015)	Survey	US	Vision impairments	Difficulty getting to destination, inconvenient, did not feel safe using PT, unreliable, poor shelter from weather while waiting, lack of access to PT.
(Falkmer et al., 2015)	Q method	Australia	Autism Spectrum Disorder (ASD) & neurotypical adults	Electronic ticketing is primary facilitator for PT usage. Crowding on PT highlighted as issues for ASD.
(Gallagher et al., 2011)	Focus group	Ireland	Vision impairments	Urban: Lack of uniformity (bus) and access issues to board/alight buses, Rural: lack of available PT.
(McEvoy & Keenan, 2014)	Focus group	Ireland	Intellectual impairments	Treated unfairly on PT, unhelpful attitudes among PT staff.
(Risser et al., 2012)	Interview + observations	Sweden	Cognitive functional limitations	Fast moving car traffic while crossing for the bus stop. Difficulty to obtain information prior to and during the trip. Lack of finding information while communicating with bus drivers.
(Velho et al., 2016)	Interviews	UK	Wheelchair users	Bottom up approach required for guidelines. Solutions to barriers in accessibility is not an end point. Wheelchair users develop tactics to deal with issues.
(Waara et al., 2013)	Survey questionnaire + focus group	Sweden	Elderly and functional limitations	Online traveller information services reduce transport anxiety.

2.6.2 Methods for PT data collection

Qualitative and quantitative methods including interviews, focus groups and surveys were primarily employed to investigate accessibility issues in the aspect of PT. However, the voluntary nature of qualitative studies means the wider disability population are not fully represented because the ends of the spectrum of disabled people are likely to be left out. Falkmer (2015) used comparative studies to gain an insight into perceived underlying barriers between Autism Spectrum Disorder (ASD) and neurotypical adults which showed that issues are prioritised differently between the two groups. Safety was revealed as a key aspect for the neurotypical group that may discourage PT, but ASD did not report safety issues as a barrier to PT (Falkmer et al., 2015). Velho et al. (2016) and Waara et al. (2013) used a mixed-methods approach to focus on the physical aspect and non-physical aspect, respectively. Velho et al. (2016) showed that inclusive designs still present accessibility problems for wheelchair users and emphasised the need to not treat the implementation of accessibility solutions as the endpoint. The "engineering approach" takes into account of the finer details of accessibility issues whilst the current sociological perspective does not. This highlights the need for more empirical evidence in the PT aspect.

2.6.3 Entrances and exits of terminals

There is limited literature investigating the accessibility of entrances/exits of PT interchanges in regards to the transition between the built environment and PT interchanges. It was revealed that interchange accessibility was poor for users in terms of infrastructure meeting their needs (Mehmood, Georgakis, & Booth, 2015). Likewise, inappropriate entrances/exit of PT terminal facilities were raised as a concern but was not explored in detail (Ahmad, 2015). Accessibility at bus stops is studied but not PT interchanges (Carlsson, 2004; Larkins et al., 2011). Poorly positioned bus stations/stops, vulnerable individuals having to cross the road to the bus stop/station encountering fast-moving vehicles (Risser et al., 2012) and long alternative routes to PT terminal entrances were highlighted as issues (Maynard, 2009).

2.6.4 Transfers in an integrated PT system

Many studies (Guo & Wilson, 2011; Iseki & Taylor, 2009) investigated how to make transfers more attractive to increase the ridership of a PT system. Trip attributes, such as travel time, transfer waiting and walking time were found to significantly influence users' perception (Chowdhury & Ceder, 2013; Eboli & Mazzulla, 2012; Zhou et al., 2007). Travel time is an important factor that governs the ridership of most PT systems (Stradling, 2002). In terms of transfer time, waiting time is perceived to be more a burden than walking time (Iseki & Taylor, 2009). This is related to the perception of waiting time to be unproductive time (McCord, Wirtz, & Mishalani, 2006). A shorter transfer waiting and walking time relieves the perceived burden of making transfers, especially in unpleasant waiting conditions (Iseki & Taylor, 2009). Other trip attributes such as availability of real-time information (Grotenhuis, Wiegmans, & Rietveld, 2007), personal safety (Singleton & Wang, 2014) and weather protection (Chowdhury et al., 2014) also influence users' willingness to make transfers. Chowdhury and Ceder (2013) discussed that transfers need to be planned in the early stages of design in order to make them efficient and attractive. The study argued that delaying the designs of transfers to later stages, which is the common practice, makes it difficult for practitioners to make them seamless. A study by Chowdhury et al. (2015) showed that, on average, PT users' desired at least a 33% reduction in their current travel time for a direct route and at least a 16% reduction in their current travel cost, given basic comfort at the interchange, to use routes with transfers. For an interchange with more comfort, on average, users desired at least a 25% reduction in their current travel time and at least a 10% reduction in their current travel cost.

However, the focus of these studies has been on able-bodied users. An integrated system means that a disabled PT user will need to interact more with the urban environment. Considering people with disabilities have varying needs and level of ability for movement, if the designs of transfer hubs and connection times do not meet the requirements of this group of users, it will discourage them from receiving the full benefits of an integrated system.

2.6.5 Advancements in PT services for the mobility disadvantaged

The increasing awareness regarding the inadequate provision of accessible PT services has resulted in advancements along with the recognition for areas of improvements. The use of favourable features has been adopted such as the outside colour of buses, colour contrasting grab rails, kneeling buses, Braille on bell-pushes, reduction of steps on and off vehicles, audible announcements, and train managers on newer carriages (Casey, Brady, & Guerin, 2013). In rail (metro) systems with multiple elevations, lifts with stairs and ramps with stairs have been implemented to better satisfy the requirements of the disabled users (European Conference of Ministers of Transport, 2004; Maynard, 2009). Furthermore, studies have indicated the importance of providing seating at appropriate points throughout PT terminals for the disabled and elderly (Cullen, 2006), as well as the location of priority seats in the vehicle, close to both the driver and to the entrance/exit, in order to ease communication with the driver and minimise the walking distance (Gallagher et al., 2011; Soltani et al., 2012).

In terms of technological advances, audible announcements to assist passengers with more severe sight loss have improved. In a study by Pavey et al. (2009), users felt that rail travel has become more accessible in recent years due to the increase of available audible announcements. The introduction of a global positioning system (GPS) provides travel options and allows the required bus to be successfully stopped by obtaining information via mobile phone (Casey et al., 2013). The development of command sets, interactive wireless transmission modules and mobile applications, such as POI Explorer and PT Explorer have been a huge benefit for visually impaired PT users (European Conference of Ministers of Transport, 2004; Korbel, Skulimowski, Wasilewski, & Wawrzyniak, 2013; Wang, Chen, Rau, & Yu, 2014). Combined with the built-in text to speech modules for Android and iOS-based smartphones, the applications focus on urban navigation to and through PT terminals and services while providing numerous ways of accessing data from PT passenger information systems (Korbel et al., 2013). This enables visually impaired users to receive PT service information such as approaching vehicles, service numbers, departure times and temporary changes in routes (European Conference of Ministers of Transport, 2004; Korbel et al., 2013).

2.7 The whole journey (travel chain)

2.7.1 The accessible journey chain

The ability to use PT is an expression of autonomy and facilitates social interactions (Asplund et al., 2012). PT journeys consist of individual elements that are linked together that make up the ‘accessible journey chain’ (Frye, 1996). Tyler (2002) illustrated this concept in the form of a bus journey made up of seven links. Based on this concept, Zhang (2011) grouped these elements into four phases to highlight the out-of-vehicle and in-vehicle phases, which can be broadly grouped as the ‘Built Environment’ and ‘Public Transport’ respectively, as depicted in Figure 2.5. The out-of-vehicle phase was better highlighted by adding two new elements in the journey chain, ‘Set off from Origin’ and ‘Walk to Destination’, which provides a more comprehensive picture of the journey by considering the links during out of vehicle stages in more detail.

The journey always starts with information because people with disabilities need to be certain that the entire journey is accessible before they set out on a trip. Typically, they cannot adapt easily to the barriers encountered. Sufficient information is required to make an informed decision as to whether it is worth taking PT or should they seek alternative modes (Stage 1). The journey physically begins as soon as they step out onto the built environment (Stage 2 and 3) which then transitions into the PT network (Stages 4 – 7) and back again (Stage 8 and 9). Every element in the chain feeds back into the information used when undertaking the next journey, and therefore, completing the cycle. Accessibility of a link or segment of a journey is only as strong as its weakest link; therefore a truly seamless PT journey can only be achieved if every single element in the journey chain is accessible without a single barrier in between (Burdett & Pomeroy, 2011; Clarkson, Coleman, Keates, & Lebbon, 2013; Maynard, 2009; Wennberg, Hydén, & Ståhl, 2010). The accessible journey chain can be broadly grouped into two main journey aspects as follows:

Built Environment: Phase 2 and Phase 4 are largely concerned with the physical built environment during travel on sidewalks/footpaths (Zhang, 2011).

Shared Spaces: The concept of shared spaces is gaining popularity around the world due to its pedestrian-oriented approach in the built environment. It connects the conventional physical built environment and PT terminals between journey elements 2 and 3 in Phase 2 and between elements 8 and 9 in Phase 4. Shared spaces can also be encountered between conventional physical built environments during a PT journey.

Public Transport: Phase 1 and Phase 3 is related to the process of travelling by PT and using amenities at the station/stop and in-vehicle (Zhang, 2011).

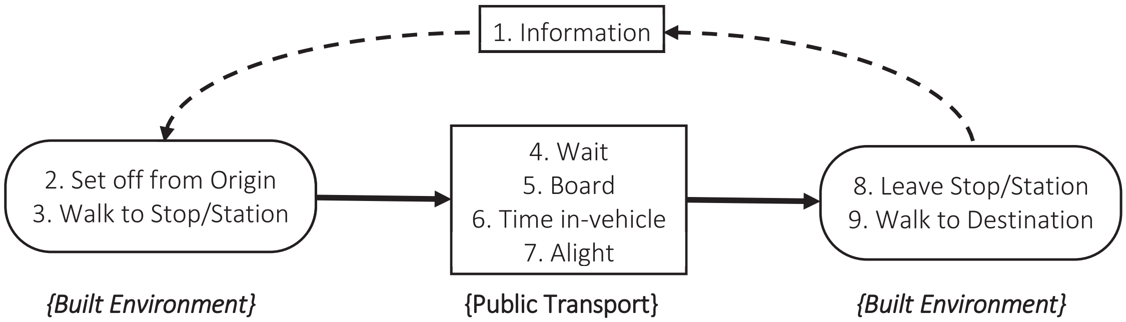

Figure 2.5: The accessible journey chain that includes 9 linked elements and 4 phases (Zhang, 2011)

The level of planning required for people with disabilities to make a seamless journey is not always considered in mainstream transport planning (Maynard, 2009). As such, this group of individuals make fewer journeys on average, travel shorter distances, and by a more limited number of modes. They often need to rely on family members or mobility services when PT services are inaccessible (Deka, 2014).

2.7.2 Accessibility issues related to travel chain

Several studies examined the physical aspects of accessibility issues for the whole PT journey chain using qualitative approaches (Ahmad, 2015; Carlsson, 2004; Gallagher et al., 2011), whereas Jensen et al. (2002) employed an objective method as well to assess and compare accessibility issues. In particular, Ahmad (2015) explored the views of people with physical disabilities towards various transport features, with a focus on amenities, to assess the accessibility level. The study highlighted that PT terminal facilities were rated as the poorest followed by the environmental conditions of the built environment in a journey. However, considering the study took place in a developing country, it is likely that the majority of the issues present in this study are already addressed in most developed countries. Gallagher et al. (2011) focused on visually impaired people and found rural and urban areas presented different issues. In general, poor accessibility to PT was highlighted to be a problem. However, rural areas suffered larger problems due to the unavailability of PT. These studies suggest that a lack of adequate facilities are the main issues in areas that are experiencing deprivation when considering the whole journey chain. However, due to the limited number of studies, this statement cannot be concluded.

Carlsson (2004) studied the usability problems for people with physical and sensory functional limitations. Many barriers associated with the environmental (physical environment barriers), personal (functional limitations) and occupational (activity undertaken) components were identified. The interaction of barriers within these components and between those in different components define the usability problem faced by individuals. Many studies have focused on the environmental and personal barriers but do not take into account the activity undertaken that may increase the environmental/personal demands on the user. Jensen et al. (2002) compared both subjective and objective approaches to evaluate the correlation of accessibility issues. The study highlighted that the sheer variation and complex details of the environment, and person behaviour resulted in accessibility issues that were reported by impaired users not matching what was captured objectively.

In contrast to previous studies that predominantly focused on physical and sensory disabilities, it was suggested that people with non-physical and often hidden disabilities, namely those with aphasia and dyslexia, face a number of barriers throughout the journey chain (Ashton et al., 2008; Lamont et al., 2013). Ashton et al. (2008) noted studies only focused on the physical aspects of travel pertaining to physical impairments and therefore looked into the communicative accessibility within PT systems for users' with aphasia. The study highlighted that issues relating to non-physical disabilities affect able-bodied users, too, such as communication, and therefore a multifaceted approach is needed. Table 2.4 highlights the key findings in regard to the whole journey perspective.

Table 2.4: Findings in the whole journey chain

Reference	Methods	Country	Research Focus	Key findings
(Ahmad, 2015)	Interview & ratings	Pakistan	Mobility impairments	PT facilities rated to be the lowest followed by poor conditions of the built environment.
(Carlsson, 2004)	Focus group	Sweden	Functional impairments	Usability problems or accessibility are affected by three components: environmental, personal and occupational.
(Gallagher et al., 2011)	Focus group	Ireland	Vision impairments	PT generally has poor accessibility; unavailability of PT in rural areas.
(Jensen et al., 2002)	Interview & objective assessment	Sweden	Functional impairments	Environmental details (accessibility problems) encountered during participant observations were not in agreement with the independent environmental assessment of the pilot instrument based on Enabler Concept.

Despite qualitative studies providing insight into accessibility issues of the travel chain, small sample sizes are often highlighted as a limitation (Ashton et al., 2008; Carlsson, 2004; Lindqvist & Lundälv, 2012). Furthermore, studies (Ashton et al., 2008; Jensen et al., 2002) examined regular users of PT on routes that are familiar to them. However, Velho et al. (2016) stated that people were found to adapt to their barriers by developing tactics to overcome issues with routes familiar to them. Therefore, these studies do not represent the full range of issues experienced by disabled individuals.

2.7.3 Social exclusion from barriers to PT use

Barriers regarding the accessibility of PT often stem from the extent to which developers, designers, planners, and policymakers are willing to create environments that work for all members of the community (Appleton-Dyer & Field, 2014). In this regard, policies in central and local government, and within organisations, are important determinants of either supporting or restricting accessibility, and in turn to creating or restricting opportunities for social participation (Overmars-Marx, Thomése, Verdonschot, & Meininger, 2014; Williams, Copestake, Eversley, & Stafford, 2008). Alongside the policy settings, the extent to which the policies are implemented has a significant bearing on if they achieve their desired impacts, and therefore reduce or maintain exclusion (Appleton-Dyer & Field, 2014).

2.8 Research gaps

A critical review of the literature has been carried out to understand the issues faced by people with disabilities when undertaking a PT journey. Based on the findings from previous research, three main research gaps have been identified. The following discusses the identification of each of these research gaps.

2.8.1 Research gap in current policies and standards

Practitioners develop their understanding of the transport needs for people with disabilities referring to a wide range of documents relating to policies, standards and guidelines. Despite policies being in place, literature has shown that barriers to the use of public transit still persist. In most cases, however, due to budgetary constraints, it becomes necessary for practitioners to prioritise accessibility features for improvement that will have the most impact in terms of benefits compared to cost resulting in discrepancies occurring between the practitioner's point of view and people with disabilities (Evans, 2009). To the authors’ knowledge, there have not been any studies which have compared the common needs of people with disabilities with the accessibility features which are prioritised by practitioners, especially which focused on the decision-maker. Gaining such understanding will help decision-makers to understand any differences between the features they prioritise and the features desired by users; thereby informing future decisions to be more inclusive.

2.8.2 Research gap in the perception of barriers in the journey chain

It is evident from previous literature that people with disabilities face a myriad of different types of barriers when travelling independently in a typical PT journey. However, the identification of these barriers is segregated, and there is limited knowledge about their relative importance to the whole journey chain, especially from the perspective of people with disabilities. The “accessible journey chain” concept has highlighted the importance of every element of the chain being accessible; otherwise, the journey is not possible to complete (Frye, 1996). Given that decision-makers are faced with budgetary constraints which hinder their ability to address every barrier means that there is a need to identify the key barriers from the perspective of people with disabilities that would bring the greatest benefits to their mobility, i.e. targeting and addressing the most critical parts of the journey chain. The findings are expected to provide decision-makers with a deeper insight into how trips are made by people with disabilities. This will better inform policymakers, planners, and practitioners to prioritise projects with more impact on improving inclusiveness.

2.8.3 Research gap in travel behaviour related to public transport involving transfers

Improvements to integrated PT systems over the years have made it a more convenient and viable mode of transport choice. The established operational values today along routes involving transfers have largely been developed with able-bodied riders in mind to ease the perceived burden of making a transfer. However, people with disabilities face different challenges compared to able-bodied riders, so these established service levels may not cater to this group of users. A previous study (Chowdhury et al., 2015) has shown that a psychological model depicting users' willingness to make transfers can be used to gain an understanding in this regard. To the author's knowledge, there have not been any studies that investigated these operational values, such as transfer time (walking and waiting) required by people with disabilities. Gaining such an understanding is expected to assist transport planners to reconsider how they design integrated systems required by people with disabilities to make transfers easily to minimise social exclusion.

Although barriers associated with PT has widely been researched, there is limited literature investigating the interaction of people with disabilities in an integrated PT system which influences their willingness to use this route. Integrated PT systems rely on users to make multi-modal transfers to reach many destinations. However, for people with disabilities, this means more interaction with the urban environment compared to a direct route. This can hinder the travel experience of a person with disabilities because of the barriers present in the urban environment in which they have to spend time in. Therefore, further investigation is required to determine the trip attributes which influence the out-of-vehicle phase during transfers on the users' willingness to use routes with it.

Chapter Three

Journey by visually impaired public transport users: barriers and consequences

Reference: Park, J., Bamford, J., Byun, H., & Chowdhury, S. (2017, November). *Journey by Visually Impaired Public Transport Users: Barriers and Consequences*. Paper presented at the 39th Australasian Transport Research Forum (ATRF), Auckland, New Zealand.

Accessibility to public transport (PT) is increasingly recognised as having a significant impact on the livelihood of people who are visually impaired (VI). The ability to travel freely is one of the pre-conditions for participating in society. Over the years, there have been advancements to better cater to the needs of this disadvantaged group of people. Despite the wealth of knowledge on the issues that continue to exist, budgetary constraints mean not every issue can be addressed. As such, many barriers to transport access still exist in the urban environment and PT systems, which often leads to social exclusion. This study attempts to identify and prioritise the key issues that require addressing, from the perspective of VI users, which would bring the greatest mobility benefits in a PT journey, from origin to destination. A series of semi-structured interviews were conducted to identify these issues. A total of 17 VI participants were involved in this study, including 6 with total blindness and 11 with partial vision, to varying degrees. The findings showed that improving bus driver training, more strategically placed pedestrian crossings and better presentation of information as a priority would bring the greatest mobility benefits.

3.1 Introduction

People with disabilities continue to be among the most marginalised group in any society by being unable to enjoy the freedom of mobility to the same extent as able-bodied people. With mobility being one of the preconditions for participating in society, mobility disadvantaged individuals are often excluded, and some are unable to perform typical journeys. Around 15% of the world's population is estimated to be living with some form of disability (World Health Organization, 2011).

Accessibility to PT is increasingly recognised as having a significant impact on the livelihood of people with disabilities. Barrier-free access to PT can transform their lives from one of isolation and dependency to one of social integration and independence (United Nations, 2007). The "social model of disability" (Barnes, 1991) conceptualises that one's disability is contingent upon an inaccessible environment, not an impairment. In this study, the focus will be on people with visual impairments whose ability to travel, and freedom of movement are impeded by their sensory disabilities. To the authors' knowledge, there is still a lack of understanding about the key barriers met by VI PT users during their PT journey, i.e. from home to destination.

The aim of this study is the identification of the key barriers which adversely affects a VI PT users' journey, and how these should be prioritised from their perspective that would bring the greatest benefit to their mobility. This study was undertaken in key cities around New Zealand (NZ), predominantly in Auckland and Dunedin, as well as Christchurch, Wellington and Whanganui, where a total of 17 participants volunteered to take part in a semi-structured interview. Until the key issues are addressed, the cycle of social exclusion will continue as they remain vulnerable and consequently limited in the extent to which they can partake in society.

This study is structured as follows: Section 3.2 presents the summary and research gap based on the review of the literature in Chapter 2 on the barriers and effects of the urban environment on the mobility for people with disabilities and the advancements that have been made to cater for their needs. Section 3.3 outlines the methodology used to collect and analyse the qualitative data, followed by Section 3.4, which presents the results. Section 3.5 presents the discussion; Section 3.6 identifies the limitations in this study, and finally, Section 3.7 concludes the study.

3.2 Summary and research gap

The literature reviewed in this study has highlighted that many issues exist in a typical journey for a disabled PT user. The existence of these issues is the driving force behind social exclusion, which results in a diminished quality of life. Although the focus of this study is for people with visual impairments, it is evident from the literature that these issues overlap with a range of disabilities. However, as opposed to other disabilities, people with visual impairments are confined to using the PT system for mobility. Over the years, improvements have been made to better cater to the needs of disabled people through various advancements in PT services. However, literature has indicated that VI PT users still continue to struggle in their journeys, getting from origin to destination. This suggests that there is still a lack of understanding about the key barriers which, if addressed, would bring the greatest mobility benefits for them, considering that addressing every issue is infeasible.

3.3 Data collection and analysis

3.3.1 Background of New Zealand's PT system

The study was undertaken primarily in the cities of Auckland and Dunedin, as well as Christchurch, Wellington and Whanganui in New Zealand (NZ). Auckland is NZ's largest and most cosmopolitan region, with a population of around 1.6 million. It is the most developed city in terms of the PT system, which consists of three modes: bus, train, and ferry with an integrated ticketing and fare system using the AT Hop card. Wellington and Christchurch also offer multiple modes of transport options for commuting purposes, but not to the extent of advancement as Auckland. However, in Dunedin and Whanganui, the PT system is not as advanced as that of the previous three cities with PT riders primarily using buses to get around.

3.3.2 Semi-structured interviews

The study adopted a qualitative approach using semi-structured interviews. The in-depth contextual and relevant data gained from interviews are considered a critical source of evidence which is not otherwise provided by existing findings (Yin, 2013). Semi-structured interviews also allow the interviewer to probe for more detail while still maintaining structure in order to collect in-depth qualitative data. The interview maintains a conversational tone, such that participants have the freedom to express their views and the chance to explore issues that are important to them (Bryman & Bell, 2015). Topical trajectories may be followed in the conversation that may stray from the guide when appropriate, and an opportunity is given for clarification or further questions if responses are unclear or new ideas emerge (Tashakkori & Teddlie, 2010).

The main purpose of this interview was to uncover the major issues that disabled travellers face in their PT journey and to explore its impact on the user. The interviews were designed to take approximately 30 minutes – 1 hour to permit enough time to explore these issues in-depth, and the responses were audio-recorded.

3.3.3 Sampling strategy

The participants were all volunteers and consisted of people with a vision impairment and who currently use or have used PT for the majority of their journeys. They were recruited primarily using the snowball sampling method and through organisations. Disabled pedestrians are a minority in the population and can be considered as a hidden population to an extent; thus, participants are less accessible. As such, the snowball sampling method was the preferred approach as the approval of the research is assured through personal endorsements made by the respondents when identifying potential participants (Atkinson & Flint, 2001).

In addition, organisations representing disadvantaged groups were contacted to invite potential members to gain more access to potential participants. Email and phone contacts were provided to potential participants to contact the interviewers directly. The goal was to recruit a sample size in the range between 12 - 20 participants as this was when thematic saturation of information was found to occur; thereby, ensuring the validity of the interview data (Crouch & McKenzie, 2006; Guest, Bunce, & Johnson, 2006).

3.3.4 Description of the key questions

To ensure research validity and the prevention of bias, the researchers abstained from asking leading questions that could dictate the direction of the discussion with preconceived notions. These questions were divided into seven different sections, as shown in Table 3.1, with each focusing on various aspect of the journey for VI users.

Table 3.1: Key questions asked in the interview

Theme	Questions
Trip Information	When and for what purposes do you use PT?
Barriers	When considering a typical journey from when you leave your home to when you reach your destination using PT, what parts of the journey present the biggest barriers and why are they an issue?
Consequences	What are the consequences of not being able to make a journey due to barriers in a PT journey? • How does this make you feel? • What impacts does not being able to participate have on your life?
Key issues	What would be the top 3 issues/barriers you would address that would bring the most improvements to your mobility?
Good qualities of a journey	What are the qualities that make a good journey?
Total Mobility Scheme	Have you used the TMS before? • In what situations do you use it and how helpful is it? Would you prefer to use TMS or travel independently and why?
Socio-demographic aspects	Age, gender, ethnicity? What would you identify your impairment as? • Do you experience any additional difficulties?

The first section asks about the participants' experience with PT and the frequency of journeys made involving these facilities. The second section revolves around the experiences of barriers faced during the journey. The third section explores the consequences of not being able to make a journey and the impact of mobility barriers on their lives and the psychological impacts as a result of exclusion. The fourth section examines the top three key issues in mobility that should be addressed from the participants' perspective. The fifth section then examines the qualities of a good journey. The sixth section considers the Total Mobility Scheme (TMS), a government implemented policy, aimed at subsidising taxi fares by 50% for people with impairments (Ministry of Transport, 2017) and whether participants would prefer to use the scheme over PT services.

The last section concludes the interview with a few socio-demographic questions including age, gender, race and a full description of their impairment along with any additional impairments they face.

3.3.5 Description of participants

A total of 17 VI participants were involved in this study, including 6 with total blindness and 11 with partial vision, to varying degrees. Table 3.2 depicts the socioeconomic characteristics of participants with 12 out of 17 participants being female. The data showed that the majority of the participants were in the age range of 45-64 with 8 participants. 12 out of 17 participants identified themselves as NZ European, 4 as European and 1 participant as Mixed-European/African. Participants were also from various cities around NZ. Participants were primarily from Auckland and Dunedin with 8 and 6 participants respectively; whereas there was only 1 participant each from the city of Christchurch, Wellington and Whanganui respectively.

Table 3.2: Socioeconomic Characteristics

Gender	Number	%
Male	5	29.4
Female	12	70.6
Age-range		
15-24	1	5.9
25-44	2	11.8
45-64	8	47.1
65-74	2	11.8
75-84	3	17.6
85+	1	5.9
Ethnicity		
European	4	23.5
NZ European	12	70.6
Mixed European	1	5.9

VI participants have low vision in varying degrees due to different conditions that affect their vision, such as Retinitis Pigmentosa, Macular Degeneration, vision on one side of their eye, and total blindness, including those who require the use of a cane and guide dogs. Many participants, particularly in the high age bands, described having additional minor difficulties due to age-related conditions such as slight hearing loss, slower reactions and poor balance. However, the participants did not consider these difficulties as the main cause of their impediment in a typical journey as opposed to vision-related impairments, which were described as the primary cause of mobility disadvantage.

3.3.6 Transcribing and coding in NVivo

Audio recordings from interviews were transcribed semi-verbatim using the Software *Nvivo*. The transcript was lightly edited, removing false starts (incomplete sentences), repetition (repeated words and sentences), stutters and non-relevant content in order to make the transcript cleaner and easier to read by the software while still capturing relevant parts.

The Qualitative Data Analysis Software program *NVivo 11 for Windows (Version 11.4.1.1064)* was used to categorise the transcribed data. The process of thematic analysis, as described by Braun and Clarke (2006), was followed. This involved a process of coding across the entire data set and then collating the codes into themes. Each transcript was read where relevant words, phrases and sentences were coded.

A code was considered relevant if it was: repeated in several places; new; explicitly stated by the participant as important; or relevant to literature. Themes from within the data were identified using an inductive approach, where the themes were strongly linked to the data collected. Therefore, no predetermined coding frame was used. Instead, it was developed as the data was coded and subsequently applied to all transcripts.

3.4 Results

The results from this study were organised into six themes, based on the key questions asked in the interview.

3.4.1 Trip information

17 participants involved in this study currently use or have used PT in the past, which included one respondent who used it with the accompaniment of somebody else. 4 participants used PT less than once a week, 7 participants used it 1 to 3 times a week, and 6 participants were frequent users of PT using it more than 3 times a week.

The results highlighted that the main purpose of using PT was for recreational purposes, which includes exercise, visiting the Blind Foundation and the library. Appointments such as medical-related, education, shopping, visiting friends and family, and work were the next most common journeys, as shown in Figure 3.1. However, for frequent PT users, their trips were mostly associated with work and educational purposes. These were derived based on the number of times keywords, relating to these trip purposes, were mentioned in the interview responses.

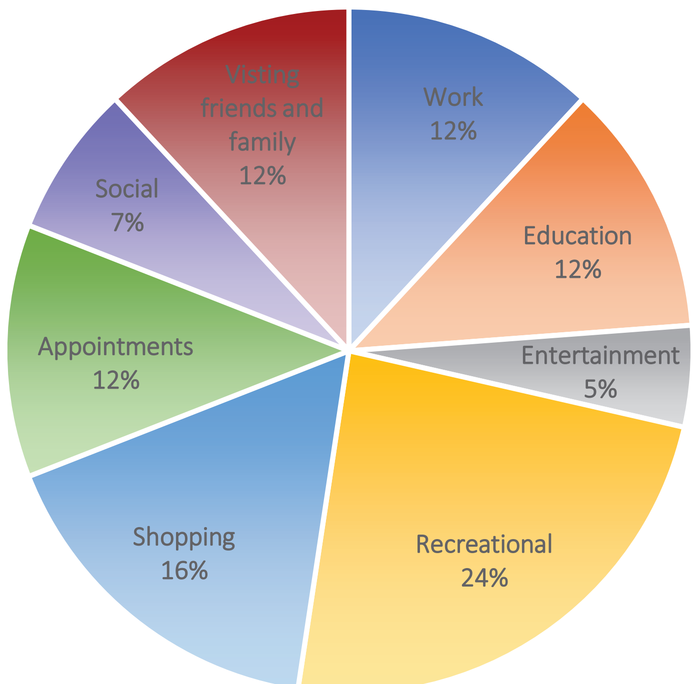

Figure 3.1: Trip purpose using PT

When participants were asked if they had access to any other modes of transport, taxis were the most common alternative as 16 out of 17 participants were covered by the TMS. All of them had access to taxis as an alternative but two participants, who were fully blind, relied on taxis for most of their activities rather than PT. This was followed by family and friends, offering their private vehicle. One participant mentioned tandem cycle as an alternative but only with the accompaniment of another person.

3.4.2 Barriers in a PT journey

Participants described the major barriers that were present in their PT journey and the number of times the issue was mentioned was recorded, depicted in Table 3.3. When the whole journey is considered, from origin to destination, the major barriers can be divided into two broad categories as PT and the physical built environment. Barriers related to the physical built environment category consisted of footpaths (quality, lack of footpaths and obstructions) and construction. Barriers related to PT includes bus driver's unawareness of disabled people's needs, poor bus infrastructure, poor bus service and poor presentation of information. Issues that did not fall into either of these two categories were categorised as other.

Table 3.3: Main barriers in a PT journey

Theme	No. of times mentioned	Description
Bus Driver's Unawareness	18	Buses not stopping despite people waiting at stops and not turning up (8). Followed by the driver forgetting to stop (5) the bus, poor driver attitude and competency (4), and driver language barrier
Bus Infrastructure	6	Steps on bus seats too close, faulty stop button, lack of bright colour to indicate edge, bus buzzers not in the same place and hop card reader does not beep loudly
Bus Service	5	Distance to and from bus stops (3), lack of shelters on bus stops, poor paths to bus stops and no direct bus route to the destination.
Construction	4	Footpath closures, cones obstructing footpath, removal of tactile and noise
Footpaths	12	Particularly obstructions in footpaths from recycling bins, cars and low-hanging branches (5). Followed by undulating footpaths (2) and audio not working for crossings (2). Poor street lighting, lack of footpaths, audio not working for crossings and lack of pedestrian crossings.
Information	13	Poor presentation of information (5) such as contrast, small print, and content of bus routes. Lack of information to choose the correct bus from multiple buses (3). Lack of real-time information (2), Lack of audio announcements on buses and ticketing machines (2) and lack of info on google maps.
Other	3	Lack of national standard for consistency in design like buttons, designs etc. Paying extra for transfer of multimodal PT and lack of knowledge around white canes.

3.4.3 Consequences

The implications of the participant's wellbeing from the barriers present in PT journeys were explored in this section. The consequences of not being able to make a journey due to the barriers in PT includes: being late or not able to go to various appointments; forced to use a taxi; requiring much more planning and thus depriving them of flexibility as they cannot make spontaneous and convenient trips; and social isolation.

When asked about their feelings, as a result, almost every respondent described having a negative feeling towards these barriers as opposed to one participant who did not mind. Table 3.4 presents the various emotions felt by respondents towards barriers in their journeys. In particular, the majority of respondents mentioned feeling isolated, followed by frustration and resentment. The statements are grouped into key themes.

Table 3.4: Feelings towards barriers in a journey

Feelings	Statements by participants
Resentment	"I mean you feel **resentment** that you're being mucked around this much"; "Resentful, you get resentful".
Frustration	"Quite frankly it makes me feel a little bit **frustrated**"; "It is very frustrating and disempowering". "I get a wee bit cross"; "I guess it's just a general sense of frustration"; "At times **pretty annoyed**".
Isolated	"I'm in this cage"; "It limits my contact with friends"; "Well I feel that I'm prevented from taking part in social activities"; "Well, I suppose there is a sense of **missing out on things**"; "So, I feel a bit **isolated** and a bit **lonely** sometimes because you can't go places by myself independently"; "If you know that they are not easily accessed by PT, It just cuts those things out as an option. It's suppressing of the diversity of life".
Stressful	"Having to change buses and go to use unfamiliar bus routes to get to places is **stressful**"; "I'm having a really stressful time because of my vision impairment, I need good lighting".

3.4.4 Qualities of a good journey

If the issues surrounding PT were addressed, 71% of the respondents indicated that they would travel more using PT than they are currently. The other 29% of respondents mentioned it would not affect their frequency of using PT because that is their only source of transport.

Key qualities from the interview results were grouped as follows:

- Bus drivers with a good attitude, good training and competency and better awareness of people with disabilities (9).

- Adequate bus information, including more real-time information of the buses that are actually arriving and reliability of buses (7).
- Good bus infrastructure such as shelters on bus stops conveniently placed bus stops that are closer to lights and on good bus routes (5).
- Obstacle-free footpaths and strategically placed pedestrian crossings (3).
- Other mentions included information in advance of major construction, more affordable pricing, including the integration of the TMS and the smart-card ticketing (AT Hop Card).

3.4.5 Key issues that require addressing

Table 3.5 presents the key issues from the perspective of VI PT users that would bring the most improvements to their mobility if addressed. The issues were grouped as narrowly to keep them as specific as possible. As a result, there were not as many overlaps. For that reason, issues that were mentioned twice or more from different participants were considered and included in the table.

Table 3.5: Prioritisation of key issues that need addressing

Theme	Frequency	Description	Evidence
Bus driver training	5	Driver training and better attitude of bus drivers	“The third one will be driver attitude and training.” “I think driver attitude, you can stop a bus and say is this the bus to queens drive or something and they’ll say can’t you read, or well have a look or no. None of which is helpful. So drivers are important no doubt.” “Better bus driver training would help with that. The bus driver that realising we're not all 100% physical, they need better training.” “Bus driver training would be another issue which would approve greatly the accessibility of the buses.”
Crossings	4	Better location of crossings	“One of my main priorities is pedestrian crossings because I have experienced difficulties in several pedestrian crossing.” “I mean by that is when we think about the design of crossings, the design of corners and streets. We should be really trying to encourage walkability.”
Real-time Information	4	Real-time audio announcement	“We do not have real-time information in Dunedin. That would be wonderful.” “What would be really cool if those things could be programmed because you could push a button to speak but if they were programmed when the bus was within 2 minutes of the thing, the automated thing will say bus number 500 to Howick is approaching.” “It's being able to give people information, real-time information in advance can help, and for those people, you want that.”
Information	3	Good presentation of information	“However, if they had black numbers on a white background, that would make it easier.” “It would be reliable information” “I find the service and information for transport services are all provided in a printed timetable and if there is a timetable at the stop, it will be rather an unsatisfactory size of the print.”
Benefits	2	Revising of the benefits system	“The total mobility scheme hasn't been reviewed for more than 5 years although at the moment it's really great and that it covers up to half price up to 40 dollars. The moment you are over 80 dollars, your mobility card can only cover up to 40. So I would say, a review and increase in total mobility scheme.” “I don't get a benefit. That gets the biggest thing, we are penalised for something we are not planned for and yet if I was young and stupid and if I want to go on the booze and smash my car up and put myself in a wheelchair and I’ll be on ACC and I’ll get a benefit whether my wife works or not.”

3.4.6 Total Mobility Scheme

16 out of 17 participants in this study were found to be covered by the TMS. One participant was not aware of the eligibility of the TMS and therefore, was not included. Everyone covered by this scheme found it very helpful as the scheme reduces the price of taxi fares by 50%. The taxis were mainly used as an alternative mode of transport for when travelling by PT is inconvenient particularly for appointments, where they cannot afford to be late, and for areas that lack a reliable PT route.

When participants were asked whether they prefer to use the taxi or travel independently using PT, the majority of responses (13/17) indicated the latter. Maintaining independence was a major reason to why participants preferred to use PT "We are independent people. We want to maintain our independence for as long as we can."; "I like being independent". However, despite their preference, they were often forced to use the taxi due to inefficient bus routes "I would prefer to use PT if I didn't have to wait for the bus if the frequency of the buses on my route were more"; "if buses were closer to home for instance and more regular, I would've been happy to take them", 5 out of 17 participants due to inefficient bus routes or stops. In reality, participants use both options depending on the situation "Every situation is different depending on where I'm going and what I'm doing. If I have to carry something heavy, suitcase or whatever but if I'm carrying a small amount, I'd rather use PT."

3.5 Discussion

The results from this study showed that many barriers still exist for VI PT users in their journey. The main barriers were due to poor bus driver attitude and competency, obstructions on footpaths, poor information, poor bus infrastructure, poor bus services and barriers from construction. These findings were consistent with the issues and barriers identified in the previous literature, which adds support to previous findings. This suggests that, despite advancements that have been made over the years to better cater to the needs of disabled people, issues which have been identified in the past still exist.

Poor bus driver attitude and competency were highlighted as the most common barrier to travelling by PT and refers to, in large part, the driver's lack of awareness of the needs of disabled people. Training manuals used by bus operators show bus drivers in dealing with VI PT users in the form of bullet points. Nevertheless, as the needs of each people are different, and how much emphasis is placed on catering for disabled people's needs are unknown. This is an important issue that stands out because results revealed that VI pedestrians rely heavily on PT to meet their mobility needs.

The consequences of these barriers included being late or not being able to complete their journey, especially going to appointments, and forces them to use a taxi instead. They described feeling resentment, frustrated, isolated and stressed due to these barriers when using PT as a result of these barriers. 71% of participants said they would travel more than they are currently, if the barriers surrounding PT were addressed.

Trips involving PT were mainly for recreational purposes. However, alternative transport modes such as taxis were often used for going to appointments or for work-related purposes. Journeys involving PT were considered unreliable due to these barriers, and for that reason, users were often deterred from PT use in these situations. Despite the majority of respondents being covered under the TMS, they preferred to use PT instead of taxis to preserve their independence.

The diverse issues present in a disabled pedestrian's journey and budgetary constraints make it difficult for decision-makers to address every issue known. In an attempt to narrow down these issues, participants were asked to prioritise the top three issues to be addressed from their perspective that would bring the greatest benefits to their mobility. The results showed that there were five key issues that required addressing. Bus driver training was prioritised as the highest followed by the better location of pedestrian crossings, availability of real-time information, improved information, and revising of the benefits from the government.

Issues relating to bus drivers align with the most common barriers found in this study and the fact that participants stated that qualities of a good journey could be improved with better bus attitude highlights the importance of improving bus driver training, which would resolve the major key issue to VI pedestrians in a PT journey. This suggests that policies and standards regarding bus driver training are an area that is worth exploring further in future research. Furthermore, buses are a popular PT mode around the world. Considering the majority of the participants were from Auckland, which is a city with a well-equipped PT system means the findings from this study can be applied to other cities around the world that utilise buses.

3.6 Limitations

There were several limitations to this study. Firstly, males were severely underrepresented with 5 of the 17 participants being male compared to 12 being females. Secondly, the sample size was too small to make definitive conclusions of the key issues to be prioritised that would benefit the greatest number of people in this disadvantaged group. A diverse range of issues presented by different people highlights the fact that everyone has a unique set of needs. Without a large sample to find distinct correlations, the key issues may not accurately reflect that of the whole population.

Lastly, Auckland is a city that is currently at the forefront of PT in NZ. PT systems in other cities around the country are not as well developed so issues existing in those cities may have already been addressed in Auckland. Therefore, the barriers experienced by VI users do not paint an accurate picture of the issues that exist in NZ as a whole. For example, buses having steps was highlighted as an accessibility issue; however, in Auckland, almost every bus in service are low floor buses.

3.7 Conclusion

The original contribution of this study is the key issues that were identified and prioritised by VI PT users. Budgetary constraints mean decision-makers are forced to choose between multitudes of potential issues to remedy, and consequently, not every issue can be addressed. Therefore, a semi-structured interview was undertaken which included a total of 17 VI participants, including 6 with total blindness and 11 with partial vision, to varying degrees to identify the key issues that would bring the greatest improvements to their PT journey, from origin (usually home) to destination, if it was addressed.

The findings showed that addressing the following key issues through better bus driver training, more strategically placed pedestrian crossings and better presentation of information would bring the greatest mobility benefit to VI PT users. The results also revealed that common barriers such as poor bus driver attitude and competency, footpaths especially obstructions, poor information, poor bus infrastructure, poor bus services and poor construction still continue to exist. This has resulted in many participants to feel isolated, frustrated and stressed, which support the findings of previous literature. In summary, this study demonstrates the importance of conducting qualitative research for those who are a minority in the community and dependent on PT for their freedom of mobility. Better transport services can alleviate social exclusion for the disabled community by giving them more independence.

Chapter Four

Investigating the barriers in a typical journey by public transport users with disabilities

Reference: Park, J., & Chowdhury, S. (2018). Investigating the barriers in a typical journey by public transport users with disabilities. *Journal of Transport & Health*, *10*, 361-368.

Accessibility to public transport (PT) is increasingly recognised as a critical element in the livelihoods of people with disabilities. Although there have been advancements to better cater to the needs of people with disabilities, budgetary constraints mean that every issue cannot be addressed. There are still many barriers restricting independent travel for this group of people. Social exclusion is often a result of their inability to use or access a PT system. The present study investigates the barriers in a typical journey chain and provides the similarities and differences in the key barriers perceived by people with physical and visual impairments. Participants volunteered from cities in New Zealand. A semi-structured interview was conducted with a sample of people with disabilities. Bus driver's attitude and unawareness of disabled users' needs was a common concern for both groups. The main barriers for physically impaired (PI) users were related to the urban environment, terminals and stops, services, and quality of footpaths. In comparison, the main barriers for visually impaired (VI) users were poor presentation of information and obstructions on footpaths. Based on the findings, the study provides recommendations for policymakers. Future research studies are encouraged to adopt the accessible journey chain when investigating barriers to riding PT.

4.1 Introduction

People with disabilities continue to be amongst the most marginalised groups in society. They are typically unable to enjoy the freedom of mobility as able-bodied individuals. With mobility being one of the preconditions for participating in society, people with disabilities are often excluded, to the extent that some are unable to perform day-to-day journeys. Accessibility to PT is increasingly recognised as having a significant impact on their livelihoods. Barrier-free access to PT can transform their lives from one of isolation and dependency to one of social integration and independence (United Nations, 2007).

Majority of the literature has focused separately on segments of a PT journey when investigating the barriers faced by people with disabilities. Broadly, they were either on the built environment (Jenkins et al., 2015; Rosenberg et al., 2013) or PT (Soltani et al., 2012; Velho et al., 2016). For people with disabilities, any barriers in the built environment can prevent them from using PT in the first place. A limited number of published literature examined barriers with respect to the whole PT journey (Ahmad, 2015; Carlsson, 2004; Gallagher et al., 2011; Sundling et al., 2014). The limitations of these studies include focusing on one type of disability, or the elderly (whose disability was associated with age). For example, Ahmad (2015) focused on physical disabilities in a rural context; while Gallagher et al. (2011) investigated barriers for people with visual impairments in the rural and urban context.

It is evident that there is limited literature concerning the whole journey chain which investigates the similarities and differences in barriers perceived between different disability types. Given the variety of disabilities, this study focuses on the two most common ones, physical and visual impairment. The present study addresses this knowledge gap by adopting the "accessible journey chain" concept. The aim is to identify the key barriers in typical PT journeys undertaken by people with disabilities. The case study is in New Zealand. Around 18% of the country's population is estimated to have a physical or vision impairment (Statistics New Zealand, 2014c). The next section of the study discusses key findings and the corresponding research need from relevant published literature in Chapter 2.

4.2 Research need

It is evident from the review that people with physical and visual impairments face many barriers when travelling independently by PT. However, the barriers are segregated, and there is limited knowledge about their importance relative to the whole journey. This study addresses this gap by examining PT journeys using the concept of the "accessible journey chain". It investigates a typical journey from an origin to a destination, from the users' perspective. This approach allows critical aspects of the journey chain, which can prevent or discourage an individual from using PT, to be examined for those with physical and visual impairments. The findings are expected to provide decision-makers with a deeper insight into how trips are made by people with disabilities.

4.3 Description of case study and data collection

4.3.1 Description of the study area

The present study was undertaken primarily in Auckland (66% of the participants), New Zealand. The other proportions of the participants included those who live in Dunedin (25%), Wellington (3%), Christchurch (3%) and Whanganui (3%). Auckland is New Zealand's largest and most cosmopolitan city, with a population of 1.6 million. The median age of those living in Auckland is 35 years. The median household income is $76,500 per annum, which is the highest across the country (Statistics New Zealand, 2014b). Auckland's PT system is composed of bus, train and ferry.

In 2008, the government produced a document called the Requirements for Urban Buses in New Zealand (RUB) with the purpose of standardising bus requirements across regional councils (New Zealand Transport Agency, 2014). In 2013, the Regional Public Transport Plan (RPTP) was produced (Auckland Transport, 2013). This plan aims to provide people PT users in Auckland with a sustainable transport system that is inclusive, safe, integrated and affordable. In August 2016, a new integrated ticketing system called AT HOP was implemented. This electronic ticketing system does not require the additional purchase of tickets when making transfers. A new mobile application that provides real-time information for navigation also became available. Around 91% of the buses are low floor buses with the ability to kneel to meet the kerb and have manual wheelchair ramps fitted. Seats near the front of the buses are designated for the elderly, and those are access-challenged. Certain buses have audio announcements. The electric trains are equipped with automatic ramps, located on the central carriage doors to allow for wheelchair access between the platform and the vehicle. The trains are fitted with audio and visual announcements. Most ferries allow for wheelchair access on board. All three modes allow for guide dogs to accompany passengers (Auckland Transport, 2017b).

Auckland has the most developed PT system in the country. Wellington offers buses, ferries, train and cable cars for riders; Christchurch provides buses and ferries only. In Wellington, 71% of the vehicles support accessibility features, and certain trains are fitted with a public-address system, automatic station information announcements and information displays. In Dunedin and Whanganui, riders primarily use buses. Some of the newer vehicles are fitted with accessible features such as priority seating areas, low floor with the ability to kneel, and wheelchair ramps to support accessibility. In Auckland, the majority of the vehicles meet the level of service as set out in the RUB. However, in other cities, the level of service is not met to the same extent. Often these guidelines are difficult to implement due to budgetary constraints. This has caused authorities to implement selected accessibility features that are suitable for the local surrounding.

4.3.2 Sampling strategy

The data collection was carried out using the snowball sampling method. For participants to be eligible, they either had to be a current PT user or have used it in the past. Organisations representing disability groups were contacted to invite their members who fit the criteria to participate. Email addresses and phone numbers were provided to organisations so that potential participants could directly contact the interviewers. Once an individual participated, they were asked to invite other people they know. This approach ensured potential participants of the research through personal endorsements. The goal was to recruit a minimum of 12 participants, for each disability type, as this was when thematic saturation of information occurred; thereby, ensuring the validity of the data (Guest et al., 2006).

4.3.3 Semi-structured interviews

Semi-structured interviews were undertaken with each participant. This approach allows for in-depth contextual and relevant data to be attained from the target population (Yin, 2013). The list of questions prepared for the interviews creates a sense of consistency as well as a form of structure. The interview maintains a conversational tone, such that participants have the freedom to express their views and the opportunity to explore issues that are important to them (Bryman & Bell, 2015). Topical trajectories may be followed in the conversation when appropriate; when an opportunity is given for clarification; when additional questions are required for clarifications; and when new ideas emerge.

The purpose of the interview questions was to uncover the major barriers in a typical journey and their impacts on the participants. The interviews were designed to take approximately 30 minutes to an hour, which was audio-recorded with permission from the participants. To prevent bias, the questions during the semi-structured interviews were straight forward and were not asked with any positive or negative tone. The questions were on: (a) purpose and frequency of trip, (b) the barriers they face in a typical PT journey, (c) the consequence of the barriers on their perceived well-being, and (d) socio-demographic characteristics.

4.3.4 Transcribing and coding in NVivo

The qualitative data analysis software *NVivo (Version 11)* was used to categorise the transcribed data. The transcripts were lightly edited by removing false starts (incomplete sentences), repetition (repeated words and sentences), stutters, and non-relevant contents to make the transcripts cleaner and easier to read by the software, while still capturing relevant information.

The process of thematic analysis, as described by Braun and Clarke (2006), was followed. This involved a process of coding across the entire data set and then collating the codes into themes. Each transcript was read where relevant words, phrases and sentences were coded. A code was considered relevant if it was: (a) repeated in several places, (b) new, and (c) explicitly stated by the participant as being important or relevant to literature. Themes from within the data were identified using an inductive approach, where the themes were strongly linked to the data collected. Therefore, no predetermined coding frame was used. Instead, it was developed as the data was coded and subsequently applied to all transcripts.

4.4 Results

4.4.1 Description of participants

A total of 32 participants were involved in this study. Of the 32, 15 participants were PI, including 10 wheelchair users and 5 who used walkers, crutches or walking sticks. The remaining 17 participants were VI, including 6 with total blindness and 11 with partial vision, to varying degrees. Table 4.1 presents the socio-demographic characteristics of the participants. The majority of participants were female, 67% in the PI group and 71% in the VI group. Around 40% of participants in the PI group were in the age range between 65 and 74; while 47% of the participants in the VI group were in the lower age range (between 45 and 64). Majority of the participants identified themselves as NZ European with around 73% and 71% in the PI and VI group, respectively. PI participants were predominantly from Auckland (87%); while 47% of VI participants were from Auckland followed by 35% from Dunedin (a smaller city located in the South Island). All of the participants lived in suburban areas.

PI participants ranged from wheelchair users, due to accidents or having a genetic condition from birth, to using various aids such as walkers, crutches or walking sticks. VI participants ranged from low vision to varying degrees, due to different conditions that affected their vision such as Retinitis Pigmentosa, Macular Degeneration and Hemianopsia to total blindness. The dataset also included those who required the use of a cane and guide dogs. Many participants, particularly in the high age bands, described having additional minor difficulties due to age-related conditions such as slight hearing loss, slower reactions and poor balance. However, the participants did not consider these health issues as the main cause of their difficulties in a typical PT journey.

4.4.2 Trip information

All 32 participants involved in this study currently use or have used PT independently in the past, with the exception of one participant who used it with the accompaniment of another person. Nine participants used PT less than once a week, 10 participants used it 1 to 3 times a week, and 12 participants were frequent users, using it more than 3 times a week. Some of the PI participants mentioned owning a car for short journeys and using PT for longer journeys (typically those greater than 30 minutes). The main purposes of the trips by frequent users were mostly associated with work and educational purposes. For non-frequent users, the main purpose of their trips was recreational and leisure, which included, exercise, visiting the Blind Foundation, the library and attending events. Appointments, such as medical and banking-related, education, shopping, visiting friends and family, and work were the second most common journeys.

Table 4.1: Socio-demographic characteristics

Socio-economic characteristics	Number	
Gender	PI	VI
Male	5 (33%)	5 (29%)
Female	10 (67%)	12 (71%)
Age-range		
15-24	2 (13%)	1 (6%)
25-44	3 (20%)	2 (12%)
45-64	3 (20%)	8 (47%)
65-74	6 (40%)	2 (12%)
75-84	1 (7%)	3 (18%)
85+	-	1 (6%)
Ethnicity		
European	2 (13%)	4 (23%)
NZ European	11 (73%)	12 (71%)
Mixed European	-	1 (6%)
Chinese European	1 (7%)	-
Australian/Aboriginal	1 (7%)	-
City		
Auckland	13 (87%)	8 (47%)
Dunedin	2 (13%)	6 (35%)
Christchurch	-	1 (6%)
Wellington	-	1 (6%)
Whanganui	-	1 (6%)

4.4.3 Barriers in a typical whole journey-chain

The major barriers are divided into two broad categories: (a) the built environment to and from the PT stop/terminal and (b) PT service, as illustrated in Figure 2.5 in Chapter 2. Table 4.2 and 4.3 provides detailed descriptions of the barriers faced by both PI and VI users. Participants named multiple elements which are related to each of the barriers. These barriers were mostly associated with buses as the train services did not require any interaction with the driver and the train stations had better accessibility features for people with disabilities. Issues that did not fall into these two categories were either wet weather or other.

The most frequently mentioned barriers for PI users were the urban environment (steep gradients, alignment of curbs, poor crossing facilities, etc.), design of terminals and stops (e.g. lack of shelters, steep ramps, inadequate access to toilets, etc.). Poor quality footpaths (e.g. cracking of pavements, obstructions, etc.) and services (poor connectivity, reliability, transfer times etc.) were mentioned equal times. The participants mentioned that the service coverage was inadequate and also that the distance to the terminals/stops, in conjunction with poor quality footpaths and reduced ease of accessibility. Bus driver's attitude and awareness of their needs, obstructions on footpaths and information (e.g. poor presentation of information, lack of real-time information, etc.) were mentioned as the main barriers. Bus driver's attitude and unawareness of disabled users' needs was a common concern for both groups. It was a bigger concern for VI participants, shown in Table 4.3.

This finding shows the difference in needs between the two groups. Depending on the level of their visual disability, some of the participants were unable to see a bus approaching and therefore, could not flag the driver to stop. This caused major impedance to complete their journey at a reasonable time. For PI users, many of the drivers would refuse to put a ramp for them to board. Other key barriers faced by VI users include footpaths (obstructions, poor street lighting and lack of footpath, etc.) and information (poor presentation, lack of information, lack of audio announcements, etc.).

Table 4.2: Description of barriers faced by PI participants

	Barriers	No. of times mentioned	Elements (number of times mentioned)
Built Environment	Distance To/From Stop/Station	5	Proximity from origin to stop/station, or stop/station to destination (5)
	Footpaths	9	Poor pavements; tree roots protruding on footpaths and driveways (3); uneven surfaces (2); undulations; cross-fall on pavements; cobbles
	Urban Environment	18	Hills (4); steep and dangerous curb or curb cuts (5); steep gradients (3); tactiles (2); poor intersections; crossing side roads; safety/security of journey to train station; cross buttons that cannot be reached at intersections
	Construction	1	Plastic walkways around construction sites
	Parking at terminals	5	Lack of accessible parking at stations (5)
	Wet Weather	3	Issues caused by wet weather such as the inability to hold an umbrella while using a mobility aid (2) and slipping on buses
Public Transport	Service	9	Poor connectivity; infrequent services; late weekend PT start times; inadequate accessible intracity and intercity bus services; reliability of buses; transfers; time duration as well as on and off points of a journey
	Terminals and Stops	11	Lack of shelters (2); steep gradient ramps at terminals/stations (3); lack of lifts at stations (2); inadequate access to toilets at stations; inadequate number of toilets at stations; inadequate number of tag off zones at train stations; gap between platform and train
	Bus Driver Attitude and Unawareness	8	Poor driver attitude and unawareness (7); buses not stopping
	In-Vehicle Facilities	8	Narrow buses with inadequate space (4); buses which are too steep to get off; steps on buses; inadequate wheelchair restraints on buses; inability of buses to kneel down

Participants were asked to prioritise their top three issues that will bring the greatest improvements to their mobility. Figure 4.1 presents the answers that could be grouped into common factors. It shows the commonalities and differences of these critical issues between PI and VI users. The numbers in the parenthesis provide the number of PI and VI participants who mentioned them. Both groups mentioned addressing the issues associated with driver training on the needs of people with disabilities, connectivity of the network and vehicle facilities (e.g. location of stop button, consistency in vehicle design, space for wheelchairs, etc.).

For PI users, they suggested improvements in the operation of PT services, in terms of greater frequency and operating hours. The terminal facilities that were desired are ease of boarding, slow gradient ramps, adequate toilets and shelters. Availability of accessible car parks at terminals was also important to PI users as many had the ability to drive and would prefer to drive for the first and last mile of their PT journey. The importance of information for VI users is clearly seen from their top three issues to be addressed, especially at terminals such as having good signage and real-time information. Audio announcements in vehicles were a critical service they desired from operators.

Table 4.3: Description of barriers faced by VI participants

	Barriers	No. of times mentioned	Elements (number of times mentioned)
Built Environment	Distance To/From Stop/Station	3	Proximity from origin to stop/station, or stop/station to destination (3)
	Footpaths	12	Obstructions in footpaths from recycling bins, cars and low hanging branches (5); undulating footpaths (2); poor street lighting; lack of footpaths
	Construction	4	Footpath closures; cones obstructing footpath; removal of tactile and noise
	Crossings	3	Audio not working for crossings (2); lack of pedestrian crossings
Public Transport	Information	13	Poor presentation of information (5) such as contrast, small print and content of bus routes; lack of information to choose correct bus from multiple buses (3); lack of real time information (2); lack of audio announcements on buses; ticketing machines (2)
	Service	1	No direct bus route to destination
	Terminals and Stops	2	Lack of shelters on bus stops; poor paths to bus stops
	Bus Driver's Attitude and Unawareness	18	Buses not stopping despite people waiting at stops and not turning up (8); driver forgetting to stop (5) the bus; poor driver attitude and unawareness (4); driver language barrier
	In-Vehicle Facilities	6	Steps on buses; seats too close; faulty stop button; lack of bright colour to indicate edge; bus buzzers not in same place; hop card reader not beeping loudly
	Other	3	Lack of national standard for consistency in design like buttons; paying extra for transfer of multimodal PT; lack of knowledge around white canes

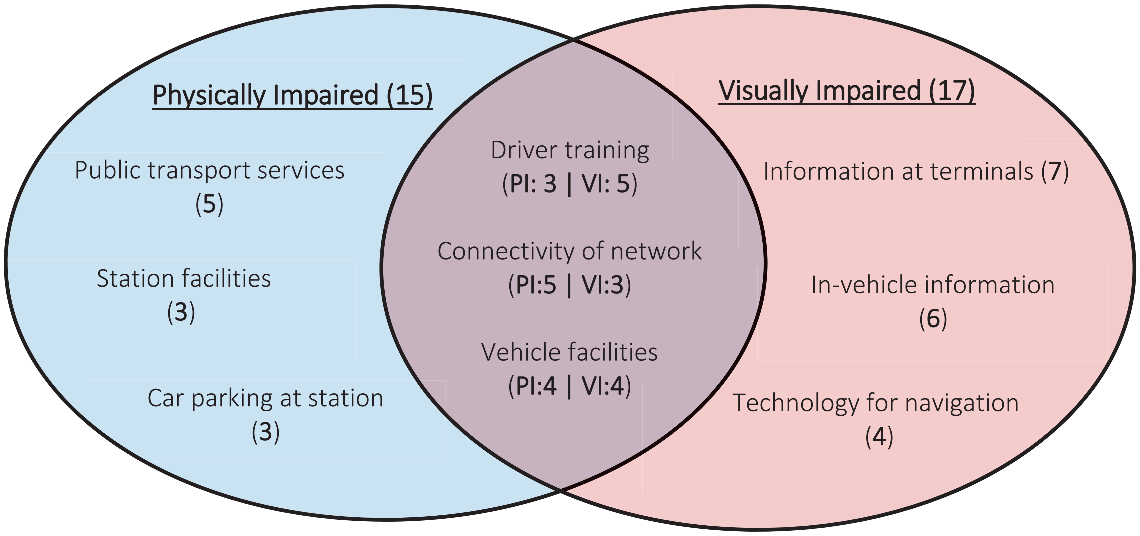

Figure 4.1: Similarities and differences of key issues between PI and VI users

4.5 Discussion

The findings revealed commonalities and differences in the barriers perceived by those with visual and physical impairments. Both groups discussed the importance of addressing issues related to driver training on the needs of people with disabilities, connectivity of the network, vehicle facilities (e.g. location of the stop button, consistency in vehicle design, space for wheelchairs, etc.) and quality of footpaths to ease their travel. For vehicle facilities, participants suggested that keeping the design of the vehicles (both interior and exterior) similar can help them feel more confident to travel independently. Participants also discussed that better services (more frequent and reliable) that support PT multi-modal travel would assist them in reaching more destinations. During the interviews, the participants discussed the unsupportive behaviour from bus drivers and how this had a negative impact on their experience. Many of the VI participants discussed that bus drivers pass them by without stopping, and some spoke rudely to them. PI users discussed that drivers were reluctant to make the additional effort to place the ramp for boarding. It requires a great deal of effort, from planning the trip to overcoming obstacles on the way, for people with disabilities to reach the bus stop. Driver interaction is particularly important for vulnerable users because they form a link between the built environment and PT during the boarding/alighting process. Well-trained workers can significantly improve the journey experience and encourage people with disabilities to travel independently. Many of the participants discussed their desire to be more independent and to interact more with society.

According to New Zealand's Land Transport Management Act (2003), regional councils must consider the needs of people who are transport disadvantaged, which includes people with disabilities, in preparing regional plans. Several guidelines such as the RTS 14 Guidelines for Facilities for Blind and Vision Impaired Pedestrians and the Auckland Transport Code of Practice (ATCOP) have various policies in place for assisting the transport disadvantaged. However, the findings from this study indicate that more focus is required to regulate these policies. An issue with these documents is that they do not offer sufficient guidance for detailed design. It is recommended to collate various relevant standards into one document for disability design and to liaise with stakeholders, who are experts in the area, during the design and planning stage, whether it is for a new or retrofitting existing infrastructure. For example, RTS 14 is a best practice guideline for VI pedestrians. It provides in-depth guidance for designers by integrating relevant pieces of information from external sources and documents them together. Although it is stated in the RTS 14 that "*all new pedestrian facilities shall be designed and installed with features detailed in this guideline*", it also states that "*the use of this document is not compulsory in New Zealand*". As a result, to save costs, designers are likely to continue to meet bare minimum standards and omit essential elements required for accessibility by those with disabilities.

Limitations of this study included the underrepresentation of males, with 33% and 29% of the participants being male in the PI and VI group, respectively. Due to the unique set of individual needs, without a larger sample of different disabilities, the key issues found cannot reflect that of the whole population. One of the main limitations of the snowball sampling method is that similar patterns can arise among the participants. However, for this study, the majority of the participants were volunteers from the disability organisations, and only a few were from referrals.

4.6 Conclusion

The aim of the present study was to identify and prioritise the key barriers in a typical PT journey by those with visual and physical impairments. The study adopted the concept of an "accessible journey chain". A semi-structured interview was conducted, which included a total of 32 participants consisting of 15 PI and 17 VI participants. They were asked about their experiences for a typical journey using PT from an origin (usually home) to a destination. A common barrier for both groups was bus driver's attitude and unawareness of their needs. VI users were more concerned about the interactions they had with bus drivers. As such, well-trained drivers can help people with disabilities feel more confident to use PT. It is recommended that PT operators liaise more closely with key stakeholders in the disability community to review and revise current training practices to offer better educational training to their drivers on the needs of visually and physically impaired users. Participants also discussed that better services to support PT multi-modal journeys and consistency in vehicle design will help them travel more independently.

The findings of the study highlight the importance of interacting with the disabled community and investigating the whole journey (from an origin to a destination). There are several reasons why such studies need to be undertaken more often. Firstly, people with disabilities have unique needs within the group itself. Different disabilities produce different barriers, as was shown in the findings. PI users had a different set of barriers to VI users. There are also some commonalities among the barriers and addressing these common barriers will ease the journey experience for a wider group. Secondly, it is the responsibility of transport practitioners to provide a safe transport system for all. Mobility and inclusion into the community are some of the basic human needs. This study provided some insights into the consequences of these barriers. People with disabilities are considered as vulnerable members of the community. Hearing their needs will make them feel more included in society and less isolated.

The research method used for this study can be replicated in other countries to find key barriers that are unique to their disability community. Decision-makers are encouraged to interact with the disability communities to understand their mobility needs, especially when implementing the infrastructure. A transport network is only efficient when designed from a holistic point of view and for all users.

Chapter Five

Gap between policymakers' priorities and users' needs in planning for accessible public transit system

Reference: Park, J., Chowdhury, S., & Wilson, D. Gap between policymakers' priorities and users' needs in planning for accessible public transit system. *Journal of Transportation Engineering, Part A: Systems*, 146(4), 04020020.

Access to public transit (PT) forms a vital part of the well-being of people with disabilities. However, people with disabilities continue to be challenged in accessing their local PT services. This study investigates the existence of any gaps in users' needs and practitioners' prioritisation of accessibility features. Senior practitioners deemed experts in the field from cities in New Zealand were invited to participate. Data were analysed using the Analytic Hierarchy Process (AHP) to determine the ranking of nine accessibility factors. The most important factors identified by practitioners are crossing facilities (0.19) followed by access to stops/stations (0.17), and quality of footpaths (0.13), all of which are parts of the built environment. The least important factors are vegetation (0.047) and information at stops (0.058), whereas users placed more weight on information at stops (0.097) and vegetation (0.089). Bus driver attitude accounted for the largest disparity in prioritisation between the two groups with a difference of 0.137. The study highlights the need to shift prioritisation closer to the needs of people with disabilities to eliminate barriers.

5.1 Introduction

The ability to stay connected and participate fully in society is essential to an individual's well-being. However, people with disabilities typically do not have the same freedom and the choice of mobility as abled-bodied individuals. Accessibility to PT is increasingly recognised to have a significant impact on their livelihoods because it is a mode that can provide the ability to perform day-to-day journeys independently. However, it is well documented that barriers in the built environment can create barriers to the use of PT systems in the first place. Numerous studies have highlighted that poor accessibility is the driving force of social exclusion for people with disabilities (Currie et al., 2010; Lindqvist & Lundälv, 2012; Titheridge et al., 2009).

A number of laws such as Australia's Disability Discrimination Act 1992, New Zealand's Human Rights Act 1993, UK's Disability Discrimination Act (DDA) 1995, and most notably, the Americans with Disabilities Act (ADA) of 1990 have been enacted to increase participation, facilitate independence and improve access for people with disabilities. Despite having regulations and standards in place, barriers to the use of PT still persist. It has been suggested that standards for inclusive design are inflexible and lack comprehensive guidance for practitioners, especially for complex or uncommon situations (Tennoy et al., 2015). Issues arise when designs cannot support the minimum accessibility requirements (Rosenberg et al., 2013).

Practitioners develop their understanding of the transport needs of people with disabilities from the above-mentioned documents. Due to budgetary constraints, however, it is necessary to prioritise accessibility features that will have the most impact. To the authors' knowledge, there have not been any studies which have compared the common needs of people with disabilities with the accessibility features practitioners prioritise. Because decision-makers prioritise accessibility features for improvement, discrepancies can occur between these two groups (Evans, 2009). A recent study by Park and Chowdhury (2018) revealed some of the main barriers faced by people with disabilities when using PT.

The aim of this study was to determine barriers faced by people whose main disability is either physical or visual and by those who can travel independently. Semi-structured interviews were undertaken with 32 participants, of whom 15 had physical impairments, and 17 had visual impairments. All 32 participants were either current users or had used PT previously. The main barriers for physically impaired users were related to the urban environment, terminals and stops, services, and quality of footpaths. In comparison, the main barriers for visually impaired users were poor presentation of information and obstructions on footpaths. Bus driver's attitude and the lack of awareness of users' needs were highlighted as a significant concern for both groups. To understand why these barriers still exist, this study focuses on the decision-makers. The aim is to determine the accessibility features most likely to be prioritised by practitioners. Senior decision-makers, who have multiple years of experience (more than 10), were invited from major cities in New Zealand to participate. It is expected that the findings will help decision-makers to understand any differences between the features that they prioritise and the features desired by users, thereby informing future decisions.

5.1.1 Research need

The review of the literature has shown that people with disabilities face myriad of barriers in a typical PT journey. These barriers, however, are mainly cited from the users' perspective. On the other hand, there is limited knowledge about the relative importance of these barriers from the perspective of transportation practitioners who can address these issues. Budgetary constraints mean that it is not feasible to address every barrier, resulting in the need to prioritise. The discrepancies in the perceived importance of these barriers between users and practitioners may be the reason that issues to mobility continue to exist for people with disabilities. The findings are expected to highlight the disparities and similarities between the importance of accessibility features from the users' and the decision-makers' point of view to better inform policies and designs to improve mobility for people with disabilities.

5.2 Research methodology

5.2.1 Data collection process

Practitioners in the field of transportation engineering, urban planning and design, and policymaking from both public and private organisations who are experts in designing transport facilities for the disabled community were sought. The practitioners selected held senior positions with multiple years of experience and are deemed as experts in this field. A snowball sampling method was used where 35 individuals were sent invitations to participate and were then asked to invite others they knew in the same areas with similar expertise. Email addresses and contact numbers of the researchers were provided for potential participants to contact. The requirement for the study was for a minimum of 12 participants to ensure thematic saturation and validity of the result (Guest et al., 2006). The aim was to gain 15-20 participants to have greater geographic coverage of the country and a broader base of expertise across transport planning and disability advocacy groups. Several studies utilised participants in this range for the analytic hierarchy process (AHP) applications. For example, in a study by Shapira and Simcha (2009), 19 senior construction equipment and safety experts assessed the relative importance of safety factors on construction sites. Similarly, in another study, 16 experts were involved with a ranking of the factors and needs for the evaluation of a telehealth system for Parkinson's disease (Cancela, Fico, & Waldmeyer, 2015).

5.2.2 AHP and questionnaire design

Data were analysed using AHP, which is a multi-criteria decision-making method that was developed by Saaty (1977; 1980) for comparing a list of alternatives or options based on their relative weights. The weights are derived through sets of paired comparisons. Humans have the natural tendency to arrange their ideas or their perceptions in a hierarchical manner against a common goal, and it is this concept that the AHP is built upon. Therefore, not all criteria will have the same importance, and so, part of the AHP process is to derive the relative priorities (weights) for the criteria. For AHP, it is suggested to have ranking preferences that are between 5 to 9 as this is the range of a person's working memory capacity (Mu & Pereyra-Rojas, 2016).

The nine accessibility features are from the findings by Park and Chowdhury (2018) pertaining to the barriers in a typical PT journey. They are shown in Table 5.1. In total, the questionnaire consisted of 36 exclusive pairwise comparisons. Between a given pair of attributes, practitioners were asked to choose a preference as to which they believed is more important when considering the needs of people with disabilities in a PT journey. The importance of one attribute over another was ranked with a scale between 1 and 9 to represent the intensity of importance. A value of 1 is given to an attribute when two attributes are of equal importance, whereas 9 represents when an attribute is extremely important over the other.

Table 5.1: Accessibility features and response scale

Attributes	Importance
Stops and Station Facilities	
Crossing Facilities	
Information at Stops	**1** – Of Equal Importance
Vegetation	**3** – Somewhat Important
Bus Driver Attitude	**5** – Important
Access to Stops and Stations	**7** – Very Important
Quality of Footpaths	**9** – Extremely Important
On-Vehicle Facilities	
Construction Works	

Each attribute can be described in more detail as follows:

- **Stop and Station Facilities –** refers to the availability of shelter, disabled toilets, seating, etc.
- **Crossing Facilities –** the appropriate location of crossings, availability of tactile surfaces, ramp slope, refuge islands, etc.
- **Information at Stops –** consisting of up to date timetables and route information, audio announcements, real-time information, good contrasting and large sized fonts, etc.
- **Vegetation –** removal of obstacles from low-hanging branches, tree roots pushing up through the footpath, wide hedges, etc.
- **Bus Driver Attitude –** competent operation of the ramps, route advice, friendliness, knowledge of various disability needs, etc.
- **Access to Stops and Stations -** availability of ramps, elevators, tactile surfaces, disabled parking, etc.
- **On-Vehicle Facilities –** the presence of disabled spaces and priority seating, audio announcements, and clear visual announcements and information, etc.
- **Construction Works –** availability of alternative routes, temporary crossings, information regarding detours, etc.
- **Quality of Footpaths –** referred to the availability of footpaths, smoothness, width, gradient, curb drops, etc.

5.2.3 AHP weights

To calculate the AHP weights for each of the nine factors, a 9x9 matrix is constructed from the 36 comparisons as depicted in Table 5.2. The diagonal elements of the matrix are always 1. In the upper triangular matrix, if attribute *i* is more important than attribute *j* the actual judgment value is recorded in the matrix element (*i,j*). On the contrary, if attribute *j* is more important than attribute *i,* then the reciprocal value is recorded. Following this process, the matrix was populated with the judgment values for every element in the upper triangular matrix. The lower triangular matrix is completed using the reciprocal values of the upper diagonal using Equation 5.1,

$$a_{ji} = \frac{1}{a_{ij}} \tag{5.1}$$

where a_{ij} = element of row *i* and column *j.*

To illustrate the process, an example is provided. Table 5.2 gives a pairwise comparison of the nine factors from one of the practitioner's responses.

Table 5.2: Pairwise comparison matrix constructed from Practitioner 1's responses

	Stop & Station Facilities	Crossing Facilities	Information at Stops	Vegetation	Bus Driver Attitude	Access to Stops and Stations	Quality of Footpaths	On-Vehicle Facilities	Construction Works
Stop & Station Facilities	**1**	0.2	5	3	5	1	0.333	1	3
Crossing Facilities	5	**1**	3	3	3	1	1	1	5
Information at Stops	0.2	0.333	**1**	1	5	0.333	0.2	0.2	3
Vegetation	0.2	0.333	1	**1**	3	0.333	0.333	0.333	3
Bus Driver Attitude	0.333	0.333	0.2	0.333	**1**	0.143	0.143	0.2	0.2
Access to Stops and Stations	1	1	3	3	7	**1**	1	1	3
Quality of Footpaths	3	1	5	3	7	1	**1**	1	3
On-Vehicle Facilities	1	1	5	3	5	1	1	**1**	3
Construction Works	0.333	0.2	0.333	0.333	5	0.333	0.333	0.333	**1**
SUM	12.07	5.4	23.53	17.67	41	6.143	5.343	6.067	24.2

The relative importance (weight) of the criterion is then derived by normalising the intensity values of each column and averaging the values of each row. The weights for the criterion "Stop & Station Facilities" is calculated as shown in Equation 5.2,

$$W_{s1} = \frac{1}{9}\left[\frac{1}{12.07} + \frac{0.2}{5.4} + \frac{5}{23.53} + \frac{3}{17.67} + \frac{5}{41} + \frac{1}{6.143} + \frac{0.333}{5.343} + \frac{1}{6.067} + \frac{3}{24.2}\right] = \mathbf{0.126} \quad (5.2)$$

where W_{s1} is the normalised eigenvector for the chosen criterion "Stop & Station Facilities" for Practitioner 1.

Following this process, the criterion weights are calculated for each practitioner. The average of all the individual weights provides the overall criterion weight, as shown in Equation 5.3,

$$W_s = \frac{1}{n}\sum_{i=1}^{n} W_{si} = \frac{1}{13}[\mathbf{0.126} + 0.141 + 0.062 + 0.022 + 0.038 + 0.047 + 0.095 + 0.138 + 0.206 + 0.079 + 0.192 + 0.13 + 0.166] = \mathbf{0.111} \quad (5.3)$$

where:

n = number of respondents involved in the pairwise comparison,

W_s = normalised eigenvector for the chosen criteria (Stop & Station Facilities).

A consistency ratio (*CR*) is required to account for the inconsistency in judgement, which is a natural occurrence due to preferences being inconsistent and intransitive. By assessing the consistency of the participants' judgement, it allows those with high *CR* (many inconsistent answers) to be removed from the analysis, which increases the robustness of the weights. This in turn improves the reliability of the results and represents a more realistic situation in preference comparisons (Saaty, 1977). Equation 5.4 is used to calculate the *CR* for each participant,

$$CR = \frac{CI}{RI} = \frac{\left(\frac{\lambda_{max} - n}{n - 1}\right)}{RI} \quad (5.4)$$

where:

CI = consistency index,

RI = random consistency index [1.45 for *n* = 9 (Saaty & Vargas, 2001)],

λ_{max} = principal eigenvalue of the matrix,

n = number of criteria.

Saaty (1990) stated that inconsistency is acceptable if the value of *CR* is smaller or equal to 0.1 (10%), but a *CR* of less than 0.2 is also considered tolerable. Thus, only participants whose responses had a *CR* value of less than 0.2 were included in the final data set. The weights of the attributes represent the importance and the priority given by each of the practitioners to improve accessibility.

5.3 Results

5.3.1 Description of participants and AHP weights

Of the selected 35 participants invited, 20 senior practitioners volunteered to participate, 16 of whom yielded a *CR* value of less than 0.2 and were therefore included in the final data set for analysis. The remaining four participants were excluded in the final data set because their *CR* values were higher than 0.2. Table 5.3 presents the characteristics of the 16 participants. The 16 practitioners consist of 10 professional experts who are employed in the public sector, three are from the private sector, and three of the participants are disability advocates. Participants were predominantly from the Auckland region (12), followed by Christchurch (2), Hawkes Bay (1) and Waikato (1).

The expert participants had around 10 years of experience or more in their respective fields, with many in the position of manager or team leader or holding senior roles. All these experts have experience and involvement in designing or planning (or both) accessible features for people with disabilities.

Table 5.3: Participant characteristic information

	Engineers	Planners	Advocates	Total
Gender				
Male	5	1	1	7
Female	4	3	2	9
Region				
Auckland	7	3	2	12
Christchurch	2	-	-	2
Hawkes Bay	-	1	-	1
Waikato	-	-	1	1
Professional Sector				
Private	3	-	-	3
Public	6	4	-	10

5.3.2 Similarities and differences among practitioners' perceived importance of accessibility features

Engineers, Planners, and Advocates

The advocates interviewed are from major disability organisations, and as such, they may have a different opinion on the relative importance of the accessibility features. Figure 5.1 provides a comparison of the AHP weights for the nine accessibility features between advocates and practitioners (both public and private). Practitioners prioritise crossing facilities the most (AHP weight: 0.19), followed by access to stops/stations (0.17), and quality of footpaths (0.13). On the other hand, disability advocates prioritise the quality of footpaths the most (AHP weight: 0.195), followed by crossing facilities (0.173), and access to stops/stations (0.147). These are the top three accessibility features out of the nine that are prioritised but in a different order by engineers/planners and advocates.

When the attributes are broadly grouped as the built environment (quality of footpaths, crossing facilities, construction works, vegetation, and access to stops/stations), practitioners and disability advocates placed a total weight of 0.647 and 0.67 respectively. Construction works (0.104), on-vehicle facilities (0.103), information at stops (0.054), and vegetation (0.052) have been weighted very similar between these two groups with the difference in weights being less than 0.01. Furthermore, both groups ranked vegetation and information at stops with the lowest priority at around 0.05 importance. However, the quality of footpaths was weighted more heavily by disability advocates at 0.195 compared to 0.136 by practitioners. On the other hand, practitioners weighted stop and station facilities at 0.11 compared with 0.065 by disability advocates.

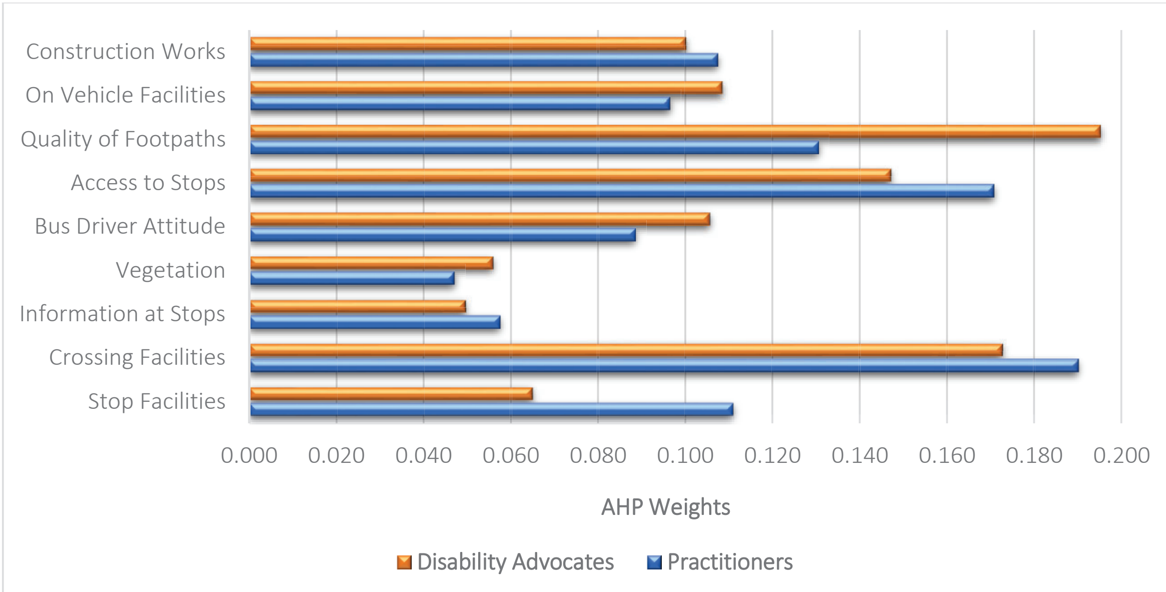

Figure 5.1: Perceived importance of accessibility features by engineers and planners compared with disability advocates

Private sector and local authority practitioners

The perceptions of practitioners working in the private sector were also compared with those in the public sector to identify any differences in views. Advocates were excluded in this comparison. An independent *t*-test was conducted using the statistical package, SPSS (version 25), to analyse the data. The results were based on the assumption of equal variance as the Levene's test for equality of variances resulted in a p-value < 0.05, except bus driver attitude, in which case equal variance was not assumed as the p-value was over the threshold. Table 5.4 provides the outputs from the SPSS analysis.

Three out of the nine attributes, namely: bus driver attitude, access to stops/stations, and construction works have significant differences (p-value < 0.05) in the AHP weights between local authority (LA) practitioners and private engineers. In particular, construction works have the largest discrepancy between the two groups, with a mean difference of 0.132. On the other hand, LA practitioners placed a higher weight on bus driver attitude and access to stops/stations, with a mean difference of 0.076 and 0.062, respectively. The other six attributes did not satisfy the *p*-value < 0.05, and thus it can be inferred that they are not statistically significant.

Table 5.4: Results of the independent T-Test on the AHP weights

Variables	*t*	df	*p*-value (2-tailed)	Mean difference	Std. error difference	95% C.I of the difference	
						Lower	Upper
Stop Facilities	1.609	11	.136	5.933	3.687	-2.182	14.048
Crossing Facilities	-1.047	11	.318	-4.667	4.459	-14.480	5.147
Information at Stops	1.073	11	.306	1.633	1.522	-1.716	4.982
Vegetation	-1.093	11	.298	-1.600	1.464	-4.822	1.622
Bus Driver Attitude	3.397	10.5	**.006**	**7.600**	2.237	2.647	12.553
Access to Stops	2.713	11	**.020**	**6.167**	2.273	1.164	11.170
Quality of Footpaths	-2.045	11	.065	-6.733	3.292	-13.979	.512
On-Vehicle Facilities	2.160	11	.054	5.000	2.315	-.094	10.094
Constructions Works	-2.590	11	**.025**	**-13.20**	5.097	-24.419	-1.981

5.3.3 Similarities and differences in practitioners' and the user's perceived importance of accessibility features

The barriers faced by physically impaired and visually impaired PT users in a previous study by Park and Chowdhury (2018) are compared with the accessibility features prioritised by practitioners. This comparison is illustrated in Figure 5.2. The weights for practitioners include all 16 participants.

There are several discrepancies and similarities in the weights of the attributes given by practitioners and users. Most notably, bus driver attitude accounted for the largest differences between the two groups with an importance weight of 0.226 placed by the users compared to 0.089 for practitioners. Several users from the study stated that "*Bus drivers can be careless, and will not take note of people waiting at the shelters*", "*Sometimes they're a bit rude*", and "*They can make you feel very small*". Differently, some practitioners stated that "*Bus driver attitude is a subjective issue that cannot be controlled easily, and therefore, we do not place a high weighting on it*".

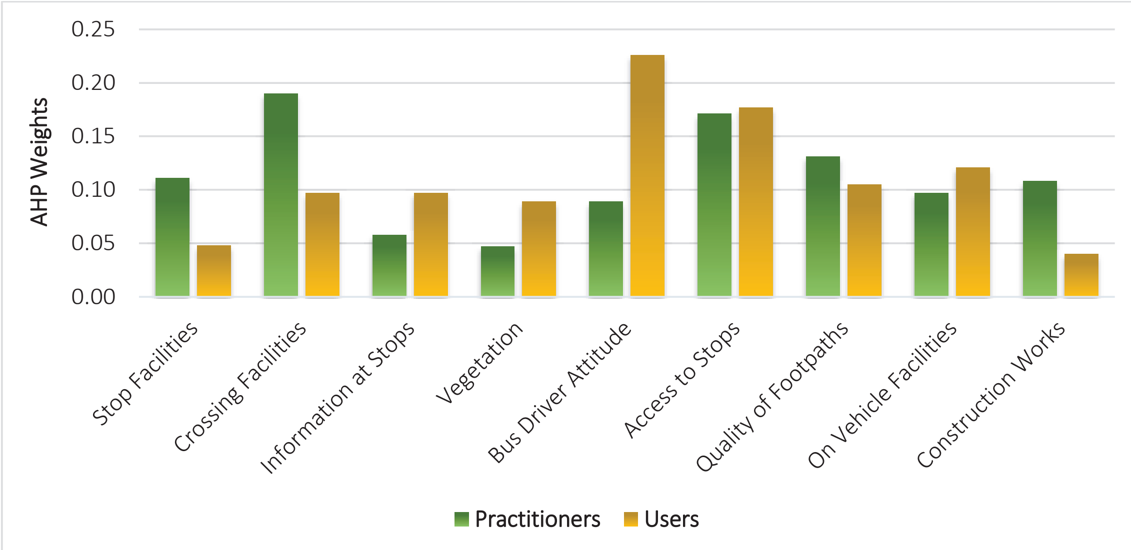

Figure 5.2: Comparison of the importance of accessibility features between practitioners and users

Another difference is that practitioners ranked crossing facilities the highest (0.19), while the weight from users is 0.097. A practitioner stated that "*Components of the journey which had higher risks were ranked with more importance, which is why crossing facilities are ranked the highest*". Similarly, practitioners placed more weight on construction works (0.108) compared to users (0.04) and stop facilities with 0.111 compared to users (0.048). Users also placed higher importance on information at stops with 0.097 compared to 0.058 from practitioners. A user stated in the previous study by Park and Chowdhury (2018) that "*There is no audio information for people with visual impairments*". Users gave vegetation a weight of 0.089 compared to 0.047 by practitioners, "*You get low hanging branches of trees that obstruct the way down the footpath*".

Both groups shared similar views regarding access to stops/stations, on-vehicle facilities, and quality of footpaths. Access to stops/stations was weighted very closely between these two groups with a marginal difference of 0.006 and ranking it as the second most important attribute. This was followed by on-vehicle facilities and quality of footpaths with a 0.024 and 0.026 difference in the weights between these two groups, respectively. The similarities in the weights of these attributes align in the sense that they are all related to physical infrastructure in some ways or another. Practitioners stated that it is *"Easier to design physical infrastructure than something subjective"*.

When the attributes relating to the built environment (access to stops/stations, crossing facilities, quality of footpath, vegetation and construction works) and PT (stop facilities, bus driver attitude, on-vehicle facilities and information at stops) were considered, practitioners placed a higher weight on the built environment with 0.647 of the attributes contributing to this aspect; whereas users were more balanced with a combined weight of 0.51. Practitioners placed a higher weight on the built environment components of the journey chain for the reason of "*If you can't get to the bus stop, then everything else is irrelevant*".

5.4 Discussion

Findings have shown that discrepancies exist between practitioners and users when prioritising the transport needs in a PT journey. Practitioners placed the highest weights on crossing facilities (0.19), followed by access to stops/stations (0.17), and quality of footpaths (0.13). Users, on the other hand, prioritised bus drivers' attitude, which made up 0.226 of the barriers mentioned in the study by Park and Chowdhury (2018), followed by access to stops/stations (0.177), and on-vehicle facilities (0.12).

The order in which these attributes are prioritised could be due to several reasons. Firstly, safety is a criterion that is heavily weighted when it comes to the ranking of projects by practitioners, and therefore, areas with a high number of pedestrian movements, risk or high injury rates are predominantly targeted to warrant the high cost involved in implementing these facilities. Secondly, practitioners tend to place more focus on the physical elements as it is much easier to design and to control compared to the subjective elements present in PT, such as driver attitude and competency. Lastly, practitioners valued the importance of the out-of-vehicle phase because if stops and stations cannot be reached, then everything else is irrelevant.

As a result, practitioners placed a higher overall weight on the built environment components of the journey chain (0.647) compared to users (0.51), who had a more balanced view with the weight of PT components. In particular, bus driver attitude had the largest difference in weight (0.137) between the two groups. Prioritising in this manner is acceptable in Auckland, where PT is well developed because users are generally well catered for once they reach the system. However, this is not always the case for other parts of the country where the PT system is not as accommodating. Bus drivers act as the bridge between the built environment and PT system, and the lack of accessible facilities in vehicles will make it less appealing to disabled PT users, or even impossible to use.

The least important factors perceived by practitioners, namely vegetation (0.047) and information at stops (0.058), were weighted much higher by users (information at stops at 0.097 and vegetation at 0.089). These factors, although not as significant, are weighted as such due to their unpredictable nature such as the absence of information and low-lying branches, for example, which have been highlighted as a major deterrent for people with disabilities. There is a necessity for practitioners to adopt a more holistic way of thinking and view of the journey chain and to consider not just the physical elements, which are more controllable but to consider other facets too.

In contrast, disability advocates and engineers/planners shared similar views regarding the prioritisation of the built environment, with 0.647 and 0.67 of the weights placed on the factors related to this component, respectively. The top three ranked attributes by disability advocates were the same as that of engineers/planners, with the quality of footpaths at 0.195, crossing facilities (0.173), and access to stops/stations (0.147). However, perceptions of the needs of people with disabilities vary depending on the nature of disability that the advocacy is associated with.

Some differences in perception were present between private-sector engineers and local authority practitioners. Three out of the nine attributes were found to have a statistically significant difference in the mean AHP weights. Private engineers rated construction works much higher, with a mean difference of 0.132, whereas local authority practitioners ranked bus driver attitude and access to stops/stations higher, with a mean difference of 0.076 and 0.062, respectively. These differences can be attributed to the scope of works that private and local authorities are involved in. The former is more specialised with a focus on design and construction, whereas the latter is associated with diverse works involving all facets of a journey chain at a higher level.

This study has several limitations, which included the underrepresentation of experts from the private sector, with three participants compared with nine from the public sector. Involving experts from other departments such as those involved in PT may provide a more balanced view of the journey chain, as opposed to experts who primarily deal with projects involved in minor safety works of the built environment.

5.5 Conclusion

The aim of the present study was to determine any gaps in disabled users’ transport needs and practitioners’ prioritisation of accessibility features. The study utilised the AHP to determine the relative weights of nine attributes that had previously been identified as barriers by people with disabilities in a PT journey chain. Sixteen senior practitioners, who were considered experts in designing transport facilities for the disabled community were involved in the study.

The results showed that there were discrepancies between practitioners and users. Practitioners placed the highest weight on crossing facilities (0.19), followed by access to stops/stations (0.17) and quality of footpaths (0.13), all of which are constituents of the built environment. From a previous study by Park and Chowdhury (2018), it was found that disabled PT users prioritised bus driver attitude the highest, which made up a weight of 0.226 of the barriers mentioned, followed by access to stops/stations (0.177), and on-vehicle facilities (0.12). The least important factors were vegetation (0.047) and information at stops (0.058). In particular, disabled PT users prioritised bus driver attitude much higher with a difference of 0.137 between these two groups.

There were some differences between private-sector engineers and local authority practitioners. Although the sample size is small, with 3 participants from the private sector compared with 9 from the public sector, the results highlighted some interesting differences. Three out of the nine attributes, consisting of bus driver attitude, access to stops/stations, and construction works were found to have a statistically significant difference in the mean AHP weights between the two groups. On the other hand, practitioners (13) and disability advocates (3) had more similarities between them, with both groups placing 0.647 and 0.67 of the total weights relating to the attributes associated with the built environment, respectively. Overall, this study highlights the over prioritising of the built environment and the need to invest more resources into the PT component of the journey chain to align closer with the transport needs of people with disabilities.

Chapter Six

An examination of people with disabilities' willingness to make transfers in an integrated public transport network

Reference: Park, J., Chowdhury, S., & Wilson, D. (2019, August). *An examination of people with disabilities' willingness to make transfers in an integrated public transport network*. Paper presented at the 16th International Conference Series on Competition and Ownership in Land Passenger Transport (Thredbo), Singapore.

Integrated public transport (PT) systems rely on users to make multi-modal transfers to reach many destinations. However, for people with disabilities, this means more interaction with the urban environment, which hinders their travel experience, compared to a direct route. To determine the needs of people with disabilities for making transfers, this study investigates the trip attributes which influences their decisions. A survey was undertaken in three major cities in New Zealand. The data involved 196 participants with disabilities who travel independently via PT or car. A considerable portion of disabled travellers can drive, so the factors that determine their willingness to use PT was also considered. The results showed that transfer waiting time had the most influence on the car driver's decision. They were 3.6 times more likely to make transfers with a 5-minute transfer waiting time and 2.3 times more likely with a 5-minute transfer walking time. Personal safety was the most significant factor in PT users' decision to make transfers. Without the presence of security guards, the proportion of users willing to make transfers decreased from 82.8% to 58.6%. The study concludes with recommendations for practitioners to make integrated systems more accessible for people with disabilities.

6.1 Introduction

People with disabilities continue to face significant exclusion from society compared to able-bodied individuals. Their inability to travel freely is associated with their difficulty in adapting to the many barriers to transport access; which is largely regarded as the driving force behind mobility-related social exclusion, resulting in a life of isolation and dependency (Church et al., 2000). Although a minority in the population, people with disabilities make up around 15% of the world's population (World Health Organization, 2011), access to reliable PT systems can significantly improve the lives of people with disabilities by providing independence and access to the opportunities offered by society (Hine & Mitchell, 2001). Therefore, research in this field has mainly focused on identifying and improving accessibility issues around PT to improve their mobility (Carlsson, 2004; Gallagher et al., 2011; Lamont et al., 2013; Soltani et al., 2012).

However, the abilities of people with disabilities are not homogeneous (Gant, 1992; Schmöcker, Quddus, Noland, & Bell, 2008). Depending on the type and severity of the disability, and whether they have access to private vehicles will dictate their travel modes. Those who have no other available transport options due to factors such as not having access to a private vehicle nor having the ability the drive (for example being legally blind) can be considered captive users. This group of users will often resort to using PT to travel independently. The decision for these users to travel is influenced by whether their journeys are accessible and barrier-free to, from, and within PT systems (Park & Chowdhury, 2018).

With a global trend towards a future of sustainable transport, there is added pressure to increase the attractiveness of PT and reduce reliance on car travel. Nowadays, PT systems around the world are integrated to provide travellers with more comfort, convenience and flexibility in their destination choices (Luk & Olszewski, 2003; Ülengin, Önsel, Topçu, Aktaş, & Kabak, 2007). However, it has been widely recognised that there is a negative perception towards transfers (Guo & Wilson, 2004). The increase in out-of-vehicle times in the journey is perceived to be more cumbersome than in-vehicle-times (Iseki & Taylor, 2009).

Numerous travel behaviour studies have investigated the factors that influence PT users' willingness to use routes involving transfers. Trip attributes, such as personal safety, travel time, transfer waiting and walking time were found to significantly influence their perception

(Chowdhury & Ceder, 2013; Eboli & Mazzulla, 2012; Zhou et al., 2007). Travel time is an important factor that governs the ridership of most PT systems (Stradling, 2002). A study by Chowdhury et al. (2015) determined the minimum reduction in travel time desired by PT users to perceive routes involving transfers as being attractive. The level of comfort provided at interchanges was found to affect these thresholds. A shorter transfer waiting and walking time relieves the perceived burden of the process of making transfers, especially in unpleasant and insecure waiting conditions (Iseki & Taylor, 2009). Personal safety at terminals was found to be the most sensitive factor that influenced the decision to use PT (Eboli & Mazzulla, 2012). For people with disabilities, this trip attribute is more significant as they are likely to feel extremely unsafe due to their perceived vulnerability and the inability to protect themselves (Marston et al., 1997; Yavuz & Welch, 2010).

Majority of the previously mentioned travel behaviour studies are catered towards able-bodied users. There is a significant knowledge gap in this regard for people with disabilities considering the discrepancy in the needs and level of ability. A few studies that were conducted on the needs of disabled PT users have highlighted the importance of removing barriers in the urban environment. An integrated system means that a disabled PT user will need to interact more with the urban environment. If the designs of these transfer stations do not meet the requirements of this group of users, it will discourage them from receiving the benefits of the new system. People with disabilities desire independence and value this to a high regard (Park & Chowdhury, 2018). For those who are able to drive and own a car, given the flexibility offered by driving, their threshold of perceiving PT as being an attractive travel mode, let alone routes involving transfer, will be much higher than those who are captive travellers (Stradling, 2002). For that reason, to an extent, their desired trip attributes may be comparable to that of able-bodied users, given both have flexibility in their travel options.

The primary objective of the present study is to examine the trip factors which influences people with disabilities willingness to use a PT route, involving a transfer, in an integrated system. The study also examines current PT users' perception of safety. The study is based in New Zealand and focuses on those who are visually and physically impaired, constituting to approximately 18% of the country's population (Statistics New Zealand, 2014c), as those with a cognitive disability, or multiple disabilities are more likely to be unable to travel independently.

The structure of this study is organised into several sections. The next section is the description of the case study and explanation of the data collection. Then, the results of the analysed data are presented. Following from this is the discussion, and lastly, the conclusion.

6.2 Case study and data collection

6.2.1 Data collection process and questionnaire

A self-administered online user preference survey was undertaken in three major cities in New Zealand, comprising of Auckland, Wellington and Christchurch. The next section discusses some of the key characteristics of case study cities. A total of 2,173 people, car drivers, and PT users participated in the survey. Of the 2,173 participants, 1,247 are from Auckland, 499 are from Wellington, and 427 are from Christchurch. 256 participants categorised themselves as having a disability. Data was collected by employing a survey company, Dynata, to distribute online questionnaires to potential participants from their extensive database and attain a representative sample of the population. The questionnaire was in English and estimated to take approximately 30 minutes to complete. The response rate was 15%, which is typical of online surveys. Potential participants were sent a reminder email after 48 hours of receiving the initial invitation, and no more than two reminders were sent per person. Both car drivers and current PT users were included in this study to obtain a holistic understanding of how people perceive transfers; given that integrated systems aim to increase ridership and increase accessible destinations.

The questionnaire consisted of general socio-demographics, trip characteristics and hypothetical scenarios. The socio-demographic questions, age, income and region, were adopted from the New Zealand (NZ) census questionnaire (Statistics New Zealand, 2014d). Trip characteristic questions included: the number of trips using their chosen transport mode per week, origin/destination details, journey times, purpose and so on.

All participants were asked if they would choose an alternative hypothetical transfer route when comparing to their current travel route. Eight hypothetical transfer route scenarios with different combinations of waiting times of 5, 10, 15 minutes, walking times of 5, 10 minutes and varying types of transfer facilities were presented. Participants were asked if they would be willing to make a transfer given the conditions and were asked to assume that the transfer station has full weather protection. This question was designed to determine whether these factors influenced these users' perception of PT involving transfers. An example of the scenarios is shown in Table 6.1.

Table 6.1: Hypothetical scenarios

Scenario 1		Scenario 2	
Waiting time	10 minutes	Waiting time	5 minutes
Walking time	5 minutes	Walking time	10 minutes
Connected walkways with cover	Yes	Connected walkways with cover	No
High-quality information on transfer	Yes	High-quality information on transfer	No
Security guards	Yes	Security guards	Yes

6.2.2 Background of cities

Auckland and Wellington are both located in the North Island of New Zealand. Auckland is New Zealand's largest and most cosmopolitan city with a population of 1.6 million. The median age of those living in Auckland is 35 years, and the median household income is $76,500 per annum, which is the highest across the country. Wellington is the capital and second most populated city of New Zealand with a population of around 500,000. Christchurch is the largest city in the South Island with a population of around 380,000 (Statistics New Zealand, 2014b).

Auckland's PT is composed of the bus, train and ferry. Around 91% of the buses are low floor buses with the ability to kneel to meet the curb and have manual wheelchair ramps fitted. Seats near the front of the buses are designated for the elderly and those who are access-challenged. Certain buses have audio announcements. The electric trains are equipped with automatic ramps, located on the central carriage doors to allow for wheelchair access between the platform and the vehicle. The trains are fitted with audio and visual announcements. Most ferries allow for wheelchair access on board. All three modes allow for guide dogs to accompany passengers (Auckland Transport, 2017b). In August 2016, a new integrated ticketing system called AT HOP was implemented. This electronic ticketing system does not require the additional purchase of tickets when making transfers. Auckland has the most developed PT system in the country. Wellington offers buses, ferries, train and cable cars for riders; Christchurch provides buses and ferries only. In Wellington, 71% of the vehicles support accessibility features, and certain trains are fitted with a public-address system, automatic station information announcements, and information displays.

6.3 Results

6.3.1 Description of participants

Out of the 256 disabled participants, data from 196 participants were deemed usable. Around 177 participants can be categorised as having a physical impairment, due to health issues related to arthritis, spinal injuries, chronic illnesses and so forth, which all constituted to limited mobility in some way or another. A lesser proportion, 14 people, identified themselves as having sensory impairments (vision or hearing) and only 5 people had a mental disability or epilepsy.

Of the 196 participants, there were 48% males and 52% females. Around 50% of the participants were in the age range above 61 years of age. About 63% of participants had an annual income below NZD 50,000, and 87% of the participants identified themselves as NZ European. Participants were predominantly from Auckland (53%), followed by 23% from Wellington and 24% from Christchurch. Table 6.2 presents a summary of the sociodemographic characteristics of the participants.

Table 6.2: Sociodemographic Characteristic

Gender	Car drivers	PT Users	Total
Male	75 (45%)	19 (66%)	**94**
Female	91 (54%)	10 (34%)	**101**
Gender Diverse	1 (1%)	-	**1**
Age-range			
16-20	1 (1%)	-	**1**
21-30	9 (5%)	2 (7%)	**11**
31-40	14 (8%)	7 (24%)	**21**
41-50	21 (13%)	8 (28%)	**29**
51-60	33 (20%)	3 (10%)	**36**
61+	89 (53%)	9 (31%)	**98**
Income (NZD)			
None	10 (6%)	1 (3%)	**11**
<$50,000	105 (63%)	19 (66%)	**124**
$50,000 - $70000	23 (14%)	5 (17%)	**28**
$70,000 - $100,000	17 (10%)	3 (10%)	**20**
>$100,000	12 (7%)	1 (3%)	**13**
Ethnicity			
NZ European	149 (89%)	21 (72%)	**170**
Other European	8 (5%)	1 (3%)	**9**
Maori	4 (2%)	3 (10%)	**7**
Pacific	3 (2%)	1 (3%)	**4**
Asian	2 (1%)	2 (7%)	**4**
Other	1 (1%)	1 (3%)	**2**
Region			
Auckland	84 (50%)	19 (66%)	**103**
Christchurch	43 (26%)	5 (17%)	**45**
Wellington	40 (24%)	5 (17%)	**48**

6.3.2 Current trip information

Out of 196 participants with disabilities, 167 drove their cars and 29 used PT as their main mode of transport. There was a higher proportion of females (54%) in the car drivers group compared to the PT users' group, which had a higher proportion of males (66%). Participants aged 61 years or older are represented more in both transport mode groups (54% and 31% in the car and PT user groups respectively) compared to the other age groups. The income distribution among car drivers and PT users is similar, with a higher proportion earning less than $50,000 NZD. Participants were predominantly NZ European with 89% and 72% in the car drivers and PT users' group respectively. Around 50% of car drivers were from Auckland, 26% were from Christchurch, and 24% were from Wellington. A higher proportion of PT users were from Auckland (66%), and 17% were from Christchurch and Wellington.

Participants in both groups were asked about the duration of their typical journeys in their respective modes. The results showed that disabled car drivers travelled short distances. Around 58% of the participants responded that their typical journeys took less than 20 minutes, followed by 34% of journeys taking between 20 to 40 minutes. Very few car journeys lasted over 40 minutes, with only 7% taking between 40 to 60 minutes. This finding shows that although people with disabilities preferred to use their car, they are limited to how long they can drive. On the other hand, disabled PT users travelled for longer distances. Around 34% of PT users stated that their journey took under 20 minutes, and 41% stated that their journey took between 20 and 40 minutes, and around 17% stated that their typical journey times were between 40 to 60 minutes. Moreover, for PT users, their journeys were not door to door as it is for car drivers. The most common trip purpose for car drivers was work and study, as around 64% of them had free parking at these destinations. For PT users, the two most common trip purposes comprised of running errands and work (71%). Of the 29 PT users, 27 were frequent riders.

Of those who use PT, 12 out of 29 participants make a transfer on their typical journey. The average waiting time to make transfers was around 19 minutes. Typically, intra-modal transfers were the most common (8 out 12 participants) being bus to bus, followed by intermodal (4 out 12) involving bus and train. Intra-modal transfers had the lowest average waiting time of 17 minutes while intermodal transfers took longer with an average waiting time of 23 minutes. Participants were asked how crowded the station is when they make a transfer. Half of the participants (six) stated that the station was a little crowded during transfers, four said the stations are not crowded when they travel, and two participants stated their station was crowded.

The lowest waiting time of 16.5 minutes is associated with stations being crowded, followed by a waiting time of 17.8 minutes when the station is a little crowded and 22.5 minutes when the station is not crowded. Figure 6.1 shows the overall journey time and the proportion of the time spent making a transfer based on the crowdedness of the station. On average, it takes 40 minutes to make a journey when the station is crowded, of which 41% of the time is spent making transfers. When the station is a little crowded, the overall journey takes 48 minutes, of which 37% of the time is spent making transfers. When the station is not crowded, the proportion of time spent making transfers is the highest at 64% given the journey takes 35 minutes. A reason for this finding is that PT services are more frequent during peak periods, which is often when the stations are crowded.

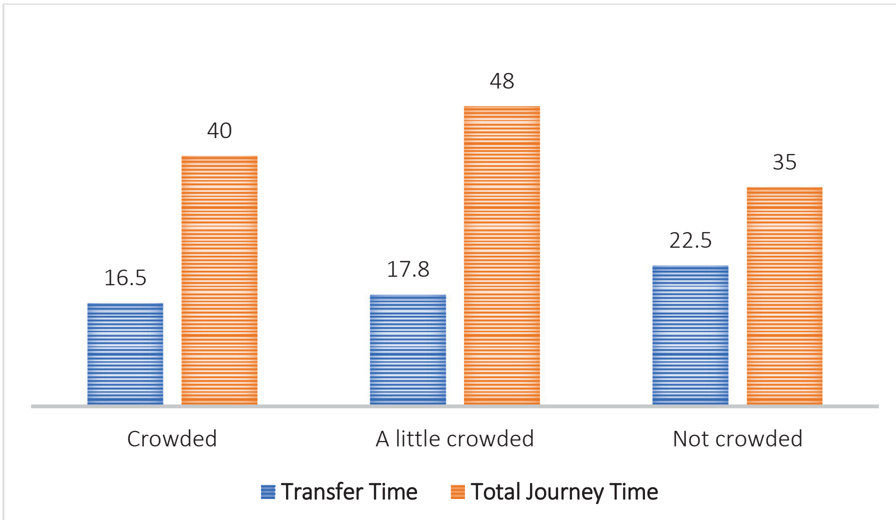

Figure 6.1: The relationship between station crowdedness and journey time (minutes)

6.3.3 Hypothetical transfer route scenarios

Participants were asked the minimum travel time savings that will increase their willingness to use a PT route requiring a transfer. Around 63% of car drivers were willing to change to a PT route that required one transfer, given some reduction in their current travel time.

Around 28% were willing to use PT, given a reduction in travel time of 5 – 10 minutes, while approximately 18% and 17% of the participants were willing to ride given a reduction in travel time of 10 – 15 minutes and 15 – 20 minutes, respectively. Around 37% of the participants were not willing to change to PT despite a reduction in travel time. These participants were asked to select the main reasons for their choice.

The main reasons car drivers preferred their choice of mode was due to: (a) poor connections in PT, (b) driving a car allows having full control of the trip, (c) more comfort, and (d) difficulty of using PT for their disability, depicted in Figure 6.2. Additionally, to determine if cost was a factor, participants were asked whether they would use PT if the total cost of the fare were reduced to which, 46.7% responded “Yes” while 53.3% responded “No”.

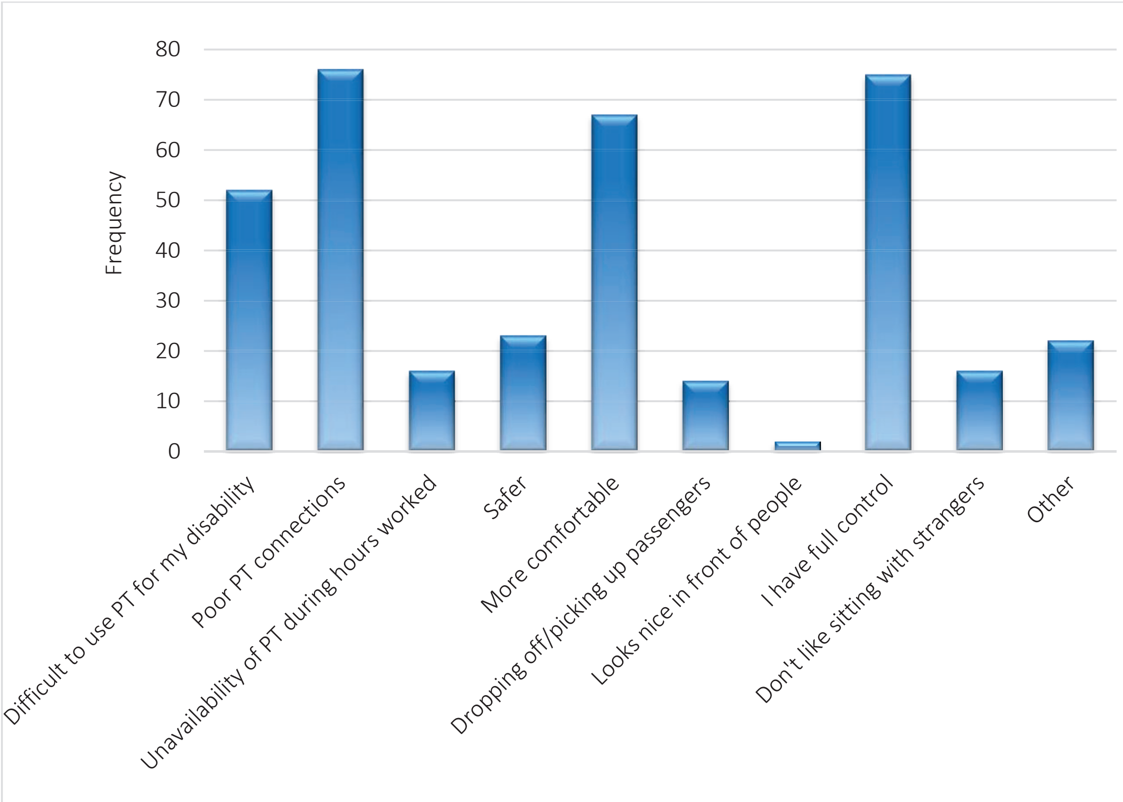

Figure 6.2: Reasons for using a car over PT

A binary logit model was fitted to the response for the eight hypothetical scenarios by car drivers. The sample size of PT users was too small to accurately fit the model; hence, it was excluded. A statistical package, SPSS (version 25), was used to analyse the data-set. Table 6.3 provides a description of the independent variables coded in SPSS. All other variables were not statistically significant when included in the model.

Table 6.3: Description of the variables

Independent variables	Description of variables
Gender	0 = Female, 1 = Male
Waiting time	5 minutes, 10 minutes, 15 minutes
Walking time	5 minutes, 10 minutes
Presence of connected walkways with cover	0 = No, 1 = Yes
High quality information	0 = No, 1 = Yes
Security	0 = No, 1 = Yes

Table 6.4 provides the outputs from the SPSS analysis, including the Odds Ratio, *p*-value, coefficients and the confidence intervals for all the statistically significant (*p*-value < 0.05) factors. Male car drivers were 2.44 times more likely to use a transfer route compared to females (Odds Ratio = 2.44). The results indicate that waiting time has considerable influence on the willingness of disabled car drivers to use transfer routes. Compared with a waiting time of 15 minutes, car drivers were 2.27 times more likely to use a transfer route with a waiting time of 10 minutes and 3.59 times more likely for 5-minute waiting time. Similarly, compared with a walking time of 10 minutes, car drivers were 2.32 times more likely to use a transfer route with a walking time of 5 minutes.

Table 6.4: Results of binary logistic regression analysis on car drivers' willingness to use new transfer route

Independent Variables	Coefficient	Wald	df	*p*-value	Odds Ratio	95% C.I of Odds Ratio	
						Lower	Upper
Gender (Males)	.893	48.364	1	.000	2.441	1.898	3.139
Waiting Time (5 mins)	1.279	16.687	1	.000	3.592	1.945	6.633
Waiting Time (10 mins)	.820	12.790	1	.000	2.272	1.449	3.561
Walking Time (5 mins)	.840	7.314	1	.007	2.317	1.260	4.259
Connected Walkways (Yes)	.491	5.279	1	.022	1.634	1.075	2.484
Information (Yes)	.341	4.236	1	.040	1.406	1.016	1.945
Security (Yes)	.587	7.543	1	.006	1.798	1.183	2.732
Constant	-3.337	38.099	1	.000	.036		
Test of model fit (Hosmer-Lemeshow test) Chi-squared = 5.421, df = 8 Nagelkerke R^2 = .110, log-likelihood (final) = 1712.535 Omnibus Test (intercept only and final model) Chi-squared = 114.684, df = 17							

The availability of provisions at transfer stations also influenced the willingness of disabled car drivers to use a new transfer route. Participants were 1.8 times more likely to make a transfer with the presence of security guards at the connection point. Similarity, when comparing connections without connected walkways or information, users were 1.63 and 1.41 times more likely to use a transfer route with the presence of these provisions.

Table 6.5 shows the break-down of transfer walking and waiting time, with the three provisions (connected walkways, information, security) kept constant. In addition, security had the greatest odds ratio out of the three provisions, so it was included for further analysis. Not surprisingly, the results show that a shorter transfer time results in a higher proportion from both groups willing to use the route. However, for the same transfer time, a shorter walking time compared to waiting time has a greater number of users willing to use the route with 57.5% car drivers and 82.8% PT users. Without the presence of security guards, the proportion of users willing to use the transfer route decreased slightly for car drivers from 57.5% to 44.9% and more significantly for PT users from 82.8% to 58.6%. The next section discusses the safety questions asked to PT users.

Table 6.5: Proportion of users willing to use transfer routes with varying waiting and walking times

Transfer Time	Waiting Time	Walking Time	Security	Car drivers	PT Users
15 mins	5 mins	10 mins	Yes	48.5%	75.9%
15 mins	10 mins	5 mins	Yes	57.5%	82.8%
20 mins	15 mins	5 mins	Yes	38.3%	72.4%
15 mins	10 mins	5 mins	No	44.9%	58.6%

6.3.4 PT users' perception of safety

PT users were asked about the perceived safety of their current route. They were asked the following questions and were asked to respond using a 5-point Likert Scale (Strongly Disagree to Strongly Agree).

- Statement 1: I feel safe waiting at the station(s).
- Statement 2: I feel safe to walk home in the dark.
- Statement 3: I have seen some verbal abuse of other passengers at the station.
- Statement 4: I have seen some physical abuse of other passengers at the station.
- Statement 5: I am worried about experiencing verbal or physical abuse myself.

Seventeen out of 29 participants agreed with Statement 1, with only 3 participants strongly disagreeing. Participants were also asked to select safety features that were present in their current station. Of the 29 participants, 15 stated there was good lighting, and 9 participants stated that the station was well designed with no hidden corners. For Statement 2, 18 out of 29 participants did not feel safe walking home at night, with 5 participants strongly disagreeing. When asked about the street lighting, 20 out of 29 users stated that there is not sufficient lighting, which is consistent with the responses to Statement 2.

Statement 3 and Statement 4 indicated that users witnessed some negative encounters on their current route. 14 participants agreed with Statement 3, and 10 participants agreed with Statement 4. A higher proportion of PT users witnessed more verbal abuse than physical abuse. Only 8 out of 29 participants stated that there was a presence of security guards at their stations. On the other hand, 10 out of 29 participants stated that there were not any of the mentioned security features at their current station. Thirteen out of 29 participants agreed with Statement 5, which indicates that a large proportion of stations still lack the necessary security provisions to make the users feel safe.

6.4 Discussion

Findings from this study indicate that safety and transfer times are important factors in the decision to use PT routes involving transfer for people with disabilities. However, transfer time was a more significant factor. Results from the binary logistic regression analysis showed that compared with a waiting time of 15 minutes, disabled car drivers were 3.6 (Odds Ratio = 3.59) with a waiting time of 5 minutes and 2.3 (Odds Ratio = 2.27) with a waiting time of 10 minutes times more likely to use PT routes involving transfers. Similarly, compared with a walking time of 10 minutes, car drivers were 2.3 (Odds Ratio = 2.32) times more likely to use a transfer route with a walking time of 5 minutes.

However, given the same transfer time, a shorter walking time had more influence on their decision to use these routes. Granted a reduction in walking time from 10 minutes to 5 minutes, 82.8% compared to 75.9% of PT users and 57.5% compared to 48.5% of car drivers were willing to use transfer routes respectively. This suggests that people with disabilities value walking time somewhat more than waiting time, which is in contrast to other studies involving able-bodied users (Iseki & Taylor, 2009; Walle & Steenberghen, 2006). The reason for this could be attributed to the fact that walking is a challenge for many people with disabilities. To further improve the perception of transfer routes, the focus should be placed in shortening the distance between connection points as much as possible.

Contradictory to the results, when car drivers were asked whether they would use PT if the service was faster, 60.5% of the participants responded "No". This implies that there is a precondition before transfer time becomes a considerable factor in the decision to use PT.

According to the results, disabled car drivers emphasised that poor connections and the difficulty of using PT due to their disability are what deters them from using PT. Many barriers exist in a PT journey, any of which presents a risk for the user of being unable to complete their journey (Park & Chowdhury, 2018). Unless people with disabilities can use the PT system reliably, up to the point where they are seated safely in the vehicle, PT on routes involving transfers will never be appealing. Therefore, it can be inferred that transfer time savings are only considered after accessibility conditions have been met. This is the main difference between able-bodied and disabled users.

Although not as significant, security was still a considerable factor in the model. Disabled car drivers were 1.8 times more likely to use a new transfer route given that there is the presence of security. Information (1.4) and connected walkways (1.6) were of lesser importance compared with the other trip attributes.

When transfer times were kept constant, security was valued by a higher proportion of PT users compared to car drivers. Given a transfer time of 15 and 20 minutes, 75.9% and 72.4% of PT users were willing to use transfer routes compared to 48.5% and 38.3% of car drivers, respectively. Almost a third of PT users did not feel that their current station had adequate security provisions resulting in them feeling unsafe. A sizeable portion of PT users' journeys involves being out-of-vehicle which exposes them to potentially negative encounters. When coupled with the fact that people with disabilities are prone to feeling more vulnerable could be a possible reason as to why they value security on a higher scale than car drivers. Car drivers, on the other hand, will not likely have the same experiences, and thus, do not place as much weighting on security.

The majority in the disabled car user and disabled PT user groups had relatively short journey times; 92% of car drivers and 75% of PT users travelled less than 40 minutes, respectively. However, car drivers travelled shorter distances on average compared to PT users, with 58% stating their journeys took less than 20 minutes. Driving for long periods may lead to severe discomfort and pain in their back, legs, and so forth due to their disability. Making PT more accessible will increase the number of destinations they can reach as they would be able to travel for longer. The results indicated that transfers form a considerable portion of the journey; up to 64% of the journey time for those making transfers. Therefore, it is vital to make this process as safe and seamless as possible.

Limitations of this study included the underrepresentation of females, with 34.5% female participants in the PT user group. The smaller sample size of PT users meant that a direct comparison of the factors (waiting and walking time) could not be made between car drivers and PT users using binary logistic regression. As the data was collected via an online survey, the study was overrepresented by those with physical impairments. As the scenarios are hypothetical, the expressed preferences may not necessarily represent the participants' behaviour, which affects the reliability of results. Even though individuals tend to overstate their preferences, the application of these surveys is to identify estimates of relative utility weights rather than absolute values.

6.5 Conclusion

This study investigated the willingness of people with disabilities to use PT routes involving transfers. The trip attributes comprised of transfer time (waiting and walking time), information, covered walkways and presence of security guards. Current PT users were asked about their perception of safety. The study used a stated preference survey to collect data from 196 participants, of which 167 are car drivers, and 29 are PT users. The results showed that transfer time was valued more highly than security for disabled car drivers. Whereas for current disabled PT users, more emphasis was placed on security. Security provisions at their current stations were revealed to be still lacking, and that improvement is needed for users to feel safe. Although the results correlate similarly to other studies involving able-bodied PT users, the results suggest that these factors only become a major influence on people with disabilities decision to use PT when the station is accessible for their needs first. Practitioners should consider placing more emphasis on security provisions at connection points. Better lighting on the streets leading to and from the station and more security guards at stations would greatly improve this aspect. Furthermore, the distance between connection points should be as direct as possible that meets the accessibility standards for people with disabilities. Proper attention to the needs of people with disabilities can make PT an attractive and more feasible option for them in the movement for a modal shift towards sustainable transport.

Chapter Seven

Investigating the needs of people with disabilities to ride public transport routes involving transfers

Reference: Park, J., & Chowdhury, S. Investigating the time and facilities required by people with disabilities to ride public transport routes involving a transfer. *Journal of Transport Geography*, (submitted March 2020).

Integrated public transport (PT) systems rely on transfers to provide a wide range of destination choices for travellers. However, most studies on the operation and planning of integrated systems have been based on the needs of able-bodied PT users. It is well understood that people with disabilities face different challenges compared to able-bodied users. This study adopts a psychological model, Weber's Law *Just-Noticeable Difference* to investigate the travel time savings and transfer time desired by people with disabilities when selecting a route with transfer(s). The study also examines the effects of accessibility features on transfer waiting and walking times. An online survey was undertaken in New Zealand's major cities. After six months of data collection, a total of 108 people with disabilities participated, comprising of physical, visual, cognitive and multiple impairments who can travel independently via PT. Results show that, on average, people with disabilities desire a 31% reduction in their current travel time to choose a route with transfer. For travel time savings, participants with multiple impairments were more willing to choose a transfer route (k = 0.458), followed by participants with cognitive impairments (k = 0.315). There is a negligible difference in willingness between participants with physical (k = 0.255) and visual impairments (k = 0.253). Overall, participants desired more transfer waiting and walking time for complex interchanges compared to simple stations. Findings from this study are expected to assist transport planners and PT operators in reconsidering how they design integrated systems to ensure accessibility for people with disabilities.

7.1 Introduction

Access to reliable PT systems has been shown to significantly improve the lives of people with disabilities by providing them with independence and access to opportunities (Jansuwan et al., 2013; Penfold, Cleghorn, Creegan, Neil, & Webster, 2008). Although a minority in the population, people with disabilities make up around 15% of the world's population (World Health Organization, 2011). It is considered best practice to not categorise people with disabilities into a homogeneous group, given the variability of their disability (World Health Organization, 2011). Depending on the type and severity of the disability, and whether they have access to private vehicles will dictate their travel modes. Those who do not have the ability to drive (for example, being legally blind) but can travel independently are considered captive PT users. The decision to travel is influenced by whether their journeys are accessible and barrier-free to, from, and within PT systems (Park & Chowdhury, 2018). Being unable to access PT due to the barriers can further add to their feeling of being socially excluded (Hine & Mitchell, 2001). It limits and sometimes prevents, their ability to participate freely and independently in society. The feeling of being isolated, unheard and unseen has a strong negative effect on their mental health and well-being (Emerson & Llewellyn, 2014; Honey, Emerson, & Llewellyn, 2011; Temple & Kelaher, 2018).

Globally, PT networks are moving towards an integrated multi-modal system (Chowdhury & Ceder, 2016). These systems rely on the user to make transfers. It has been widely recognised that there is a negative perception of transfers. The process of making a transfer is perceived to be more burdensome than in-vehicle times (Guo & Wilson, 2007). As such, integrated systems aim to minimise the transfer times (waiting and walking) and reduce this perceived burden. However, such operational values have been developed with a focus on able-bodied commuters (Ceder, Chowdhury, Taghipouran, & Olsen, 2013; Chowdhury et al., 2015; Guo & Wilson, 2007). It is well understood that people with disabilities have different transport needs (Ahmad, 2015; Gallagher et al., 2011; Jansuwan et al., 2013; Park & Chowdhury, 2018). The barriers that exist with PT use are primarily associated with the urban environment. To make a transfer, PT riders need to egress and board another vehicle. For people with disabilities, unless proper facilities are in place, the physical movement to make a transfer can become a barrier for independent travel. So, there is a possibility that integrated systems can create more barriers for people with disability and add to their social exclusion if the design of the systems does not incorporate their needs.

In the development of integrated systems, transport planners will need to understand the transfer time and facilities required by people with disabilities to make transfers easily. To date, there have not been any studies to understand the transfer time required by people with disabilities. This study addresses this research gap and aims to determine: (a) the travel time savings desired by disabled PT users to choose a route with transfer, (b) the average time required to wait and walk when making a transfer, and (c) the effects of accessibility features at stops/stations on transfer time. The study adopts Weber's Law *Just-Noticeable Difference* (JND). Data is collected from major cities in New Zealand. Disabled PT users who can travel independently were invited to participate.

The study is organised as follows: Section 7.2 discusses the research gap from the literature review in Chapter 2, Section 7.3 provides a description of the study area and the design of the survey questionnaire. Section 7.4 is data analysis and results, Section 7.5 is a discussion of the results, and lastly, Section 7.6 provides the conclusion.

7.2 Research gap

The focus of studies pertaining to integrated PT system has been on able-bodied users. To the authors' knowledge, there have not been any studies which have investigated how people with disabilities perceive transfers. An integrated system means that a disabled PT user will need to interact more with the urban environment. This is a significant knowledge gap as people with disabilities have varying needs and level of ability for movement. If the designs of transfer hubs and connection times do not meet the requirements of this group of users, it will discourage them from receiving the full benefits of an integrated system. Incorrect optimisation of the transfer time can create further challenges for people with disabilities to ride PT, as it is unknown what is their desired transfer time.

7.3 Case study cities, data collection and questionnaire design

7.3.1 Background of case study cities

Auckland and Wellington are located in the North Island of New Zealand. Auckland is New Zealand's largest and most cosmopolitan city, with a population of 1.4 million. Wellington is the capital and second most populated city of New Zealand with a population of around 500,000. Christchurch is the largest city in the South Island with a population of around 340,000, followed by Dunedin with a population of around 120,000 (Statistics New Zealand, 2014a). Auckland has the most developed PT system in the country. Auckland's PT system is composed of bus, train, and ferry. Around 91% of the buses are low floor buses with the ability to kneel to meet the curb and have manual wheelchair ramps fitted. Certain buses have audio announcements (Auckland Transport, 2017b). The electric trains are equipped with automatic ramps, located on the central carriage doors to allow for wheelchair access between the platform and the vehicle. The trains are fitted with audio and visual announcements. Most ferries allow for wheelchair access on board. People with disabilities are eligible for an accessible concession on their PT fares (Auckland Transport, 2017a). Wellington offers buses, ferries, train and cable cars for riders; Christchurch and Dunedin primarily provide buses while Christchurch has ferries as well (Christchurch City Council, 2019; Otago Regional Council, 2019; Wellington City Council, 2019).

7.3.2 Data collection and questionnaire design

The data collection was carried out through a self-administered online user preference survey. Key people and organisations representing disability groups were contacted nationally to distribute the online questionnaire and invite their members to participate. Participation was voluntary. For participants to be eligible, they either had to be a current PT user or have used it in the last five years. The data collection period was for six months. A total of 165 people with disabilities responded to the questionnaire. One of the reasons for the lower response rate discussed by the key people in the organisations contacted was that the disabled community feel disengaged and do not believe their voices are heard by practitioners. In a workshop undertaken at the University of Auckland in February 2017, people with disabilities voiced that authorities do not value and prioritise their concerns. They expressed that after giving their opinions and feedback, they do not see any significant changes in the system. This impression by the disabled community on the local government could be one of the reasons for their reluctance to be involved in the present study.

The questionnaire was designed to determine the perceived time required by people with disabilities to make transfers. The questionnaire consisted of general socio-demographics (age, gender, ethnicity, disability type and location of residence), trip characteristics, and hypothetical scenarios. Table 7.1 shows the trip characteristic and hypothetical scenario questions that were asked to the participants, including those that are common between those who currently ride a direct route and those who currently make transfers.

Table 7.1: Trip characteristic and hypothetical scenario questions

Questions for direct route riders	Questions for riders who currently make a transfer
Trip characteristic questions	
What is your main form of public transport?	
On a weekly basis, how often do you use public transport when you are travelling?	
Approximately how long is your current public transport journey?	
Do you have any card concessions or discount fares?	
Do you have access to other modes of transport?	
Please select all the applicable accessibility features and rate on a scale of 1-5, how well they meet your needs.	
-	How many transfers do you make?
-	On average, how long do you wait to catch the second vehicle?
-	How long do you have to walk to make the transfer?
-	What stop/station do you normally start your public transport ride from?
-	Rate your current satisfaction of the transfer route on a scale of 1-5.
Hypothetical scenario questions	
From the following, please select the **minimum travel time** savings needed for you to consider taking the new route.	
Please select the **maximum** time that you are waiting to **wait** for another vehicle	
Please select the **maximum** time that you are willing to **walk** to make a transfer	
What is the **maximum** time that you are willing to **wait** to make a transfer if the transfer-making station has **better** facilities such as: Real-time audio announcements, amenities including accessible toilets, sheltered seating and waiting areas, etc.?	
What is the **maximum** time that you are willing to **walk** to make a transfer if there are **better** facilities such as: Informative signage, quality walking paths, and crossing facilities, sheltered walkways, etc.?	
What additional facilities/features would improve the ease of making transfers?	

These questions were designed to determine participants desired travel time savings, transfer waiting time and transfer walking time. The questionnaire was estimated to take 10-20 minutes of the participant's time. The questions were worded, such that they can be easily read using audio apps for those who are visually impaired. All the questions were closed-ended and allowed the participant to select from a range of responses for ease of completion. The responses for the socio-demographic questions on age, income, and region, were adopted from the New Zealand Census questionnaire (Statistics New Zealand, 2014d). All participants were asked if they would choose a hypothetical alternative route that is part of an integrated system and requires them to make one transfer.

7.3.3 Just Noticeable Difference

The Expected Utility Theory (EUT) is commonly used to model the decision-making behaviour of travellers when faced with multiple travel alternatives. This theory assumes that users have perfect knowledge about the alternatives they are choosing from and that they make rational decisions based on utility maximisation. However, the theory is unable to capture the vagueness and imprecise reasoning that exists in real-world decision making. As such, studies investigating route choices have begun to use alternative methods (Avineri & Prashker, 2004; Avineri & Prashker, 2005; Ceder et al., 2013). The present study adopts an experimental psychological model, Weber's Law Just-Noticeable Difference (JND).

Weber's Law is used to determine the critical ratio k of change in the magnitude of a stimuli ΔL to the original magnitude of stimuli (L) at which the observer just notices a change. This is formulated mathematically, as shown in Equation 7.1 (Wei, Yanfang, & Xingli, 2011).

$$k = \frac{\Delta L}{\mathrm{L}} \tag{7.1}$$

In the instance of transfers within a PT network, the change in stimuli magnitude corresponds to the travel time savings (ΔT) when choosing the transfer route over the direct route. The magnitude of the original stimuli corresponds to the travel time on the direct route (T_d). The value of k corresponds to the critical ratio of ΔT to T_d which will induce a route-choice change from the direct route to the transfer route, which is part of an integrated system. The advantage of using JND is that the concept is based on perception and is able to quantify the perceived differences. As such, Weber's Law is adopted in the present study to capture the perceived difference thresholds in travel time and transfer time which influences people with disabilities decision to make transfers. This study builds on the work done by Chowdhury et al. (2015), which adopted JND to determine choices of able-bodied commuters when deciding to ride a route with transfer in an integrated system.

7.4 Results

7.4.1 Description of participants

Of the 165 responses, responses from 108 participants were deemed useable for analysis. The unusable data was due to the majority of the questions being left incomplete. Participants comprised of 57% females, 37% males and 6% identified themselves as gender diverse. Around 59% of the participants were in the age group of 24 to 65 years old. Approximately 69% of the participants identified themselves as NZ European and participants were predominantly from Auckland (71%). About 31% of participants categorised themselves as having visual impairments, 31% with physical impairments, 21% with multiple impairments, including some combination of physical, visual, hearing or developmental and cognitive impairments, and 18% with cognitive impairments. Table 7.2 presents a summary of the sociodemographic characteristics of the participants.

7.4.2 Current trips by participants

Out of the 108 participants, 85% selected buses as their main form of PT while 12% used trains and 3% used ferries. Around 49% of participants identified themselves as frequent riders; these riders used PT more than three times a week. Approximately 55% of participants stated that the duration of their typical journey is between 30 to 60 minutes, followed by 17% of participants stating that their journeys take over 60 minutes. The journey times for 16% of participants were between 10 to 19 minutes while the trips for the remaining participants (13%) took between 20 to 29 minutes. Around 74% of the participants used a concession card when using PT. Predominantly this consisted of accessible concessions including Total Mobility and the Super Gold Card, which is a concession for seniors and veterans. Younger participants (below 30) held other types of concession, such as a concession card or a smart-ticketing card.

The data indicated that participants were primarily non-captive riders – those who have access to private vehicles and the ability to drive independently.

Table 7.2: Sociodemographic characteristics of participants

Gender	Total
Male	19 (33%)
Female	35 (61%)
Gender Diverse	3 (5%)
Age-range	
<24	4 (7%)
24-44	21 (37%)
45-65	20 (35%)
65+	12 (21%)
Ethnicity	
NZ European	44 (77%)
Other European	6 (11%)
Maori	4 (7%)
Other	3 (5%)
Region	
Auckland	30 (53%)
Christchurch	2 (4%)
Dunedin	11 (19%)
Wellington	6 (11%)
Other	8 (14%)
Main Impairment	
Physical	17 (30%)
Vision	20 (35%)
Cognitive	2 (4%)
Multiple	15 (26%)
Other	3 (5%)

Out of 108 participants, 86% stated having access to other modes of transport. Of those, family and friends comprised of the main providers of alternate transport, followed by taxi services and having access to a private vehicle. Half of the participants' journeys (54 out of the 108) involved making a transfer, out of which, 29% made one transfer, 14% made two transfers and 7% made three or more transfers. The average waiting time to make transfers was 13 minutes. The average walking time for participants to make a transfer was 3.8 minutes. Figure 7.1 shows the locations of where the participants started their journeys and that they are from different geographical parts of Auckland.

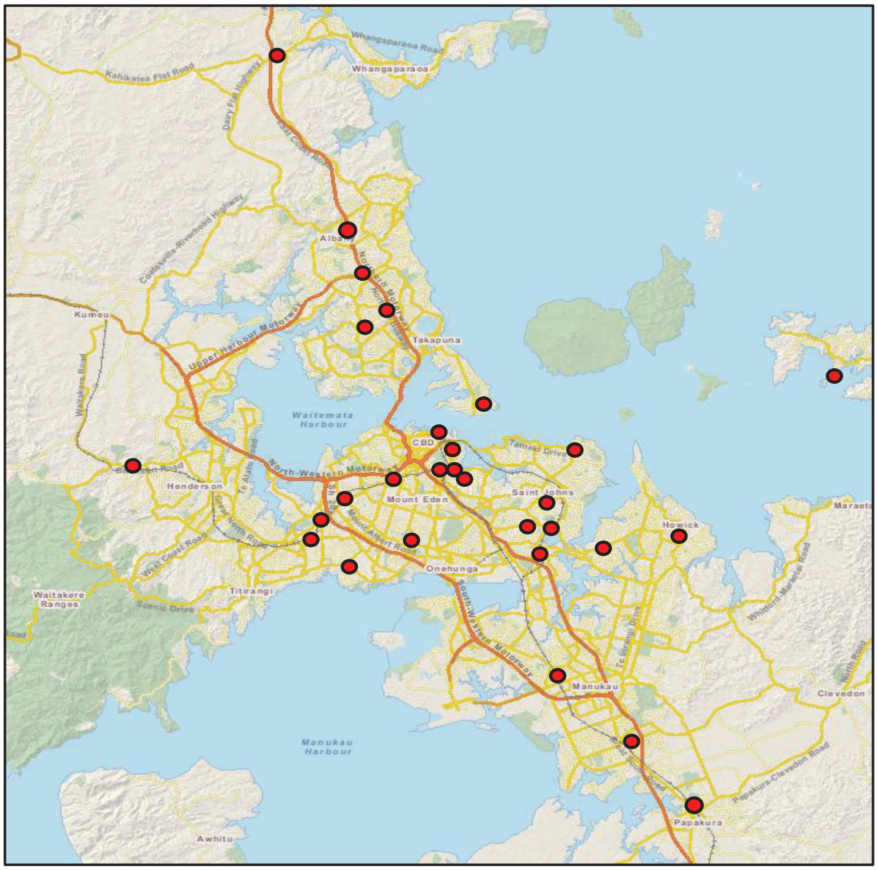

Figure 7.1: Journey origins of participants in Auckland city

7.4.3 Evaluation of current accessibility features

The participants were asked to select all the available accessibility features at the stop or station (origins) they commonly use on a weekly basis and rate how well the features met their needs on a scale of 1 to 5, with 1 being “Poor” and 5 being “Excellent.” The ratings of each feature varied as the availability of accessible features are dependent on the stop/station. Figure 7.2 provides the total responses for each rating given to the accessibility features.

The results showed that “good quality walking paths” to and from stops/stations were rated as the highest accessibility feature available with around 52% of the participants providing a rating of 4 and 5. This was followed by the availability and quality of tactile ground indicators (51%) and the presence of pedestrian crossing facilities (49%).

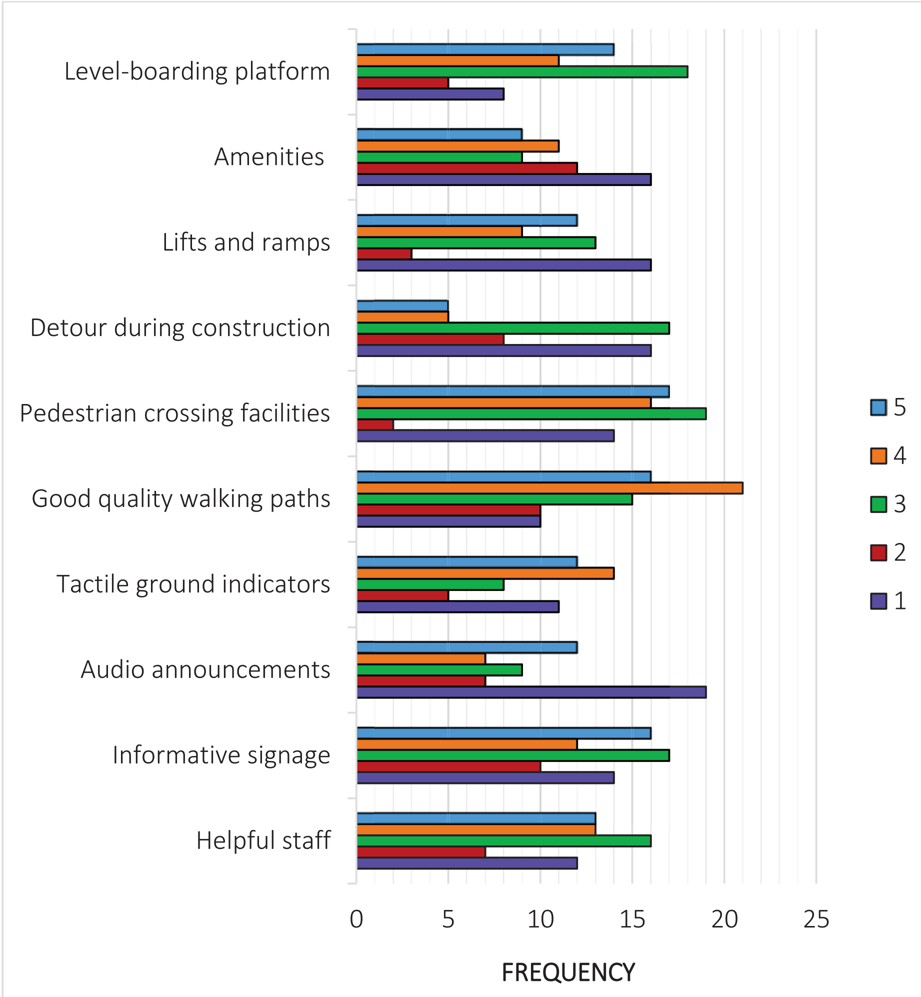

Figure 7.2: Ratings of accessibility features present at stops/stations

On the other hand, the availability of amenities such as accessible toilets, seating areas were rated the lowest with 49% of participants providing a rating of 1 and 2. This was followed by the availability of audio announcements (48%) and the availability of accessible detour walking routes during construction (47%). Finally, users were asked of the overall satisfaction with their current transfer route on a scale of 1 to 5, with 1 being "Poor" and 5 being "Excellent". Around 44% of participants were satisfied with their current transfer route and responded with high ratings (4 and 5), while 35% of participants rated their route as average (3), and 20% of participants responded with low ratings (1 and 2), indicating dissatisfaction of their current transfer route. This implies that appropriate facilities are in place at some transfer points to meet the minimum accessibility requirement for independent travel. Out of those who responded with low ratings, they stated that weatherproof shelters at bus stops, gentler ramp gradients, availability of real-time timetable and amenities (for example, accessible toilets) would improve the ease of making transfers.

7.4.4 Hypothetical transfer-making scenario

As shown in Table 7.1, the hypothetical scenarios included asking participants the minimum travel time savings they desired and the maximum time they were willing to wait and walk to make the transfer. The questions related to walking and waiting times were based on two types of terminals. One with basic facilities, seating and shelter with limited accessibility features, and the other terminal has good accessibility features and amenities such as real-time audio announcements, accessible toilets, level-platforms, etc. A statistical package, SPSS (version 26) was used to analyse the data.

7.4.5 Travel time savings

The results revealed an inverse relationship between the average *k* values and participants' current travel time for an interchange with basic accessibility features, as shown in Figure 7.3. Disabled PT users desired a minimum travel time saving of at least 31% from their current travel time of a direct route (*k* value = 0.31). The findings for the average k value for travel time savings for disabled PT users were compared to the results of a previous study by Chowdhury et al. (2015), which found that able-bodied PT users desired a minimum travel time saving of at least 33% from their current travel time (*k* value = 0.33) for an interchange with basic facilities. The average k value is slightly lower for disabled PT users compared to able-bodied PT users.

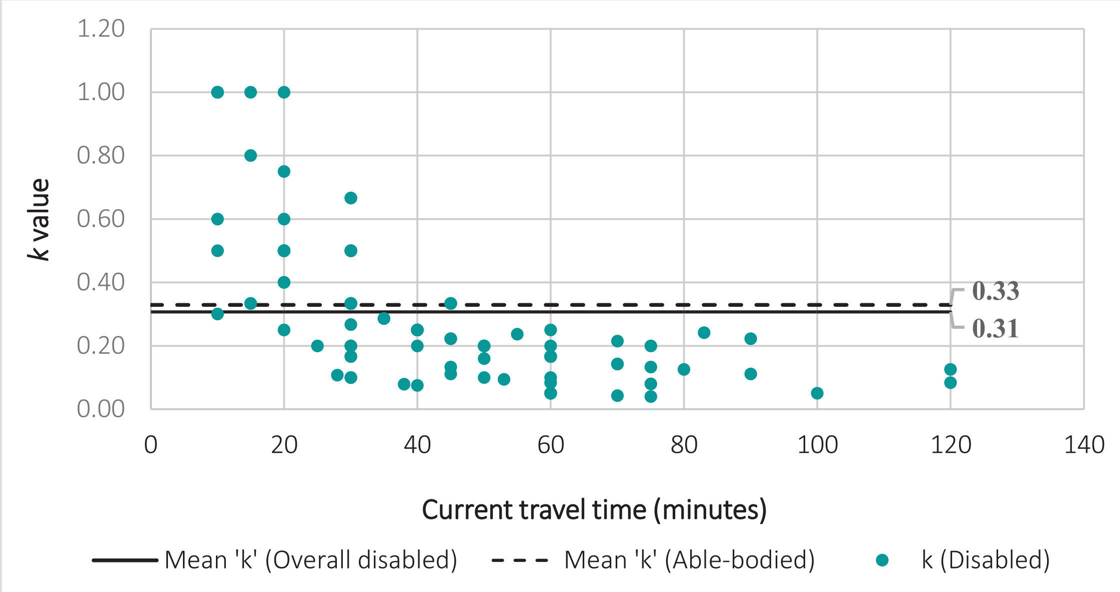

Figure 7.3: Relationship between k values of disabled vs able-bodied participants' current travel time for a basic interchange

The 54 participants who chose to ride a direct route can be categorised into their disability groups as physical (39%), visual (26%), multiple (19%) and cognitive (17%). Those who made transfers can be categorised into their disability groups as physical (22%), visual (37%), multiple (22%), and cognitive (19%). A greater portion of participants with visual impairments made transfers, while a greater proportion of participants with physical impairments chose the direct route. Table 7.3 shows the difference in the average k values for PT users with different disability types.

Table 7.3: Summary of values for travel time savings

Travel Time Savings	Physical Impairment	Visual Impairment	Cognitive Impairment	Multiple Impairment	Total average k for all disabled users
Average k values for all users	0.255	0.253	0.315	0.458	**0.307**
Average k values of those who make a transfer	0.237	0.237	0.226	0.249	**0.233**
Average k values of those who ride a direct route	0.384	0.434	0.451	0.466	**0.406**

There is a small difference in the average k values for those with physical impairments (0.255) and those with visual impairments (0.253). The average k value is higher for PT users with cognitive impairments (0.315). For PT users with multiple impairments, the average k value (0.458) is much higher than the other three disability groups. A series of independent t-tests indicated that the average k values for PT users with physical impairments and those with multiple impairments are statistically significant (p-value = 0.031), as well as users with visual impairments and multiple impairments (p-value = 0.029). There is no statistical significance for the average k values between those with cognitive impairments (p-value > 0.05) and the other three disability groups.

Examining the average k values between those who currently make transfers and those who ride a direct route shows some interesting findings. The average k value for those who ride a direct route (0.406) is greater than the k value for those who currently make a transfer (0.233). A possible reason for this is that the average journey time for participants who currently make a transfer is greater, on average 56 minutes, compared to those who ride a direct route, on average 31 minutes. As such, those who currently make a transfer are less sensitive to travel time savings compared to direct route riders. The independent t-test revealed that there is a statistically significant difference (p-value = 0.001) in the average k value for travel time savings between those who make transfers and those who ride a direct route.

7.4.6 Waiting and walking time

Given that over half of the participants (54%) who currently ride a route involving a transfer gave a rating between 1 and 3 for their satisfaction with existing accessibility features, it is of interest to understand whether the quality of the interchange has an effect on their desired transfer time. Results show that for waiting time, the average k value given an interchange with basic amenities is 1.186, whereas the k value for an interchange with good accessibility features increased to 1.354. Similarly, for walking time, the average k value was 2.496 for a basic interchange, which increased to 3.389, given an interchange with good accessibility features. However, there was no statistical significance for both waiting times (p-value = 0.464) and walking time (p-value = 0.251) k values between a basic interchange and an interchange with good accessibility features. Table 7.4 shows the mean ($\bar{x}$) and time (t) in minutes of the two data set with the range for both quality levels of the interchange.

The k values for transfer waiting and walking times cannot be determined for the participants who did not make a transfer. The average maximum time these participants are willing to wait to make a transfer is 11.0 minutes at an interchange with basic accessibility features and 11.3 minutes for one with good accessibility features. The average transfer walking time is very similar to the two types of interchanges. They were willing to walk 6.9 minutes for an interchange with basic accessibility features and 7.8 minutes for an interchange with better facilities.

Table 7.4: JND for waiting time and walking time

Trip attribute		Basic interchange	Good accessibility interchange
Waiting time	$\bar{x}$	1.186±.136	1.354±.185
	t	11.0	11.3
Walking time	$\bar{x}$	2.496±.412	3.389±.653
	t	6.9	7.8

7.5 Discussion

Overall, the results have shown that, on average, disabled PT users desired a very similar reduction in their current travel time to choose a route with a transfer compared to able-bodied PT users. Disabled PT users desired at least a 31% reduction for an interchange with basic amenities compared to able-bodied PT users who desired at least 33%, as found by Chowdhury et al. (2015). This finding shows that the overall reduction in travel time desired by both able-bodied and disabled PT users to ride a route with a transfer, in an integrated system, is around 30%. The main priority of disabled riders is to ensure that the journey is entirely accessible before consideration of other trip attributes such as comfort and cost. Majority of participants (86%) were not captive users and have access to other forms of travel. Thus integrated PT routes with transfers need to be accessible and competitive, in terms of travel time, to encourage independent ridership by those with disabilities.

Further analysis of the users who were dissatisfied (20% of those who currently make a transfer) stated that weatherproof shelters at bus stops, lower ramp gradients, availability of real-time schedules and service amenities would improve their ease of making transfers. These types of facilities are more commonly present at major interchanges and are less available in suburban stops/stations. The whole journey chain concept requires all elements to be accessible for a person with a disability to successfully complete it. Stations and stops which are not accessible can cause disabled PT users to be left in the middle of their journey. Consequently, this discourages the use of PT and compels them to seek alternatives, sometimes more costly, transport options such as mobility taxis which provide a more reliable service. This highlights the need for PT operators to ensure that all stops/stations comply with the minimum accessibility design standards.

When the results of disabled PT users were disaggregated into different disability types (physical, visual, cognitive and multiple impairments), users with physical and visual impairments desired at least a 25% reduction in their current travel time, followed by cognitive impairments at 32% and multiple impairments at 46%. Travelling and sitting down for long periods may lead to severe discomfort for users with multiple impairments. Further, a greater portion of users with visual impairments (37%) used PT on routes involving transfers compared to 26% on a direct route. In contrast, physically impaired travellers were more frequent riders of direct routes (39%) compared to transfer routes (22%). The increase in average k values for transfer waiting and walking time with better accessibility features was also an interesting finding. A possible explanation for this finding is that disabled PT users desired more time for major interchanges due to the increase in size and complexity of movement. Although most interchanges are equipped with accessible facilities such as lifts and ramps to support the movement of physically impaired users, the additional distance and time it takes to manoeuvre can be deterring and exhausting for these users; hence they prefer simpler walking routes. For visually impaired riders, the assistance of mobile apps in addition to the staff at most interchanges can make navigating around busy and large interchanges more manageable. Findings also showed that improvement in the accessibility features did not have any statistical significance in the k values for both the transfer waiting and walking times. As mentioned previously, disabled PT users will only make the journey if the whole journey is accessible. Therefore, once minimum accessibility design standards are met, any additional benefit or comfort from improved facilities is likely to be less influential in their decision to make transfers.

This study revealed major challenges to engage people with disabilities. The data collection process was for around six months, where many disability organisations and groups were contacted. They expressed their frustration of providing feedback, as a community to transport authorities, and not seeing improvements in the system. This relationship needs to be built through community engagement work and more importantly, for the needs of people with disabilities to influence design standards. Also, more stringent regulations around design standards compliance and guidelines are required to ensure accessibility is a priority in design and construction. Otherwise, this community will continue to be excluded and isolated from the opportunities provided by society and remain as an after-thought.

7.6 Conclusion

Majority of the studies (Chowdhury & Ceder, 2013; Eboli & Mazzulla, 2012; Zhou et al., 2007) on the design and operation of integrated PT systems have focused on the needs of able-bodied riders. The minimisation of transfer times for commuters has received considerable attention (Chowdhury & Ceder, 2016). However, vulnerable PT users, such as people with disabilities, encounter additional challenges compared to able-bodied riders. This study investigated: (a) the travel time savings desired by disabled riders to choose a route with transfer, (b) the time required to wait and walk when making a transfer, and (c) the effects of accessibility features at stops/stations on transfer times. A number of organisations and disability groups were contacted for around six months to engage with people with disabilities and whom are independent riders. Data from 108 participants were deemed usable. This group comprised of those with physical, visual, cognitive and multiple impairments. Weber's Law *Just-Noticeable Difference* was adopted for this study.

The results showed that people with disabilities desired, on average, at least a 31% reduction in their current travel time to consider riding a different route with a transfer. This is similar to able-bodied riders who desired, on average, a 33% reduction (Chowdhury et al., 2015). Those who currently make a transfer were found to be less sensitive to travel time savings compared to those who currently rode a direct route. Interestingly, improvements in the quality of accessible features at stops/stations did not have a statistically significant effect on their desired transfer waiting and walking times. However, the increase in the average k

value showed that people with disabilities require more time to make a transfer at major interchanges compared to smaller stops/stations. Around 20% of current users, whose journey involved a transfer, were dissatisfied with the existing accessibility features on their route. They stated that weatherproof shelters at bus stops, gentler ramp gradients, availability of real-time timetable and service amenities would improve their ease of making transfers.

PT provides an opportunity for people with disabilities to travel independently and to be a part of society. This can only be achieved if the whole journey chain is accessible. Therefore, operators are responsible for ensuring that all stops/stations operate in compliance with accessibility design standards when planning, designing and implementing an integrated system. During data collection, participants expressed their frustration of providing feedback and not seeing improvements in the system. It is imperative that the time and effort given by the disability community are valued by transport authorities and used to influence policymaking to build this relationship and progress towards a more inclusive society.

Chapter Eight

Summary of findings, discussion and future direction

8.1 Summary of key findings

This section provides a summary of the key findings for the two main research questions stated in Section 1.5.

a) What are the barriers faced by people with disabilities from a whole journey perspective due to current public transport systems' operations and policymaking?

b) What are the potential barriers from the current designs of integrated systems, and how can they be addressed for people with disabilities?

Research question (a) comprised of objectives 1 and 2.

Objective 1: Examine the key barriers in typical public transport (PT) journeys which would bring the greatest mobility benefits, when addressed, by focusing on the two most common types, physical and visual impairment, by adopting the "accessible journey chain" concept.

Objective 2: Determine the prioritisation of accessibility features in a typical PT journey from the practitioners' perspective.

Research question (b) included the following objectives.

Objective 3: Investigate the influence of trip attributes on the willingness of disabled PT users (captive and non-captive) to use an integrated PT route involving transfers.

Objective 4: Determine the least travel time and transfer time (walking and waiting) savings for an integrated PT route involving a transfer that will be attractive to disabled PT users.

The purpose of the first research question was to determine the barriers in a typical PT trip from origin to destination. The whole journey chain concept considers the way information is required for each phase of a trip and the interaction between the built environment and the PT system. The second research question determines the barriers that can occur from the implementation of an integrated PT system. One of the key features of an integrated system is to increase ridership by strategically placing transfer hubs in the network. This converts a traditional PT network with multiple direct routes into a multi-modal network where a typical trip will require the user to make a transfer. For people with disabilities, the increased interaction with the urban environment will mean that they are more likely to encounter additional barriers from requiring to make transfers.

8.1.1 Research Question (a) – Overall Journey Chain

Objective 1 was achieved by undertaking the studies presented in Chapters 3 and 4. Chapter 3 examined the key barriers in a PT journey encountered by people with visual impairments, by adopting a qualitative approach which included a series of semi-structured interviews. This allowed a more in-depth investigation of the issues as well as offering insight into the emotional wellbeing of the participants. Participants expressed their emotional concerns, passionately and with great sincerity. They discussed the impact of these barriers on their mental and social wellbeing.

The aim consisted of two parts: (a) to identify the key barriers which adversely affected visually impaired PT users in their journeys; (b) how these issues should be prioritised based on their travel needs. Semi-structured interviews were conducted face-to-face and remotely through Skype around major cities in New Zealand. The cities comprised of Auckland, Christchurch, Dunedin, Wellington and Whanganui. The data were analysed using a qualitative data analysis software program *Nvivo (Version 11)* to transcribe semi-verbatim and categorise the data using thematic analysis. The findings are as follows:

- The main barriers for visually impaired PT users found are poor bus driver attitude and competency, obstructions on the footpaths, insufficient information, poor bus infrastructure, inadequate bus services, and barriers from construction.

- Bus driver's lack of awareness of the needs of disabled people was highlighted as the most common barrier to travelling by PT. This can be improved with better bus driver training.
- Many participants felt a range of negative emotions, such as isolation, frustration, resentment and stress. Their main concern was not being heard by decision-makers.
- Around 71% of the participants stated they would travel more than they are currently if their barriers were addressed.
- Users preferred to use PT over taxis to preserve their independence but are forced to choose the latter due to the unreliability of services and negative experience with driver behaviour.

Chapter 4 extends the study in Chapter 3 by including the travel experience of those with physical impairments. Thereby, the similarities and differences in the barriers perceived between physical and visual impaired riders are investigated. The "accessible journey chain" concept was adopted to identify critical barriers. The findings are as follows:

- The common barriers to both physically and visually impaired users highlighted the need to address issues related to driver training by increasing their awareness of the needs of people with disabilities; connectivity of the network; vehicle facilities (e.g. location of the stop button, vehicle design consistency, wheelchair space, etc.); and the quality of footpaths.
- Unsupportive behaviour from bus drivers has a negative impact on their experiences. Well-trained drivers can help people with disabilities feel more comfortable and confident to use PT as they are often the primary contact and act as a link between the built environment and PT system.
- Barriers faced by physically impaired users were predominantly associated with the built environment aspect of the journey chain. On the other hand, the PT system presented more barriers for visually impaired users.
- More focus is needed to ensure guidelines and best practice documents such as RTS14 – Guidelines for Facilities for Blind and Vision Impaired Pedestrians and the Auckland Transport Code of Practice (ATCOP) are regulated and followed correctly by practitioners.

Objective 2 was achieved by the study presented in Chapter 5. The study aimed to understand any differences in the prioritisation of accessibility features by decision-makers and practitioners compared to those by disabled PT users. The travel needs of disabled riders found in Chapter 4 were used for comparison with the viewpoints of practitioners. Senior decision-makers in the field of transportation engineering, urban planning and design, and policymaking from both private and public organisations, who have multiple years of experience were invited to participate from major cities in New Zealand. A multi-criteria decision-making method Analytic Hierarchy Process (AHP) was employed to investigate the relative importance of the accessibility features. The findings from the study are given below.

- Results showed that discrepancies exist between practitioners and users in the prioritisation of accessible features for a PT journey.
- Practitioners placed the highest weights on crossing facilities (0.19), followed by access to stops/stations (0.17) and quality of footpaths (0.13), all of which are constituents of the built environment. Users prioritised bus drivers' attitude (0.23), followed by access to stops/stations (0.18) and in-vehicle facilities (0.12). The largest difference in prioritisation between practitioners and users is bus driver attitude with a difference of 0.137.
- Practitioners placed more focus on the physical elements as it was easier to design and control as opposed to subjective elements such as driver behaviour. This is illustrated by a higher overall weight placed on the built environment components (0.647) by practitioners compared to the weights placed by users (0.51).
- Vegetation (0.047) and information at stops (0.058) was perceived to be the least important factors by practitioners. Users, on the other hand, placed a higher weighting on these factors (vegetation at 0.089 and information at stops at 0.097).
- Disability advocates and practitioners shared similar views in the prioritisation of accessibility features pertaining to the built environment, 0.67 and 0.647, respectively.
- There were differences in perception between private-sector engineers and local authority practitioners for three out of the nine attributes (access to stops, bus driver attitude and construction works), with the former rating construction works as the highest, resulting in the largest mean difference in the weight (0.132). Whereas, local authority practitioners

rated the factors comprising of bus driver attitude and access to stops/stations higher with a difference of 0.076 and 0.062, respectively.

8.1.2 Research Question (b) – Public Transport

Objective 3 was achieved by undertaking the study presented in Chapter 6. There were two parts to the study aim: (a) to examine the trip factors which influences people with disabilities willingness to use a PT route involving a transfer in an integrated system; (b) to examine current PT users' perception of safety using these routes. The focus was primarily on those with physical and visual impairments and who are current users of PT or with access to a private vehicle. Data were obtained by conducting a user-preference survey in New Zealand's three major cities (Auckland, Wellington and Christchurch) and analysed using binary logistic regression models. The findings are as follows:

- Disabled car drivers were more willing to use transfer routes given a shorter transfer time. Compared to a 15-minute waiting time, a 5-minute waiting time resulted in an Odds Ratio of 3.59 while 10 minutes waiting time resulted in an Odds Ratio of 2.27. Given a shorter walking time of 5 minutes, compared to 10 minutes resulted in an Odds Ratio of 2.32.
- Results suggest people with disabilities value walking time more than waiting time. A decrease in walking time from 10 minutes to 5 minutes resulted in 83% of PT users compared to 76%, and 57% compared to 48% of car drivers willing to use transfer routes, respectively.
- Poor connections and the difficulty of using PT due to their disability were the main factors that deter disabled car drivers from using PT. 60.5% of car drivers stated that they would not use PT even if the service were faster. The results implied that accessibility is a precondition for PT users' self-efficacy before transfer time becomes an important factor in their willingness to make transfers.
- Other trip attributes contributed to the willingness of disabled car users to use a transfer route in the model. Security was a considerable factor (Odds Ratio = 1.8), followed by the presence of connected walkways (Odds Ratio = 1.6) and information (Odds Ratio = 1.4).
- The results showed that transfer time was valued higher than security for disabled car drivers. Oppositely, current disabled PT users placed more emphasis on security. When

transfer times were kept constant, security was valued by a higher proportion of PT users compared to car drivers. Given a transfer time of 15 and 20 minutes, 75.9% and 72.4% of PT users were willing to use transfer routes compared to 48.5% and 38.3% of car drivers, respectively.

The study presented in Chapter 7 was undertaken to achieve Objective 4. The study aimed to determine: (a) the travel time savings desired by disabled PT users to choose a route with transfer, (b) the time required to wait and walk when making a transfer, and (c) the effects of accessibility features at stops/stations on transfer time which will induce a change in route choice. The study adopts an experimental psychological model, Weber's Law *Just-Noticeable Difference* (JND) to investigate the threshold values of time savings required by these users in order for them to perceive a well-connected route involving a transfer as being more attractive than their current route. An online user preference survey was employed in New Zealand to collect data. The findings from the study are as follows:

- Disabled PT users, on average, desired a very similar reduction in their current travel time to choose a route with a transfer compared to able-bodied PT users. Disabled PT users desired at least a 31% reduction for an interchange with basic amenities compared to able-bodied PT users who desired at least 33%, as found in the study by Chowdhury et al. (2015).
- The main priority of disabled PT users is to ensure that their journey is entirely accessible before they consider other factors such as travel time, comfort and cost. Appropriate facilities are required to be in place to meet the minimum accessibility requirement for independent travel. Disabled PT users desire a competitive reduction in journey time, similar to able-bodied PT users, due to the additional inconvenience of making transfers.
- Those who currently make a transfer (k value = 0.233) were found to be less sensitive to travel time savings compared to the participants who currently ride a direct route (k value = 0.406).
- The findings showed that improvements in the quality of accessibility features at an interchange did not have a statistically significant effect on their desired k values for both the transfer waiting and walking times.
- Different disability types desired a different percentage reduction in their current travel time. Users with physical and visual impairments desired at least a 25% reduction, users

with cognitive impairments at 32%, and multiple impairments at 46%. Physically impaired users were more prominent riders of direct routes (39%) compared to transfer routes (22%). Whereas a greater proportion of visually impaired users made transfers (37%) compared to 26% of direct routes.

8.2 Originality and Contribution

A well-designed PT system has the capability to provide access to a vast number of opportunities offered by society (Hine & Mitchell, 2001). Barnes (1991) highlighted that one's disability is contingent upon an inaccessible environment, not an impairment. Previous studies (Crudden et al., 2015; Lamont et al., 2013; Risser et al., 2012; Rosenberg et al., 2013) have, therefore, investigated transport accessibility barriers for people with disabilities in the built environment and their ridership of PT. However, a limited number of studies have examined these barriers through the perspective of a whole journey chain, from origin to destination. This approach is becoming ever more important, given the increasing complexity of journeys as a byproduct of the continuous evolution of the built environment and PT systems becoming integrated. The "accessible journey chain" concept emphasises the importance of the link between every element of the chain for the user to complete the journey with minimum disruption. Thus, any transportation infrastructure providing mobility for disabled travellers is only as strong as its weakest link in the journey chain. This research adopted the accessible journey chain concept to explore barriers faced by independent riders with disabilities. It provides an in-depth exploration of the issues.

When examining the barriers experienced by people with disability to ride PT, most studies either focused on one type of disability (Ahmad, 2015; Crudden et al., 2015; Earl et al., 2016; Gallagher et al., 2011; Havik et al., 2012; McEvoy & Keenan, 2014; Parkin & Smithies, 2012; Risser et al., 2012; Velho et al., 2016) or investigated a single aspect of the journey chain, as highlighted in Chapter 2. The studies in Chapters 3 and 4 adopted the "whole journey chain" concept to identify the critical barriers in a PT journey as well as investigating similarities and differences in the perceived barriers between two common disability types, physical and visual impairment. This approached revealed that although there are some similarities, which are mostly associated with driver behaviour, PT service and the network, there were also many differences. These two studies empathise the importance of not implementing a “one size fits all” approach, and to consider the various needs due to their unique challenges. Both studies were conducted using semi-structured interviews. This allowed the participants to answer open-ended questions. During the interviews, the participants expressed, passionately, the emotional impact caused by these barriers. Feeling isolated, unheard and neglected were the common emotions expressed. Although it was not the initial intent of the research to delve into the psychological wellbeing, it could not be avoided and stand as an important contribution from the two studies.

Chapter 5 examines the barriers in the transport network by investigating any gaps in the prioritisation between practitioners and the needs of disabled PT users. To the author’s knowledge, the study provides for the first time in literature, a comparison between the viewpoints of practitioners and users. Practitioners were found to place more emphasis on the physical elements of the journey chain, namely the built environment. Conversely, users placed more emphasis on the PT aspect. This finding provides some explanation as to the persistence of the barriers in the network. Every element of the journey chain must be accessible for people with disabilities to complete the trip successfully. The results highlight the need to shift the way of thinking for practitioners to adopt a more balanced view and take into account the needs of disabled riders to ensure the whole journey is as seamless as possible. Private engineers tend to place more focus on the design and construction aspect, which skews the overall weighting more heavily towards the built environment. Local authority engineers have a more balanced view regarding the PT journey chain. Private engineers are required to be more aware of the needs as they are generally involved with the more technical aspect of design and planning.

Numerous studies (Atkins, 1990; Chowdhury et al., 2015; Dell'Olio, Ibeas, Cecín, & dell'Olio, 2011; Eboli & Mazzulla, 2012; Iseki & Taylor, 2009; Kumar, Kulkarni, & Parida, 2011; Stradling, 2002) have stated that travel time and safety are important attributes of travel behaviour. However, the findings from these studies apply specifically to able-bodied PT users. To the author’s knowledge, there are no studies that examined disabled PT users’ perception of these attributes in a PT route involving transfers. An integrated system involves more routes with transfers. For disabled riders, this means that they will need to interact more with the urban environment, which exposes them to additional barriers. Chapters 6 and 7 highlight the importance of reducing travel and transfer time for people with disabilities, similar to findings in previous studies (Chowdhury et al., 2015) on the condition that infrastructure facilitating transfers are accessible. The studies found that building PT infrastructure and planning routes such that transfer time is minimised, in particular walking time, will have a greater chance of attracting patronage from disabled travellers, especially private vehicle users. This aligns with their preference to minimise the time spent in unsafe waiting conditions as personal safety was confirmed to be a considerable factor in their decision to use PT, given their perceived vulnerability and the inability to protect themselves (Marston et al., 1997; Yavuz & Welch, 2010). Those who ride a direct route were found to be more sensitive to travel time savings compared to participants who currently make a transfer.

Interestingly, in contrast to the findings by Chowdhury et al. (2015) for able-bodied riders, improving the quality of comfort for stops/stations did not have an effect on disabled riders' desired transfer waiting and walking time. It can be inferred that once a certain threshold for accessibility has been reached, any additional improvements will result in negligible benefit. This reinforces the importance of having stringent regulations to ensure that PT infrastructure, especially suburban stops/stations, are compliant with accessibility design standards to allow disabled users to ride PT as an alternative mode – one that provides independence and integration with society.

Overall, the mixed qualitative and quantitative approach of this research presented a thorough understanding of the ongoing accessibility challenges faced by people with disabilities. There is strong evidence that people with disabilities experience exclusion in their day to day lives. They feel that their concerns are not being heard by transport authorities. Barriers present from inconsistencies in the network can make the exhaustive time and effort put into the planning of journeys less effective. The negative emotions associated with not having the freedom of independent travel due to barriers in the system has led to feelings of isolation and resentment. Participants expressed the detrimental effect on their quality of life and overall mental wellbeing. Their distrust in the transport system and the loss of confidence in themselves is the driving force that continues to fuel social exclusion. Ensuring that people with disabilities gain and maintain confidence in the transport system, through the development of a more inclusive society is essential to alleviate, and eventually, break the vicious cycle of social exclusion.

8.3 Limitations

The nature of this research involving a qualitative approach required the author to connect with participants on a personal level. Physically being in the comfort of their own homes on numerous occasions behind closed doors provided a rare insight into their day to day lives. This section provides a reflection of the author's experiences and the unique and various challenges faced throughout the course of this study.

- **Relationship with practitioners:** Findings have shown that there is a sense of severe disappointment among the disability community. The data collection process for Chapter 7 was for many months, where a multitude of disability organisations and groups were contacted. Although advocates representing the community often voice their concerns that needs of the people are neglected by the government, their lack of involvement when offered the opportunity suggests there is frustration towards researchers, practitioners and policymakers. Their main concern, as expressed in the accessibility workshop in February 2017 held at the University of Auckland, was that their efforts feel futile when they do not see the prioritisation of their needs and continue to face the same barriers. Advocates expressed that they are "tired of explaining the same thing over and over again".
- **Challenge in attaining data from different disability groups:** Getting participants to give their time and effort to complete the surveys was a major challenge during the data collection stage, especially in anonymous surveys. A considerable number of survey responses were non-useable due to being incomplete. Physically impaired users followed by visually impaired formed the majority of the responses as they are more independent compared to other disability types, which allowed them to answer the surveys wholly and correctly. Other disability types were more challenging as they did not reach out even though additional assistance was offered, and therefore, the appropriate guidance could not be provided to produce viable data. Various networking events such as the Universal Design Symposium, Accessibility Workshop, Australasian Transport Research Forum, and numerous seminars were imperative to network with key people from disability

organisations who can reach out to their large group of members. Data collected by employing the snowball sampling method will present some bias to the results. Participants from the same group of population may have a tendency to express similar barriers; thereby, the view of the entire disability population will not be fully represented. However, the research still highlights the key barriers faced by the target participants as defined in the scope.

- **Advantages and disadvantages of qualitative method:** The most thorough data came from the qualitative methodology involving face to face interviews for the studies conducted in Chapters 3 and 4. However, this presented a unique challenge in the sense that each participant required immense emotional investment in order for them to open up completely. The quality and richness of the data were dependent on the co-operation and trust of the participants. Maintaining professionalism was immensely taxing, as there were many emotions expressed by the participants during the data collection. It was apparent that they were under a lot of frustration and burden, especially as they wished to contribute more to society but could not due to their circumstance and the constraints in the environment.

8.4 Recommendations to practitioners

This section provides recommendations to decision-makers and practitioners based on the findings of this research to improve the journey experience of people with disabilities when using PT. Table 8.1 presents the summary of recommendations from each study conducted in this study.

Table 8.1: Summary of recommendations

Chapter	Title	Recommendations
Chapter 3	Journey by visually impaired public transport users: barriers and consequences	• Improving bus driver training methods, increased number of strategically placed pedestrian crossings and improved presentation of information would bring the greatest mobility benefit to visually impaired PT users.
Chapter 4	Investigating the barriers in a typical journey by public transport users with disabilities	• Practitioners to adopt the "accessible journey chain" concept in their way of thinking to better connect the first and last leg of a journey to infrastructure projects. • Decision-makers are encouraged to interact with the disability community to understand their mobility needs better when implementing infrastructure in the transport network. • PT operators to liaise more closely with key stakeholders in the disability community to review and revise current training practices to offer better educational training to their bus drivers on the needs of physically and visually impaired users. • Collate relevant standards into one document for disability design and to liaise with stakeholders as early as possible in the planning and design stages to ensure essential design elements are not omitted.
Chapter 5	Gap between policymakers' priorities and users' needs in planning for accessible public transit system	• Practitioners to place more focus on improving the subjective elements of the PT journey chain, such as behavioural consistency, e.g. bus driver behaviour around people with disabilities. • Practitioners from different fields of expertise such as the local authorities (including internal) and private practitioners to liaise earlier and more regularly in the design and planning. • Early engagement and involvement of experts from the disability sector to identify and address issues from high-level design down to detailed design.

Chapter	Title	Recommendations
Chapter 6	An examination of people with disabilities' willingness to make transfers in an integrated public transport network	• Minimising the distance between connection points that is accessible to improve the ease of travelling independently for disabled PT users. • Increased security provisions at station connection points: 1. The regular presence of trained security personnel, especially outside peak pedestrian hours. 2. Better lighting on adjacent streets surrounding the station.
Chapter 7	Investigating the needs of people with disabilities to ride public transport routes involving transfers	• PT operators, when planning, designing and implementing an integrated system ensure that all connection points, especially suburban stops and stations, are compliant with accessibility design standards. • Consistent and transparent communication throughout the project cycle: planning, design and construction to all disability stakeholders involved, especially any changes to the design so their input can be taken into account.

- As per Chapters 3 and 4, PT operators are to liaise more closely with key stakeholders in the disability community to review and revise current training practices and offer better educational training to their drivers on the needs of passengers with disabilities. Different disabilities present different needs which must be accommodated accordingly. For example, the two most common disabilities are physical or visual impairments. Physically impaired users require physical intervention from the driver to operate the ramp or by securing the user's mobility aid to the vehicle. Whereas visually impaired users rely on drivers to convey information and essentially to act as their eyes. Bus drivers play an essential role in providing a seamless transfer between the built environment and the PT component of the journey chain. Taking them through the process of being in the shoes of a person with disabilities would provide insight into their difficulties and improve their understanding of their needs and how to best cater to them.
- It is recommended to collate various guidelines for disability design into one document for easier and more convenient access for practitioners. Local authorities and private consultancy practitioners in Auckland follow the Auckland Transport Code of Practice (ATCOP). However, the guidelines are tedious to use and are not always straightforward to navigate around. ATCOP refers to other specialised documents for disability design such as

the RTS 14 Guidelines for Facilities for Blind and Vision Impaired Pedestrians and others which are all segregated. This further exacerbates the demanding works already on the plates of practitioners that can result in fine details being overlooked, especially if accessing and collating the required information is perceived to be bothersome.

- Early and regular engagements with key experts in the field of accessibility during the design and planning stage for implementing new or retrofitting existing infrastructure, as discussed in Chapters 5 and 7. Working as a Transportation Engineer at Auckland Transport, an Auckland Council Controlled Organisation, allowed the author to gain insight into the organisation policies and internal traffic safety and operational processes. New infrastructure such as footpaths, crossing facilities, accessibility features, for example, are implemented as part of consent requirements during the subdivision and land development by developers. Practitioners involved in this process have a major responsibility. They are under significant time constraints to capture all the appropriate facilities during the consenting phase as per best practice guidelines and standards. Seeking guidance from disability experts is the most ideal time at this stage of planning as all the required facilities to support accessibility can be requested at the developer's expense as well as optimising connectivity for people with disabilities. Once this opportunity is lost, it is very costly and difficult to go back to retrofit existing infrastructure due to organisational, budgetary constraints. It is recommended that disability experts are continually involved in all stages of the project cycle to ensure compliance.

8.5 Future directions

Evidence from the review of the existing literature has shown that there is limited research surrounding travel behaviour relating to the PT journey chain for people with disabilities. Findings from this research covered the aspect of examining PT trips as a whole journey, from origin to destination, and a more detailed examination of routes involving transfers. Several future research opportunities have been identified.

This research examined the transport needs of users consisting primarily of physical and visual impairments. Further investigation to understand the critical barriers of other disability types, including mental health, should be extended to bring mobility benefits to a broader number of users.

Bus driver's unawareness of the needs of people with disabilities has been highlighted as a critical issue in this study. Therefore, research gaining insight into the current awareness and knowledge of bus drivers would assist in determining the gaps in their ability to accommodate riders with different disability types. A qualitative approach can be employed to delve deeper into this topic by involving experts from the disability community to identify issues in the current training practices. Findings from the study can be used to improve current practices and introduce guidelines, which can be adopted by bus companies and transport agencies to better cater for people with disabilities.

The application of the Universal Design (UD) principle to transport infrastructure promotes accessibility and usability to people with all ranges of abilities from the young to the elderly, those using wheeled devices such as prams and strollers, and people with varying disabilities. For people with disabilities, their needs are determined by the degree and nature of their disability. In an ideal world, UD would accommodate the broadest spectrum of people, between and including, the two extreme levels of mobility that governs the range of their independence – the lower end (disability) and the upper end (able-bodied).

However, budgetary and resource constraints limit the practicality of accommodating for everybody, especially those whose level of mobility is situated on the very low end of the spectrum. Specialised facilities to accommodate the extent of these needs become correspondingly more complicated with the severity and uniqueness of the disability as they rely more and more on external assistance to gain mobility. To implement such provisions in design comes with a high financial cost. When this is coupled with the very few numbers of individuals who would benefit from such a specialised design would make the option inefficient, based on the cost-benefit analysis, which is primarily used by many authorities to determine the effectiveness of any given investments. Infrastructure predominantly caters for the majority of the population towards the able-bodied side of the spectrum due to its high benefit/cost ratio.

Given these constraints, this highlights the need to determine the threshold line in which UD can provide the most value for money as well as accommodating as many people close to the ends of the spectrum as possible as certain infrastructure cannot truly be universally designed. Where design becomes infeasible because it steps outside of this threshold of feasibility and practicality, alternative methods to accommodate users in this range should be explored such as utilising mobility as a service, e.g. specialised feeder bus service to pick up users and drop off to the PT interchange or door-to-door to ensure inclusion and optimising the costs.

Chapter Nine

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Appendices

Questionnaires

Given are the semi-structured interview questionnaire, pairwise comparison questionnaire and two stated preference surveys conducted throughout the research.

Appendix A: Semi-structured interview questionnaires

Appendix B: Pairwise comparison questionnaires

Appendix C: Stated preference surveys

A1: Semi-structured Interview Questionnaire

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Interview Questionnaire

Pre-determined interview question guidelines (These questions are a guideline only. Depending on the participant's response, the questions may be asked differently, in a different order or some questions may not be asked at all. Additional probing questions may be asked to further build on a response.):

To start off the interview, I would like to ask:

1. Do you use public transport? If no, then go to (4).
2. How frequently do you use public transport?
3. When do you use public transport?
4. Do you have access to other modes of transport?

The following questions will relate to your experiences of the barriers in public transport journeys

5. When considering a typical journey from when you leave your home to when you reach your destination using public transport, what parts of the journey present the biggest barriers and why are they an issue?
6. Do these issues put you off from making future journeys?
7. Do certain types of journeys such as shopping, recreational, medical related, and etc. present additional barriers?
   - What types of journeys present the most difficulties and why?
8. What are the consequences of not being able to make a journey?

The following questions will explore how mobility barriers have an impact on your life

9. What kind of activities would you like to do that you find it difficult to participate due to the barriers in a public transport journey?
   - Why are you unable to do it?
   - How does this make you feel?
   - What impacts does not being able to participate in these activities have on your life?

We are now going to talk about what makes a good journey and the key issues that should be addressed from your perspective

10. What are the qualities that make a good journey?
11. How often would you travel if the issues that were compromising your journeys were addressed?

12. What would be the top 3 issues/barriers you would address first that would bring the most improvements to your mobility and how would you go about addressing it?
    - How would it benefit you?
13. What are your thoughts on universal design, do they meet your needs for accessibility?
14. Do you get involved with the planning of accessible design?
    - Is this generally for new infrastructure projects or for retrofitting of existing infrastructure?
    - Do you feel that your input gets implemented into the final project?

I want to talk briefly about how you feel about having shared spaces (Pictures or explanations will be provided) in a public transport journey

15. Have you used shared spaces before?
    - Do you mind journeys that include shared spaces?
    - Would shared spaces improve the surroundings of public transport interchanges and why?

The following questions will be briefly on the total mobility scheme

16. Have you used the total mobility scheme before?
    - In what situations do you use it and how helpful is it?
    - Would you prefer to use the TMS or travel independently and why?

To conclude the interview, I would like to ask you some quick sociodemographic questions

17. What age group are you in? <15, 15-24, 25-44, 45-64, 65-74, 75-84, 85+
18. Gender: M / F / Other
19. What ethnicity do you identify yourself as?
20. What would you identify your impairment as?
    - Do you experience any additional difficulties?
    - (For hidden impairments) Do you identify yourself as having a particular impairment? (If no) Are there any activities of your daily life that you have difficulties with?

Approved by the University Of Auckland Human Participants Ethics Committee on 28/11/2016 for three years. Reference Number 018308

A2: Participant Information Sheet

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PARTICIPANT INFORMATION SHEET

The Development of an Equitable Evaluation Framework of Inclusive Design in Transport

Name of Researcher: Jun Park

Name of Supervisors: Dr Subeh Chowdhury & Dr Douglas Wilson

Researcher Introduction

My name is Jun Park and I am currently a Doctoral (PhD) student in the Department of Civil and Environmental Engineering at the University of Auckland. Joshua Bamford and Hayley Byun, both 4th year engineering students, will be assisting me in the interview process. My supervisors are Dr Subeh Chowdhury and Dr Douglas Wilson in the Department of Civil and Environmental Engineering.

Project description and invitation

You are cordially invited to participate in this transportation research study and I would appreciate any assistance you can offer. The purpose of this interview is to further my understanding of the barriers or issues faced by disadvantaged pedestrians in their journeys involving public transport and to find and prioritise potential solutions to these issues from your perspective. Disadvantaged pedestrians in this research includes the elderly over 65 years of age and individuals with disabilities, such as: Physical (mobility impairments), Sensory (hearing and/or seeing impairments) and Dementia. This research aims to identify key factors relating to recurring issues and its impact on disadvantaged pedestrians to develop a framework in evaluating the benefits of addressing these issues using qualitative data from this interview.

Your participation in this study is voluntary and you may decline this invitation to participate without penalty. Your opinions will represent your own personal opinions, and not necessarily those of your organisation. There will be no direct or immediate personal benefits from your participation in this research, except for the contribution to the study. However, I expect that the results for this research will improve the awareness regarding disadvantaged pedestrian's needs in their journeys, which can benefit you indirectly.

Project Procedures

I would like to invite you to an individual interview session to share your opinions and experience, and to explore how you perceive the current environment in relation to your journey.

The interview session will take between 30 minutes and one hour. The interview questions are attached. However, these questions are guidelines only and are subject to change depending on the nature of the responses. The interview will be recorded with an audio recorder and will be transcribed semi-verbatim by Joshua Bamford, Hayley Byun and the researcher. You have the opportunity to view/edit your interview transcript and amend it prior to analysis, if you wish. You will have 14 days from the date of receipt to return your edited transcript.

The summary of findings may be requested which can be emailed or posted to the address specified in the Consent Form.

Data Storage, Retention, Destruction, and Future Use

A voice recorder will be used during the interview. Audio recordings will be transcribed and kept in a secure location (at the University of Auckland campus) separate from the Consent Forms for at least six years, after which they will be destroyed (digital files will be permanently deleted off the system and any hard copies of information shredded). The responses from this interview may be used in other studies such as PhD or undergraduate research projects and may be used for publication purposes, including conference presentations.

Right to Withdraw from Participation

You have the right to withdraw from participation at any time, without needing to provide a reason. You may withdraw your data from the study at any time for up to one month following the interview.

Confidentiality of Responses

All responses during the interview session will be kept completely confidential. Responses will be kept in a locked file to which only the researchers and supervisor have access. It cannot be completely guaranteed that participant anonymity will be preserved, however the researchers will strive to protect the anonymity of participants at all stages of the research. Individuals' names and other identifying information will be disguised in the research report. The researchers will report what is said, but will not attribute statements to identifiable individuals. All participants, will be given the opportunity to review the final report before it is published externally.

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For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Research Office, Private Bag 92019, Auckland 1142. Telephone 09 373-7599 ext. 83711. Email: ro-ethics@auckland.ac.nz.

Approved by the University of Auckland Human Participants Ethics Committee on 28/11/2016 for three years. Reference Number 018308

A3: Consent Form

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Consent Form (Semi-Structured Interview)

The Development of an Equitable Evaluation Framework of Inclusive Design in Transport

THIS CONSENT FORM WILL BE HELD FOR SIX YEARS

I agree to voluntarily take part in this research and I have read the Participant Information Sheet.

I have been given and have understood an explanation of this research project. I have had an opportunity to ask questions and have them answered satisfactorily.

I understand that this interview will take between 30 minutes to an hour.

I understand that I will be recorded and that recordings will be transcribed by the researcher and fellow students.

I understand that I am free to withdraw my interview responses at any time up to one month after the interview date without giving a reason.

I understand that the data will be stored for six years and that the security and privacy of data will be maintained.

I understand that the response of my interview (including any audio recording) will be stored in a secure location, within the University of Auckland premises, for six years, after which time it will be destroyed.

I understand that I can request a copy of my transcript of my interview, and I will have 14 days to review and amend it, if I wish to do so.

I understand that my name will not be used and every effort will be made to ensure identifying information is not included in the research report or in any other publication relating to this study.

I understand that, while the researchers will strive to retain my anonymity, it cannot be fully guaranteed.

I understand that the opinions expressed in this interview are my own.
I **wish / do not wish** to view the interview transcript.

I **wish / do not wish** to receive a summary of findings, which can be emailed or posted to me at this address: ______________________

I **agree / do not agree** to the use of my responses in future work such as for publication purposes and PhD or undergraduate research project.

The participant provided oral consent instead: **Yes / NA**

Signed: ____

Name (please print clearly): _______________________________________

Date: ____

Approved by the University Of Auckland Human Participants Ethics Committee on 28/11/16 for three years. Reference Number 018308

B1: Pairwise Comparison Questionnaire

Designers and policymakers perception of the transport needs for people with disabilities

Sam Wolk, Tim Paterson-Catto, Jun Park, Dr. Subeh Chowdhury

Direction: For each item refer to the columns **Attribute A** and **Attribute B**, and choose a preference as to which you believe is more important when considering the needs of people with disabilities undertaking a typical public transport journey from leaving their home to reaching their destination. Under the **preference** heading, write either **A** or **B** and rank how important your chosen preference is compared with the other attribute under the **importance** heading. If you believe both attributes are of equal importance, rank the importance as 1 to express equal importance.

Please select your prefered attribute (A or B) Please rank importance on a scale of 1-9:
1 - Of Equal Importance
3 - Somewhat more Important
5 - More Important
7 - Strongly more Important
9 - Extremely more Important

Item	Attribute A	Attribute B	Preference	Importance
1	Stop and Station Facilities	Crossing Facilities		
2	Crossing Facilities	On-Vehicle Facilities		
3	Information at Stops	On-Vehicle Facilities		
4	Vegetation	Access to Stops and Stations		
5	Vegetation	Bus Driver Attitude		
6	Bus Driver Attitude	Quality of Footpaths		
7	Access to Stops and Stations	Bus Driver Attitude		

8	Vegetation	Construction works		
9	Stop and Station Facilities	Bus Driver Attitude		
10	Stop and Station Facilities	Construction works		
11	Information at Stops	Construction works		
12	Access to Stops and Stations	Information at Stops		
13	Bus Driver Attitude	Crossing Facilities		
14	Information at Stops	Crossing Facilities		
15	Stop and Station Facilities	Access to Stops and Stations		
16	Stop and Station Facilities	On-Vehicle Facilities		
17	Access to Stops and Stations	Construction works		
18	Vegetation	Information at Stops		
19	Bus Driver Attitude	Information at Stops		
20	Stop and Station Facilities	Information at Stops		
21	Crossing Facilities	Construction works		
22	Vegetation	On-Vehicle Facilities		
23	Access to Stops and Stations	On-Vehicle Facilities		

24	Stop and Station Facilities	Quality of Footpaths		
25	Bus Driver Attitude	Construction works		
26	Construction works	On-Vehicle Facilities		
27	Construction works	Quality of Footpaths		
28	Vegetation	Crossing Facilities		
29	Access to Stops and Stations	Crossing Facilities		
30	Crossing Facilities	Quality of Footpaths		
31	Access to Stops and Stations	Quality of Footpaths		
32	Vegetation	Quality of Footpaths		
33	Vegetation	Stop and Station Facilities		
34	On-Vehicle Facilities	Quality of Footpaths		
35	Information at Stops	Quality of Footpaths		
36	Bus Driver Attitude	On-Vehicle Facilities		

Approved by the University of Auckland Human Participants Ethics Committee on 29 June 2018 for three years.

Reference Number 021354

B2: Glossary of Terms

Department of Civil and Environmental Engineering
20 Symonds Street, Auckland, 1010
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New Zealand

GLOSSARY OF TERMS

Stop and Station Facilities

- Availability of shelter, disabled toilets, seating, etc.

Crossing Facilities

- Appropriate location of crossings, availability of tactile surfaces, ramp slope, refuge islands, etc.

Information at Stops

- Up to date timetables and route information, audio announcements, real time information, good contrasting and larger sized fonts, etc.

Vegetation

- Removal of obstacles from low-hanging branches, tree roots pushing up through the footpath, wide hedges, etc.

Bus Driver Attitude

- Operating the ramps, route advice, friendliness, knowledge of various disability needs, etc.

Access to Stops and Stations

- Availability of ramps, tactile surfaces, escalators, elevators, disabled parking, etc.

On Vehicle Facilities

- Disabled spaces and priority seating, audio announcements and visual information, etc.

Construction Works

- Alternative routes, temporary crossings, information regarding detours, etc.

Quality of Footpaths

- Availability of footpaths, smoothness, width, gradient, kerb drops, etc.

B3: Participant Information Sheet

Department of Civil and Environmental Engineering
20 Symonds Street, Auckland, 1010
0800 616 263

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Private Bag 92019
Auckland, 1142
New Zealand

PARTICIPANT INFORMATION SHEET

Project Title: Designers and policymakers perception of the transport needs for people with disabilities

Researchers: Sam Wolk, Tim Paterson Catto and Jun Park

Supervisor: Dr Subeh Chowdhury

Researcher Introduction

Our names are Sam Wolk and Tim Paterson-Catto, and we are Honours students in Civil Engineering at the University of Auckland under the supervision of Dr Subeh Chowdhury.

Project Description and Invitation

This research aims to determine how practitioners perceive and prioritise the needs of people with disabilities and design for them. One of the transport goals of Auckland Transport is to increase the number of public transport users, and people with disabilities have been found to be very reliant on this mode of transport. However, previous studies have shown that they encounter many barriers in their journeys that can result in them being unable to complete it. As such, we are investigating the perception of how their needs are prioritised among practitioners.

You have been chosen because you are in a profession that involves transportation engineering design or policymaking. We would like to invite you to take part in a questionnaire to establish these. Your assistance will be greatly appreciated.

Project Procedures

This project involves filling out a questionnaire that consists of 36 pairwise comparisons between 9 attributes that were identified to be important for people with disabilities when undertaking public transport journeys. Further instructions can be found in the questionnaire, and it is estimated that the questionnaire will take around 10 minutes to complete. Please refer to the "Glossary of Terms" document while completing the questionnaire.

There will be an opportunity for all participants to view the results of the research. This will be a general report based on all data from the study with no individual identification.

Data Storage/retention/destruction/future use

In the future, we may use the data from this research to compare with other research. The data may be used in presentations and academic publications; individuals or organisations will not be identifiable in any of these. The electronic data gathered in this research will be stored in an electronic data file with all coding information removed (after data matching). The file will be kept confidential on a password-protected computer for six years at the University of Auckland

Right to Withdraw from Participation

Participants have the right to withdraw from participating in the research at any time before and during data collection.

Anonymity and Confidentiality

Participant's identities will be kept anonymous, and information identifying the participant will be removed after the data collection phase is completed. There will be no disclosure of personal information in any discussion or report of the research, except for organisation and job information to identify as either a transport designer or policy maker

Ethical Issues

The views that you express do not represent those of the organisation with which you work. Further, we assure that the participation or non-participation in this research will not affect your employment situation in any way as it will not be identifiable.

For any other concerns please see the contact details below for Sam Wolk, Tim Paterson-Catto and Dr. Subeh Chowdhury. We encourage you to contact them with any concerns regarding the research process.

Contact Details

Researchers:

Sam Wolk Ph: +64 21 486 747
swol411@aucklanduni.ac.nz

Tim Paterson-Catto Ph: +64 21 208 2436

tpat778@aucklanduni.ac.nz

Research Supervisor:
Dr Subeh Chowdhury Ph: +64 9 923 4116
s.chowdhury@auckland.ac.nz

Faculty of Engineering postal address:
Faculty of Engineering, The University of Auckland
Private Bag 92019
Auckland Mail Centre, Auckland 1142
New Zealand

For any concerns regarding ethical issues you may contact the Chair:

The University of Auckland Human Participants Ethics Committee (UAHPEC)
University of Auckland, Research Office, Private Bag 92019, Auckland 1142.
Telephone 09 373-7599 ext.

Approved by the University of Auckland Human Participants Ethics Committee on 29 June 2018 for three years. Reference Number 021354

B4: Consent Form

Department of Civil and Environmental Engineering
20 Symonds Street, Auckland, 1010
0800 616 263

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Auckland, 1142
New Zealand

CONSENT FORM

THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

Project Title: Designers' and policymakers' perceptions of transport needs for the disabled

Supervisor: Dr Subeh Chowdhury

Researchers: Sam Wolk, Tim Paterson Catto and Jun Park

I have read the Participant Information Sheet and have understood the nature of the research, and why I have been selected. I have had the opportunity to ask questions and have had them answered to my satisfaction.

- I agree to take part in this research.
- I understand that I am free to withdraw my participation at any time and to withdraw any data up until the completion of data collection.
- I wish / do not wish to receive a summary of findings.

Name: ______________________________

Signature: ______________________________ Date: ______________

Approved by the University of Auckland Human Participants Ethics Committee on 29 June 2018 for three years. Reference Number 021354

C1: Stated Preference Survey #1

Questionnaire on Public Transport

Question Type	Instruction Text
SC	*Please select one only*
MC	*Please select as many as apply*
SC GRID X ROW	*Please select one answer per row*
MC GRID X ROW	*You can select multiple answers per row but please ensure that each row has at least one answer*
OE – CHA	*Please type your answer into the box below*
OE – NUM	*Please type a number into the box(es) below*
SLIDER	*Please click and drag the marker to the appropriate point on the scale. The 'Next' button will not appear until all statements have an answer*

ASK ALL, SC, TERMINATE IF CODES 3,4,5

QREGION. Which part of the country do you currently live in?

1. Auckland
2. Wellington (including Upper Hutt and Lower Hutt)
3. Other North Island area
4. Rest of Canterbury (excluding Christchurch)
5. Other South Island area
6. Christchurch

ASK ALL, SC

QGENDER. What is your gender?

1. Male
2. Female
3. Gender Diverse

ASK ALL, SC

QAGE. What is your age range?

1. < 16 **[TERMINATE]**
2. 16-20
3. 21-30
4. 31-40
5. 41-50
6. 51-60
7. 61+

ASK ALL, SC

QOCCUPATION. Which of the following best describes your employment status?

1. Full time (30 or more hours per week)
2. Part-time
3. Contract, freelance or temporary employee
4. Self-employed
5. Retired
6. Fulltime homemaker/ stay-at-home parent
7. Full-time student
8. Unemployed

ASK ALL, SC

Q3. What is your annual income before tax (approximately)?

1. None
2. Under $50,000
3. $50,000 to $70,000
4. $70,000 to $100,000
5. Over $100,000

ASK ALL, SC, CODE 9=OE-CHAR

Q4. Which ethnic group do you belong to (most strongly identify with)?

1. New Zealand European
2. Maori
3. Samoan
4. Tongan
5. Cook Island Maori
6. Niuean
7. Chinese
8. Indian

10. Other European

9. Other; please state: _________________________

ASK ALL, SC

Q5. What is your main mode of transport?

1. Bus
2. Train
3. Bike
4. Walking
5. Ferry
6. Car
7. Other; please state:______________________________

ASK ALL, SC

Q18. Do you have any disabilities that affect your mobility?

1. Yes
2. No
3. Rather not say

ASK IF Q18=1, OE CHA

Q18a Please describe the disability: _____________________

ASK ALL, OE-CHAR
Q6. Where do you live?
Name of suburb:____________________

ASK ALL, OE-CHAR
Q7. Where do you work or study?
Name of suburb:____________________

Section B (Car users)

ASK IF Q5=6, SC
Q19. Do you have free parking at your work/study?

1) **Yes**
2) **No**

ASK IF Q19=2, OE-NUM, RANGE 1-9999
Q19a. How much is your parking fee per day?

ASK IF Q5=6, OE-NUM RANGE 1-9999
Q20. How much do you pay for petrol per week?

ASK IF Q5=6, SC
Q21. How long is your typical journey?

1. Less than 20 minutes
2. Between 20 minutes and 40 minutes
3. Between 40 minutes and 1 hour
4. Over 1 hour

ASK IF Q5=6, MC, CODE 10=OE-CHAR
Q22. What are your main reason(s) for choosing to use a car instead of public transport?

1. It is difficult to use public transport for my disability
2. Poor public transport connection to my destination
3. There are no public transport services during the hours I work
4. It is safer
5. It is more comfortable
6. I have other passengers to drop off/pick up
7. Looks nice in front of my friends and co-workers
8. I have full control of my trip
9. I do not have to sit with strangers
10. Other; please state: _________________

ASK IF Q5=6, SC
Q23. Would you use public transport if the service was faster?

1. Yes
2. No

ASK IF Q5=6, SC
Q24. Would you use public transport if the total cost of the fare was reduced?

1. Yes
2. No

Section C – I use public transport

ASK IF Q5=1,2,5, SC

Q8. How often do you use public transport?

1. Every day/ every weekday
2. Every few days
3. Once a week
4. Once a month

ASK IF Q5=1,2,5, MC

Q9. What is the common purpose of your trips?

1. To get to work
2. For education
3. To run errands
4. Other; please state: ___________________

ASK IF Q5=1,2,5, SC

Q10. How long is your typical journey?

1. Less than 20 minutes
2. Between 20 minutes and 40 minutes
3. Between 40 minutes and 1 hour
4. Over 1 hour

ASK IF Q5=1,2,5, SC

Q11. How long is your walk to the station from your home?

1. Less than 5 minutes
2. Between 5 - 10 minutes
3. Between 10 – 15 mins
4. Get dropped off by someone/park my car nearby

ASK IF Q5=1,2,5, CODE 5 = EXCLUSIVE, MC

Q12. Select the safety features in your current station.

1. Good lighting in the station at night
2. Station is well designed, no hidden corners
3. There are security guards present
4. The streets are well-lit when I leave the station at night
5. None of the above

ASK IF Q5=1,2,5, SLIDER

Q13. ***Please move the slider to the number on the scale that applies to you***

1. I feel safe waiting at the station(s)	*Strongly Disagree*	*1*	*2*	*3*	*4*	*5*	*Strongly Agree*
2. I feel safe to walk home in the dark	*Strongly Disagree*	*1*	*2*	*3*	*4*	*5*	*Strongly Agree*
3. I have seen some verbal abuse of other passengers at the station	*Strongly Disagree*	*1*	*2*	*3*	*4*	*5*	*Strongly Agree*
4. I have seen some physical abuse of other passengers at the station	*Strongly Disagree*	*1*	*2*	*3*	*4*	*5*	*Strongly Agree*
5. I am worried about experiencing verbal or physical abuse myself	*Strongly Disagree*	*1*	*2*	*3*	*4*	*5*	*Strongly Agree*

ASK IF Q13 ROW 5= 4 OR 5, MC, CODE 4 = OE-CHAR

Q13a. Are you worried because of:

1. how you look
2. the neighbourhood of the station
3. how the other passengers look
4. Other; please state:______________

ASK IF Q5=1,2,5, SC

Q14a. Do you make a transfer?

1. Yes
2. No

ASK IF Q14a = CODE 1

Q14b. How long is the waiting time:

______ mins

ASK IF Q14a = CODE 1

Q14c. You make the transfer….

Please type mode of transport you are transferring from and to:

FROM: **OE-CHAR** **(e.g. bus or train)**

TO: **OE-CHAR** **(e.g. bus or train)**

ASK IF Q14a = CODE 1, MC, 5 = EXC

Q14d. The location where you make a transfer has …

1. CCTV
2. Security guards
3. Emergency telephones
4. Good lighting at the station
5. None of these security features

ASK IF Q14a = CODE 1, SC

Q14e. When you make a transfer, the station is usually crowded …

1. Yes
2. A little
3. No

Section D – Consider making a transfer

ASK IF Q14a=2 OR Q5=CODE 6

SC. CODE 4 MUST USE TEXT BOX

Say, with new improvements in public transport, you can SAVE TIME. However, you must make ONE transfer.

Q15. What is the MINIMUM travel time reduction from your current route that will convince you to use the new route with ONE transfer?

1. Minimum 5 to 10 minutes
2. Minimum 10 to 15 minutes
3. Minimum 15 to 20 minutes
4. I will not take this new route with a transfer
   Reason is (please specify): ______________________________

ASK IF Q5=CODE 6, SC

Q15a. (ONLY FOR CAR USERS) What is the MINIMUM <u>travel cost reduction</u> from your current trip cost that will convince you to use the new public transport route?

1. Minimum 5%
2. Minimum 10%
3. Minimum 15%
4. Minimum 20%
5. Minimum 25%
6. Minimum 30%
7. Minimum 35-50%

ASK ALL, RANDOMISE SCENARIOS 4-8

SC PER SCENARIO. SHOW 1 SCENARIO PER SCREEN (WITHOUT SCENARIO NAME/HEADING)

Q16. For each of the following alternatives, decide if you would like to use the new transfer route. The transfer station has full weather protection.

A. **Scenario 1**	
Waiting time	10 minutes
Walking time	5 minutes
Connected walkways with cover	Yes
High quality information on	Yes
Security guards	Yes

1. Yes
2. No

B. **Scenario 2**	
Waiting time	5 minutes
Walking time	10 minutes
Connected walkways with cover	Yes
High quality information on	Yes
Security guards	Yes

1. Yes
2. No

C. **Scenario 3**	
Waiting time	15 minutes
Walking time	5 minutes
Connected walkways with cover	Yes
High quality information on	Yes
Security guards	Yes

1. Yes
2. No

D. Scenario 4	
Waiting time	10 minutes
Walking time	5 minutes
Connected walkways with cover	Yes
High quality information on	Yes
Security guards	No

1. Yes
2. No

E. **Scenario 5**	
Waiting time	5 minutes
Walking time	5 minutes
Connected walkways with cover	Yes
High quality information on	Yes
Security guards	No

1. Yes
2. No

F. **Scenario 6**	
Waiting time	5 minutes
Walking time	10 minutes
Connected walkways with cover	No
High quality information on transfer	Yes
Security guards	Yes

1. Yes
2. No

G. **Scenario 7**	
Waiting time	10 minutes
Walking time	5 minutes
Connected walkways with cover	Yes
High quality information on transfer	No
Security guards	No

1. Yes
2. No

H. **Scenario 8**	
Waiting time	5 minutes
Walking time	10 minutes
Connected walkways with cover	No
High quality information on transfer	No
Security guards	Yes

1. Yes
2. No

C2: Stated preference Survey #2

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

QUESTIONNAIRE ABOUT PUBLIC TRANSPORT ROUTES WITH TRANSFERS

Section A: General Information

Please answer the following questions

1. **Gender:** ☐ Female ☐ Male ☐ Gender Diverse

2. **Age:** ☐ Under 24 ☐ 24 – 44 ☐ 45 – 64 ☐ Over 65

3. **Please categorise your MAIN disability from one of the following: Cognitive, Physical, Visual or Other (Please specify):**

   ....

4. **On a weekly basis, how often do you use public transport when you are travelling (1 trip = going & returning)?** ☐ LESS than 3 trips per week ☐ 3 or MORE trips per week

5. **How long is your current public transport journey (from home to destination) in minutes:.........?**

For the following questions, please tick all the available accessibility features in the current network and rate how well they meet your needs on a scale of 1-5, with 1 being "Poor" and 5 being "Excellent".

☐ Helpful and readily available staff:.........

☐ Informative signage placed around the station:.........

☐ Audio announcements in stations/stops:.........

☐ Tactiles, including directional tactiles:.........

☐ Quality of walking paths to the next stop/station:.........

☐ Accessible detour routes for pedestrians during construction works:.........

☐ Availability of Lifts and Ramps:.........

☐ Amenities such as accessible toilets, availability of seating/space in waiting areas, etc:.........

☐ Platforms providing level Boarding and Alighting of vehicles:.........

6. **Does your journey require you to transfer (e.g. from bus to bus, bus to train, bus to ferry)?** ☐ Yes ☐ No

If yes, please answer the following questions.

6.1. How many transfers do you make?...........

6.2. How long do you have to walk to make the transfer?.............

6.3. On average, how long do you wait to catch the second vehicle?.............

6.4. Overall, how well do accessibility provisions meet your needs during transfers (1-5)?.........

6.5. Rate your current satisfaction of the transfer route on a scale of 1-5, with 1 being "Poor" and 5 being "Excellent":............

7. **Do you have access to other modes of transport (e.g. private vehicle, family and/or friends, taxis, etc.)?** ☐ Yes ☐ No

8. **Are you covered by the Total Mobility Scheme?** ☐ Yes ☐ No

Section B: Transfer Service

If you do not make transfers, please answer the following questions assuming you need to make transfers.

Say there is another route which can save you time. But you need to make a transfer.

9. **Please choose the minimum travel time saving needed for you to consider taking the new route.**

5mins, 8mins, 10mins, 12mins, 13mins, 15mins, 18mins, 20mins, 22mins, 23mins, 25mins, 30mins

10. **Please choose the maximum time that you are willing to wait for another vehicle.**

2mins, 3mins, 5mins, 8mins, 10min, 12mins, 15mins, 18mins, 20mins, 22mins, 25mins, 30mins, Other (please specify): ....mins.

11. Please choose the maximum time that you are willing to walk to make a transfer.

2mins, 3mins, 5mins, 8mins, 10min, 12mins, 15mins, 18mins, 20mins, 22mins, 25mins, 30mins, Other (please specify): ....mins.

12. You said X mins is the most ideal time for making a transfer. Please choose the maximum time for making a transfer given better infrastructure to aid this process. For example, availability of: good quality footpaths, more information and signage, directional or guidance tactiles, sheltered stations, comfortable seating and waiting areas, audio announcements, level-platforms, etc.

No change from above, 2mins, 5mins, 8mins, 10mins, 12mins, 15mins, 18mins, 20mins, 22mins, 25mins, 30mins, Other (please specify): ....mins.

13. What additional accessibility features would improve your journey experience while making transfers?

....

To enter the draw to win one of give $100 Countdown Vouchers, please follow the link to enter your details: https://auckland.au1.qualtrics.com/jfe/form/SV_d40vhVpenGeqKa1

Please feel free to share this research with others who may potentially be interested in participating by forwarding the "Participant Information Sheet" document. Your help will be greatly appreciated.

Thank you for your help!

C3: Cover Letter

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

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The University of Auckland
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Auckland 1142
New Zealand

Investigating the transfer time (walking and waiting) desired by a public transport user with disabilities

My name is Jun Park, and I am a PhD student in the Faculty of Engineering at the University of Auckland.

I would like to invite you to participate in an anonymous online survey as part of my research to understand how transfer time can influence the perception of using public transport involving transfers for people with disabilities. Furthermore, the research aims to evaluate the current state of accessible features available in public transport and to identify any additional improvements that will make public transport more accommodating.

I would appreciate any assistance you can offer.

If you choose to participate, you have the opportunity to enter the draw to win one of five $100 Countdown Vouchers.

Please see the attached Participant Information Sheet (PIS) for details regarding taking part in the research. If you have any questions or require any assistance, please do not hesitate to contact me.

Email: hpar706@aucklanduni.ac.nz

Approved by the University of Auckland Human Participants Ethics Committee on 19/07/2018 for three years. Reference Number 021503

C4: Participant Information Sheet

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

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PARTICIPANT INFORMATION SHEET

Investigating the transfer time (walking and waiting) desired by a public transport user with disabilities

Name of Researcher: Jun Park
Name of Supervisors: Dr Subeh Chowdhury & Dr Douglas Wilson

Researcher Introduction
My name is Jun Park and I am currently a Doctoral (PhD) student in Civil Engineering at the University of Auckland. My supervisors are Dr Subeh Chowdhury and Dr Douglas Wilson in the Department of Civil and Environmental Engineering.

Project description and invitation
You are cordially invited to participate in this transportation research study and I would appreciate any assistance you can offer. The purpose of this survey is to further our understanding of how the desired transfer time, including walking and waiting, can affect the perception of public transport involving transfers. The results will help determine the most optimal transfer time to make public transport routes involving transfers be perceived as being more attractive compared to other transport modes. The research also aims to assess the current state of accessible features available in the public transport system and to identify additional improvements that will improve perception towards the process of transfers.

Project Procedures
We would like to invite you to participate in an anonymous online survey about your opinion on various aspects of the public transport system involving transfers. The questionnaire is made up of two parts: the first part is the general section which includes questions on travel information and demographics. The second part explores the transfer aspect of public

transport that involves choosing your answers from a range of options. The survey will take approximately 5 to 10 minutes to complete and no IP addresses or other identifying information will be gathered. No information which could identify you as its source will be elicited.

The link to the survey is provided below:

https://auckland.au1.qualtrics.com/jfe/form/SV_d40vhVpenGeqKa1

If you would like to take part but require assistance, please contact the researcher for an interview to go through the survey with you. The interview will take approximately 20 minutes.

Upon completion of the survey or interview, you will be given the opportunity to enter the draw to win one of five $100 Countdown Vouchers. To enter, please follow the link at the end of the survey to enter your details for the draw. Your details will be kept separate from your responses. If you partook in the interview, assistance will be provided for this process. You can also request to receive a summary of the findings from this research in the same link above.

By taking part in the online survey, your submission will count as consent. If you are taking part in the interview, you will need to give consent by signing the consent form provided.

Please feel free to share this research by forwarding this document with others who may potentially be interested in participating. Your help will be greatly appreciated.

Right to Withdraw from Participation
You have the right to withdraw from participation at any time without needing to provide a reason. However, because the survey is anonymous, it will not be possible to withdraw your data after the survey has been submitted. If you took part in the interview, you cannot withdraw your responses after you have left the interview.

Data Storage, Retention, Destruction, and Future Use
Your response will be kept in a secure location on University premises for up to six years, after which it will be destroyed (digital files will be permanently deleted off the system and any hard copies of information shredded). The analysed responses from this survey may be used in other studies such as PhD research projects, conference presentations and publication purposes.

Confidentiality of Responses
Your response to this survey is completely anonymous and confidential, and the interview is completely confidential. Responses will be kept in a locked file to which only the researchers and supervisor have access. If the information you provide is published, you will not be identifiable as its source in any way.

Contact Details
Thank you very much for your time and consideration. If you wish to know more about the study, or have any concerns, please feel free to contact me.

Researcher
Jun Park
Doctoral Candidate
hpar706@aucklanduni.ac.nz

Research Supervisor (main):
Dr Subeh Chowdhury
09 923 4116
s.chowdhury@auckland.ac.nz

Research Supervisor (co-supervisor):
Dr Douglas Wilson
09 923 7948
dj.wilson@auckland.ac.nz

Head of Department:
Prof Pierre Quenneville
09 923 7920
p.quenneville@auckland.ac.nz

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Research Office, Private Bag 92019, Auckland 1142. Telephone 09 373-7599 ext. 83711. Email: ro-ethics@auckland.ac.nz.

Approved by the University Of Auckland Human Participants Ethics Committee on 19/07/2018 for three years. Reference Number 021503

C5: Consent Form

THE UNIVERSITY OF AUCKLAND
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NEW ZEALAND

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Auckland 1142
New Zealand

Consent Form

Investigating the transfer time (walking and waiting) desired by a public transport user with disabilities

THIS CONSENT FORM WILL BE HELD FOR SIX YEARS

I agree to voluntarily take part in this research and I have read the Participant Information Sheet.

I have been given and have understood an explanation of this research project. I have had an opportunity to ask questions and have them answered satisfactorily.

I understand that the questions asked during this interview will be directly from the survey and the answers provided will be used to complete the survey form.

I understand that this interview will take approximately 20 minutes.

I understand that I cannot withdraw my interview responses after I have left the interview.

I understand that the data will be stored for six years and that the security and privacy of data will be maintained.

I understand that the response of my interview will be stored in a secure location, within the University of Auckland premises, for six years, after which time it will be destroyed.

I understand that any identifying information will not be included in the research report or in any other publication relating to this study.

I wish/do not wish to receive a summary of findings, which can be emailed to me at this email address:...

Name (please print clearly): ___________________________________

Signed: ____

Date: ____

Approved by the University of Auckland Human Participants Ethics Committee on 19/07/2018 for three years. Reference Number 021503