ACCESSIBILITY IN AOTEAROA:

A Mixed-Methods Study of

Low-Emissions Transport Demand

In the Greater Wellington Region

HanLing Petredean

A 120-point thesis submitted to Victoria University of Wellington
in partial fulfilment of requirements for the degree of
Master of Environmental Studies

Victoria University of Wellington
Te Herenga Waka

School of Geography, Environment, and Earth Sciences

March 2020

Abstract

Like many nations, Aotearoa New Zealand's land-use and transport development has prioritised planning for mobility, *movement*, over accessibility, *access*. This has contributed to an auto-centric transportation system and a high national road emissions profile. In light of the imminent threat of catastrophic climate change, a low-emissions transport sector transition is needed. Understanding how and why people travel is a critical prerequisite for achieving this shift.

Planners and policymakers increasingly recognise that transport demand is fundamentally influenced by the desire for access over movement. An accessibility-based framework aligns with this interpretation and supports analysing personal and contextual drivers of transport demand. Policymakers tasked with promoting a low-emissions transport sector transition are seeking to identify existing low-emissions transport uptake constraints and potential avenues for their improvement.

Using a mixed-methods approach, this thesis addresses an existing gap in the literature by analysing low-emissions transport demand in the Greater Wellington Region (GWR), informed by an accessibility-based framework. Survey responses supplied quantitative data on user-based needs, abilities, and attitudes towards GWR low-emissions transport options. Practicality – the degree to which a transport option facilitates access in reasonable time, at reasonable cost, and with reasonable ease – was found to be the strongest predictor of ability to use low-emissions transport. Qualitative data was also collated from stakeholders knowledgeable of transport policy and planning at the local, regional, and central government level. This provided insight into GWR low-emissions transport supply and oversight, as well as the impact of land-use policies, transport policy and funding structures, and governance agendas and capabilities. These findings support augmenting low-emissions transport with an accessibility orientation, but also reveal the challenges of doing so within current governance structures.

Key words: accessibility; low-emissions transport; land use; public transport; active transport; Greater Wellington Region; Wellington; New Zealand

Acknowledgments

Like its subject matter, this thesis was influenced by a confluence of contextual and personal factors.

The Greater Wellington Region has irrevocably shaped my being, providing me with a home and community, and has both inspired and sustained my research. I am forever grateful to live amongst its rich natural diversity and am committed to assisting in its adaptation and resilience in future years of climate change associated uncertainty.

This thesis is also the product of countless individuals who have supported me at every stage of its creation.

To those who participated in the interview process and questionnaire, thank you for your time and knowledge. Your insight was an essential component of this thesis.

To my supervisor, Ralph Chapman, I extend my heartfelt gratitude for your guidance and wisdom. Your support has remained unwavering throughout these past two years, helping to shape the very nature of my academic inquiry and my climate change policy career. I will treasure our regular correspondence and café catch-ups, and hope to continue our discussions in future years.

To the SGEES faculty and staff, thank you for providing me with a rich array of academic opportunities. My time at VUW has been one of immense growth and has fuelled my commitment and passion for environmental studies.

To my ENVI Studies cohort, thank you for your vibrant humour, intelligence, and friendship. I cannot wait to witness each of you excel in your future careers and achievements.

A special thank you is owed to each of my fellow 102A office members. Such a level of comradery is unique, and one that sustained me during each 'theseus' trial and tribulation (Stuff quiz team for life!).

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Terms

A-S-I	Avoid-Shift-Improve
CBD	Central Business District
EV	Electric (Private) Vehicle
GPS	Government Policy Statement (on Land Transport)
GWR	Greater Wellington Region
GWRC	Greater Wellington Regional Council
IAF	Investment Assessment Framework
ICT	Information and Communications Technology
JTW	Journey to Work
LDV	Light Duty Vehicle
LTP	Long Term Plan
MfE	Ministry for the Environment
MoT	Ministry of Transport
NLTF	National Land Transport Fund
NLTP	National Land Transport Programme
NZCTU	New Zealand Council of Trade Unions
NZD	New Zealand Dollars
NZTA	New Zealand Transport Agency
OECD	Organisation for Economic Co-operation and Development
RLTP	Regional Land Transport Plan
RPTP	Regional Public Transport Plan
RTC	Regional Transport Committee
SEU	Social Exclusion Unit
SIA	Social Impact Assessment
TRSE	Transport Related Social Exclusion
VUW	Victoria University of Wellington
WCC	Wellington City Council

Chapter 1. Introduction

"Transportation is the machine for mobility…a city is a machine for accessibility."

-Levinson et al. (2005)

1.1 Background

The need for de-carbonisation of the domestic transport system has risen to the forefront of nationwide climate change policy and discourse in Aotearoa New Zealand (NZPC, 2018; MoT, 2018c; New Zealand Government, 2018; Chapman, 2008). An energy sector subset – the nation's second highest emissions profile – road vehicle emissions accounted for 39.1% of gross national carbon dioxide (CO_2) emissions in 2016 (Stats NZ, 2019). At the regional level, mobile sources account for approximately 37% of the Greater Wellington Region's **(GWR)** gross emissions, with petrol-based road transport emissions constituting 18% of that total (URS New Zealand Ltd., 2014). District-wise, transportation represents approximately 60% of Wellington City's emissions profile (AECOM NZ Ltd., 2016).

Efforts to achieve net zero carbon emissions by 2050 – in accordance with the Climate Change Response (Zero Carbon) Amendment Bill 2019 – will inevitably require significant reductions in GWR road transport emissions. Local travel patterns will have to change to the point that the majority of trips are fuelled by low- or zero-carbon based transport modes and services.

Given transport's fundamental role in facilitating access to goods, services, people and businesses, disruption to this sector will create broad impacts across multiple areas of regional activity. Historically, the prioritisation of roading infrastructure and a dependence on fossil-fuelled private vehicles has characterised Aotearoa New Zealand's transport sector. Transitioning to a low-emissions transport system will require policy designed to displace these high-emitting transport modes, shift usage patterns towards sustainable options, and improve the efficiency of existing transport modes and infrastructure.

A successful transition must be predicated on a preliminary examination of what drives transport behaviour and transport demand. An accessibility framework offers a strong

evaluative tool in this respect. Conceptually, in the transport context, *accessibility* relates to the ease with which people reach goods, services, or activities (collectively known as *opportunities*). Although transport policies have traditionally prioritised increased mobility, efficiencies in travel speed and trip distance, the concept of accessibility has gradually percolated into international transport policy and planning discourse (Litman, 2003; Chapman, 2018; Banister, 2018; ITF, 2019).

An accessibility framework recognises that *access* is the ultimate driver of transport demand, with a few notable exceptions in which movement is a goal in and of itself (jogging, horse-back riding, pleasure drives) (Litman, 2003). This perspective aligns with a holistic understanding of transport demand, and allows that access can be augmented through avenues other than improved mobility, including improved land-use accessibility (reduction in the distance between destinations) or improved mobility substitutes (information and communications technology (ICT) and delivery services) (Litman, 2003; Chapman, 2018).

An accessibility framework gives particular consideration to non-motorised modes of transport and the influence of land-use patterns. It supports an integrated view of transportation and land-use systems, and posits that the distribution of destinations, land-use composition, network connectivity, and public and active transport conditions, all affect transportation system demand and performance (Litman, 2003).

In accessibility terms, a "*transport problem*" is any cost, barrier, or risk hindering access to opportunities. This interpretation expands the range of both transport problems, and potential solutions. An accessibility framework is thus complex. However, this permits greater insight into transport demand. It is apt to inform efforts to promote a low-emissions transport sector, such as through targeted augmentation of existing low-emissions transport services (public buses, railways, and cycle lanes). Augmenting low-emissions transport with an accessibility orientation can increase its practicality and overall appeal, incentivising greater uptake and wider sector sustainability. Prioritising an integrated view of land-use and transportation may promote reduced travel need, shifts to public and active transport, and corresponding reductions in fossil-fuel based vehicle emissions (Litman, 2003; Chapman, 2018; Banister, 2018).

An accessibility framework also recognises the importance of relative user-based perceptions of transport, such as the reasonable ease of using a transport mode, and acknowledges that individuals have different interpretations of "ease", informed by unique user-based needs and abilities. Not every individual has the same ability to transition to or use low-emissions transport as a means of accessing their desired opportunities. Moreover, under an accessibility framework, this ability is a function of several personal (absolute and relative) factors, including personal circumstances (e.g. income and physical ability) and structural or surrounding contextual factors (land-use development, patterns of settlement, network connectivity, and topography).

Identifying these relative factors can assist in improving the ability of low-emissions transport modes and services to accommodate a wider range of user needs and abilities. This can also reveal demographics or communities facing disproportionate barriers to using low-emissions transport, which could also inform efforts to prevent transport disadvantage and social exclusion. While this thesis addresses some of these factors, a full quantification is beyond the scope of this research.

It is difficult be definitive about the nature of a future low- to zero-emissions GWR transport system. Shifting transport demand will require a combination of strategic measures, such as through policy and planning, regulation, infrastructural improvements, and public information campaigns. This will prove challenging as overarching policy and funding frameworks are hierarchical. Changes to national policy and planning objectives are therefore a co-rerequisite to any meaningful change in the GWR's transport system. At present, the linkages between central, regional, and local level transport policy and funding are a barrier to the very transformations these existing governance structures must undergo in order to reflect an accessibility-based transport planning perspective.

Although existing policy and governance frameworks, as well as transport infrastructure and services, must undergo substantive change if they are to be reoriented around accessibility, recent centuries have seen multiple major upheavals in transport systems. The sector has become resistant to change, as infrastructure has become locked in, but faced with the need for a meaningful low-emisisons transport sector transition, the very necessity of effective transport can act as an impetus for transformation. It is not

unreasonable to expect fundamental changes in our means of access to opportunities, and to one another, by 2050.

1.2 The Greater Wellington Region

The GWR was selected as a case study for this research. Located at the North Island's southernmost tip, the GWR covers a land area of 813,005 hectares and consists of eight districts (Figure 1.1): Wellington City, Lower Hutt City, Porirua City, Kāpiti District, Upper Hutt City, South Wairarapa District, Carterton District, and Masterton District (GWRC, 2016).

Although situated in the southwest periphery, Wellington City is the clear regional focal point in terms of economic, political, and social activity. This results in high commuting rates into and out of the area from neighbouring districts. Approximately 73,000 people travel to and from the Wellington Central Business District **(CBD)** for work each day (NZTA, 2019c). With a population of 210,400 usual residents in 2019 (forecast to increase to 250,000 by 2043), Wellington City is the most populous regional district. The estimated total GWR population was 521,500 as at 2018 (.id, 2016, 2018a, 2019b).

Figure 1.1: Map of the Greater Wellington Region
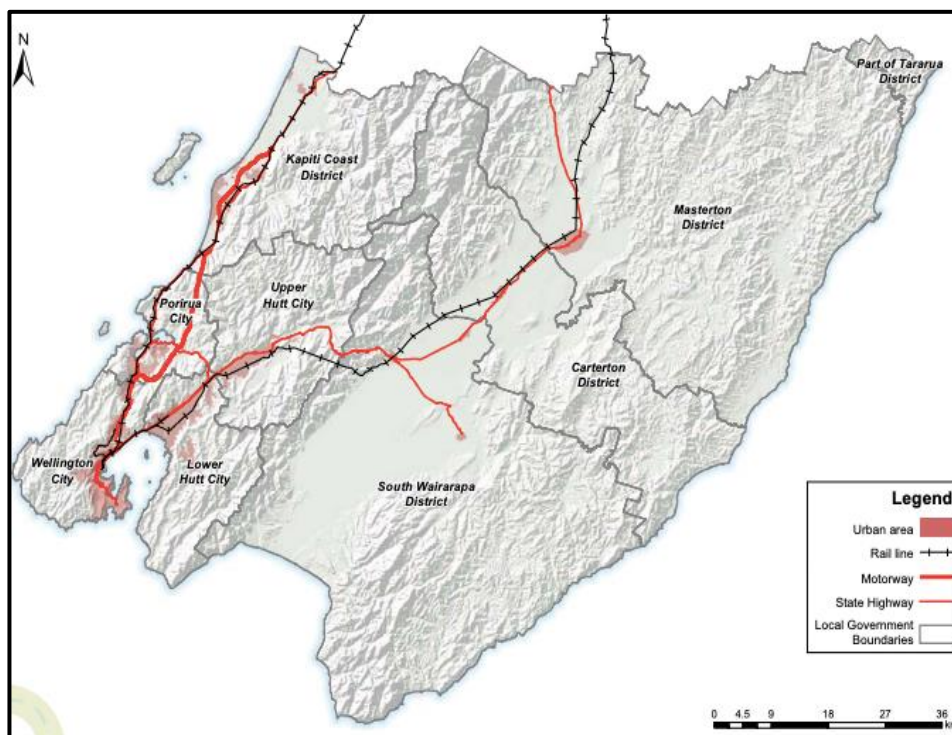
Sourced from GWRC (2016)

1.2.1   Regional Transport Dynamics

The GWR's transport network provides access to opportunities through a mixture of public transport services and infrastructure, the most extensive being rail, motorways, and state highways. According to the Greater Wellington Regional Council's **(GWRC)** Regional Land Transport Plan **(RLTP)** (2015), geographic constraints have established a moderately compact urban form along the region's transport corridors, which supports relatively high rates of public transport use, although levels are variegated among districts.

Smaller arterial roads facilitate critical access to the main roadways, namely State Highways 1 and 2, areas of employment, and sub-regional and local centres (GWRC, 2015). In addition to public and private motorised transport, roadways are shared by active transport users, predominantly cyclists and pedestrians. Local roads also cater for local traffic and access to private property (GWRC, 2015).

Over 75% of the regional population lies in the four cities in its southwestern corner: Wellington City, Lower Hutt, Porirua, and Upper Hutt. The South Wairarapa, Carterton, and Masterton districts are largely rural. Intrinsic differences in travel needs — such as larger distances between services and population centres– make access by public and active transport comparatively less cost-effective, time-saving, and reasonable in rural areas. Accordingly, this research has centred on higher-density urban districts, particularly Wellington City.

2001-2013 Census Journey to Work **(JTW)** data for the GWR indicates that Wellington City serves as the primary regional workplace destination, accounting for six of the 10 largest JTW movements from origin to destination, and with 37.6% of JTW trips terminating in the Wellington CBD (GWRC, 2013). Lower Hutt Central was the second most common end destination for regional journeys (12.9%) (GWRC, 2013).

Recent census data indicates 21.3% of regional JTW trips were made by public transport (bus, ferry, train) and 10.4% via active transport (walking, cycling) (.id, 2018b). Total regional public transport use increased by 17% between 2001 and 2013, although overall public transport patronage growth rates were relatively low (1.2%) between 2005 and 2012 (GWRC, 2015). Explanatory factors for this variance may include: historical rail

reliability issues; slow and unreliable bus journeys along some routes; and the increased popularity of some active transport modes (GWRC, 2015).

The private vehicle is unequivocally the leading regional transport mode. In 2013, 42.5% of households had access to two or more vehicles, the regional extremes being Carterton District (56.3%) and Wellington City (36.0%) (.id & GWRC, 2018). 46.6% of all JTW trips in 2013 were via private vehicle, the only exception being trips starting and finishing within the Wellington CBD (GWRC, 2013). There, only 29.2% of JTW were made by private vehicle, reflective of higher levels of public bus (17.3%) and walking (19.3%) JTW travel (GWRC, 2013; .id, 2018b).

The overall trend is for JTWs by private vehicle to increase in step with distance from the Wellington CBD (GWRC, 2013; MoT, 2018b). The outlying areas of Upper Hutt North, North Kāpiti, Wairarapa, and Eastern Bays/Wainuiomata evince the highest rate of JTWs by private vehicle, at 54-62% (GWRC, 2013). Self-sufficiency – the proportion of journeys intra-district – was higher for areas of significant employment, such as the Wellington CBD (GWRC, 2013). In contrast, there have been large self-sufficiency reductions in Paraparaumu, Upper Hutt Central/South, North Kāpiti, and Lower Hutt Central since 2001 (GWRC, 2013).

These modal use and travel patterns give a rudimentary degree of insight into regional transport demand. However, these statistics do not account for wider patterns of access beyond primary commute travel, and are not informative as to the practicality, proximity, or affordability of select transport modes for individuals. Nor are they illuminating as to personal reasons underlying modal choice or travel behaviour.

Lifestyle and employment factors, as well as regional costs and affordability, can partially explain transport patterns along accessibility parameters. Regional trends in inner-city housing development and population growth, particularly within Wellington City, suggest that as a result of increased proximity to services and employment, people are more likely to make more trips by active modes (and to some extent, public transport), and fewer trips by private vehicle (GWRC, 2013; Chapman, 2018). Changing demographics could also impact travel patterns and transport demand. For instance, trends among younger

generations towards high-density urban living and lower rates of car ownership could result in higher levels of public and active transport uptake.

Even so, affordability is a significant barrier to accessing high-density, inner-city living. Wellington City is among the least affordable urban residential housing areas in the country (WCC & The Property Group, 2014). Trade-offs between housing and transport costs therefore persist. Living farther from the city centre corresponds to lower property costs, but higher transport costs and greater private vehicle dependence (GWRC, 2015; .id, 2013). Income therefore plays a significant role in determining locations of residence, modal uptake, and access patterns, influencing individual and community interaction.

1.3 Purpose

The underlying objective of this thesis was to understand drivers of GWR low-emissions transport demand so as to inform policies designed to promote a low-emission transport sector transition. This was predicated on the informed hypothesis that GWR residents diverge in their ability and desire to shift to low-emissions transport, and that auto-centric policy and planning has heavily skewed the GWR's transport supply.

This insight informed the choice to explore an accessibility-based framework to evaluate residential travel patterns and transport use, as well as the contextual factors affecting the realisation of a region's low-emissions transport system. The research therefore aimed to assess the challenges of a low-emissions transport transition, and attitudes towards accessibility-based planning measures, within current transport policy and planning structures.

1.4 Outcome and Contribution of this Research

This thesis aimed to contribute to the literature by investigating drivers of GWR low-emissions transport demand in the context of mounting national concern about road transport emissions and sector sustainability. These research findings are of interest to those tasked with facilitating a meaningful low-emissions transport transition, specifically regional policymakers seeking to encourage reductions in petrol-based private vehicle

dependency and promote corresponding increases in low-emissions transport demand. This research will also contribute towards the development of guidance for improving low-emissions transport services along accessibility-based planning lines.

1.5 Thesis Outline

This thesis is divided into six chapters. Following this introductory overview of the research area and purpose, Chapter Two provides a comprehensive outline of the fundamental subject areas and associated literature informing this thesis, and describes the research gap addressed. Beginning with an overview of accessibility, this abstract conceptualisation is then grounded in relation to transport. Accessibility's emerging role in contemporary transport policy and planning is then examined. Broader applications of accessibility-based planning in relation to equitable access, urban development, and sustainability are then briefly outlined. Lastly, the choice of research framework is justified by examining the linkages between accessibility, low-emissions transport, and governance. This provides the foundation for the four research questions outlined in the concluding portion of the chapter.

Chapter Three provides further background and context, specific to overarching transport policy and funding processes in Aotearoa New Zealand, as well as accessibility's status in domestic transport policy and planning at the central, regional, and local levels.

Chapter Four outlines the methodological approach employed, outlining the structure and manner in which the research was conducted. It provides details on the research design, methodological paradigm, and developmental process behind the survey questionnaire and interview questions. Specific details on the interview and survey participant selection process is also supplied. The chapter concludes with a description of the methods used to analyse the qualitative and quantitative data collated.

Chapter Five presents research results in order of the four research question. Section one provides the quantitative results of the survey questionnaire, and describes existing patterns of GWR residential transport use and their motivators. Variables predictive of lesser low-emissions transport use ability are then identified through a correlation matrix and a regression model in section two. Section three describes the results of quantitative

and qualitative data collated from the survey questionnaire, detailing six primary factors influencing low-emissions transport use. The final section summarises the qualitative data collated from stakeholder interviews, and outlines the challenges of incorporating accessibility-based planning to address low-emissions transport use through existing transport policy and funding processes.

Chapter Six provides a comparative evaluation of key research findings with those in the extant literature. The applicability and informative capacity of these findings for policy development is then presented, followed by a discussion of the study's limitations and notable avenues for future research. This thesis concludes with a summation of salient abstractions and research findings.

Chapter 2. Literature Review

This literature review outlines in five primary sections, the intersections between:

  (i)   accessibility;

  (ii) transport policy and planning;

  (iii) low-emissions transport; and

  (iv) governance roles and capabilities.

The chapter begins with an orientation on the conceptual underpinnings of accessibility, followed with an explanation of its emerging centrality in transport sector discourse and policy design. Accessibility is then examined from a planning perspective and compared to conventional transport-planning methods, principally the mobility paradigm. This is followed by a brief examination of the wider applications of accessibility-based planning, primarily in relation to equity, urban development, and sustainability. The role of carbon-based transport is then examined within the context of climate change, particularly petrol-based private vehicles. Governance roles and capabilities are then discussed in relation to transport supply and oversight, as well as accessibility-based planning. The final section summarises the conceptual framework employed by this thesis, as well as the research gap identified, and research questions used to guide the direction of the research (and methodologies used).

2.1 Accessibility

2.1.1 Conceptualisations of Accessibility

Accessibility plays a critical role in economic, social, and overall wellbeing. Although the concept of accessibility has been subject to interpretive variability, a growing body of literature has contributed to its emerging centrality in mainstream policy and discourse (Banister, 2018; Pyrialakou et al., 2016; Fol & Gallez, 2014; Farrington & Farrington, 2005; Chapman, 2018; Halden et al., 2005; Levinson et al., 2005).

Despite its resistance to traditional empirical definition, it is clear that the concept of accessibility is centred on the interaction between land-use and transport systems, and exists as a function of individual movement. The relative availability of transportation to

individuals, the temporal and spatial distribution of their activities, and the social and economic roles of those individuals are determinative as to when, where, and for how long they must pursue those activities. Halden et al. (2005) assert that accessibility can be examined from two primary viewpoints (Figure 2.1): *origin accessibility*, "the ease with which any individual or group of people can reach an opportunity or a defined set of opportunities," and *destination accessibility*, "the ease with which a given destination can be reached from an origin or set of origins" (David Simmonds Consultancy et al., 1998). For clarity, this thesis employs a user-based (origin) interpretation of accessibility.

Figure 2.1: The Primary Components of Accessibility
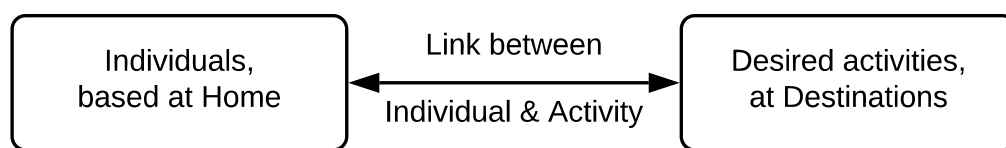
Sourced from Halden et al. (2005)

Accessibility can be further characterised in terms of three questions: *who/where, what*, and *how*?

(i) *Who* or *Where* refers to accessibility as an attribute of people or places.

(ii) *What* relates to the opportunities being reached – the land-uses, activity supply points or resources (including people) that allow individuals or places to satisfy their needs.

(iii) *How* refers to the factors that separate people and places from supply points – the distance, time, cost, information, and other factors acting as deterrents or barriers to access (DHC, 2000, as cited in Halden et al., 2005).

Most definitions of accessibility include reference to *who/where, what*, and *how*. However, the literature remains divided on interpretations of relative and absolute accessibility parameters. One such relative parameter, "reasonable ease" of access, is referenced by several researchers (Halden et al., 2005; Levinson et al. 2005; David Simmons Consultancy et al., 1998; SEU, 2003; Ross, 2000, as cited in Halden et al., 2005), while others omit its incorporation (Litman, 2003; Geurs & Van Eck, 2001; Gray, 1989, as cited in Halden et al. 2005; Handy, 2002). This could be due to the considerable

challenges associated with measuring relative degrees of "ease," which detracts from the practicality of incorporating accessibility in empirical measurement.

Farrington and Farrington (2005) nonetheless uphold that analysis must be conducted through the integration of absolute and relative variables, as accessibility is fundamentally defined by both the individual and their destination. Relative terms are thus necessary as interpretations of relative ease will vary according to the individual's needs and abilities (Farrington & Farrington, 2005; Halden et al., 2005). Such an approach recognises the increasingly complex relationships between people, place, space, and opportunities (Miller, 2005).

Even acknowledging for this interpretive variance, most definitions align on four major determinants of accessibility (Table 2.1): *land-use, transport*, *time* and *individual components* (Fol & Gallez, 2014; Banister, 2018; Litman, 2003; SEU, 2003). For clarity, this thesis uses an amalgamated definition of accessibility advanced by the UK's Social Exclusion Unit (SEU) (2003) and Halden et al. (2005):

> *An individual's ability to access opportunities at reasonable cost, in reasonable time, and with reasonable ease using an integrated transport system without being restricted by physical, financial, or safety concerns.*

Table 2.1 Four Major Determinants of Accessibility

Land Use	The geographic distribution of activities and destinations, and their composition (types of activities and destinations); non-motorised conditions (the existence and quality of pedestrian walkways, cycling routes); and area connectivity (how roads or paths link and intersect).
Transport	The nature of the transport system (quality, safety, comfortability, reliability); and the density of and proximity to supply points (the modes, services, and necessary infrastructure available and the distances between).
Time	The time it takes to achieve access from the individual's point of origin and desired destination (interaction time); and a function of travel speed, distance travelled, and individual circumstances.
Individual Components	User-based needs and abilities (e.g. relative income, physical ability, gender, age, personal preferences, area of residence).

2.2 Accessibility and Transport

Although accessibility is strongly linked to transport, it is not itself an attribute *of* a transport system (Halden et al., 2005; Farrington & Farrington, 2005; Chapman, 2018; Banister, 2018; Litman, 2019). Accessibility is instead oriented around people and opportunities, encapsulating the broader role of transport from a user viewpoint. A desire for access is thus the ultimate driver of most transport demand.

This represents a significant departure from traditional transport planning, which has been predominantly occupied with the procurement and development of physical mobility. Conventional transport analyses have focused on isolated movement patterns between homes and destinations, and have been criticised as offering little to no consideration of travellers and their motivations for interaction (Halden et al., 2005; DHC, 2000). As a result, people and opportunities have primarily been considered "only to the extent that the characteristics of the people (e.g. physical disability or car ownership) or of the places (e.g. pedestrianised area) affect mobility and the demand for travel" (Halden et al., 2005). The literature has widely acknowledged the dominance of mobility-based measurement in transportation planning (Halden et al., 2005; Fol & Gallez, 2014; Banister, 2018; Mullen & Marsden, 2016; Litman, 2003; Farrington & Farrington, 2005).

2.2.1 Accessibility versus Mobility

The terms 'accessibility' and 'mobility' have at times been used interchangeably and, while erroneous, this common conflation does point to the close relationship between the two concepts (Fol & Gallez, 2004).

To characterise the difference, mobility – or the 'how' factor – reflects the potential for *movement* of people and goods (Litman, 2003; Halden et al., 2005)*,* whereas accessibility refers to the potential for *interaction* (Hansen, 1959). Litman (2003) states that a mobility paradigm assumes that 'travel' means person- or ton-miles (total trip distance), and that 'trip' means a person- or vehicle-trip. From this perspective, transport users are primarily motorists as most person- and ton-miles are made by motor vehicles, but it is recognised that some individuals rely on non-motorised modes, and some areas might have larger levels of active transport (Litman, 2003).

Mobility planning can support an integrated view of the transportation system, with attention to connections between modes, but tends to assign less weight to non-motorised modes or land-use factors affecting accessibility (Litman, 2003). This is principally because mobility assumes that any increase in travel mileage or speed benefits society. As non-motorised modes move slower and travel shorter distances on average, their proliferation is thus considered disadvantageous (Litman, 2003; Banister, 2018). Perambulation and public transport are instead seen as complementary to private vehicles, beneficial only insofar as they increase travel mileage and trip speed efficiencies. Convenient highway access and parking is thus of greater importance than measures to improve walking and cycling facilities.

However, as Chapman (2018) states, access can be provided *without* mobility. And if so, it will tend to be preferred. This assertion is supported by studies which demonstrate that most people perceive travel based on time, not average trip mileage (U.S National Household Travel Survey, 2003, as cited in Litman, 2003). This general preference for reduced travel time as opposed to greater distances at greater speed aligns more with an accessibility- rather than mobility-based planning perspective. Accessibility more readily supports reductions in travel time as a result of increased land use and transport system integration, which prioritises closer proximity to common opportunities, and enhanced network connectivity (Litman, 2003).

In comparison, mobility-based efficiency gains do not always correlate to direct reductions in travel time and can paradoxically result in longer travel times, such as through the rebound effect[1] (Chapman, 2018; Litman, 2003; Banister, 2007a). Additional negative externalities can include decreased connectivity, congestion, parking and non-motorised transport difficulties. A highway through a city centre may reduce travel times by permitting increased vehicle speeds, but at the expense of creating ongoing severance and nuisance damages to others, such as pedestrians and cyclists (Chapman, 2018). Private vehicle dependency and road emissions output has also increased through the prioritisation of roading-oriented infrastructure, such as highways, mass transit, and parking structures.

---

[1] The tendency for total demand for energy to decrease less than expected after energy efficiency improvements are introduced, due to the resultant decrease in the cost of energy services (Lah, 2015).

Interaction, as opposed to movement, highlights the value of an accessibility-based planning framework, which focuses more on the opportunities available to the individual, as opposed to their resources and characteristics (e.g., car ownership, physical ability, trip rates, speed of travel), although these are also considered. Even so, it is relatively easy to apprehend the difficulty in separating the two concepts, particularly given that policies to increase mobility will generally increase accessibility (Handy, 2002).

Correlation does not, however, signify an immutable causal relationship. Fol and Gallez (2014) found that in the US, mobility-oriented transport planning corresponded to decreased accessibility by encouraging sprawl and a scattered pattern of urban development. With this understanding, and in light of escalating social and environmental concerns, there is rising scepticism as to whether improving mobility should be the central aim of transport policy (Cervero, 1997; Bertolini et al., 2005).

2.3 Accessibility-based Transport Evaluation

Analysing transport systems through an accessibility framework requires consideration of both *absolute* (e.g. transport system supply, topography) and *relative* (e.g. user-based needs and abilities, perceptions of reasonable ease) variables. This facilitates insight into complex drivers of transport demand and transcends narrower mobility parameters. However, the promotion of relative measures, such as 'reasonable ease', 'reasonable cost', and 'reasonable time', leads to difficulty in its application as a framework for transport policy and planning, and accounts for its perception as an overly-complex, "slippery" concept (Halden et al., 2005; Gould, 1969). It is clear why mobility has been dominant as a transport policy planning paradigm, as its application as an empirical framework is relatively straightforward and aligns with utilitarian measurements of social cost and benefit.

Establishing a core *framework* of informed accessibility parameters is considered essential to progress accessibility beyond conceptual terms (Abley & Halden, 2013; Levinson et al., 2005). Yet developing consistent parameters presents notable obstacles, including:

(i) accurately sectioning the population to reflect their abilities and perceptions (complicated by the fact that these are often specific to individuals or small groups);

(ii) ensuring a broad enough view of all transport and communications options – which in turn necessitates detailed consideration of available modes and services; and

(iii) clarifying when absolute, or explicit, variables can be defined and/or when comparatives are needed (e.g. physical ability (explicit) vs. ease (implicit) (Halden et al., 2005).

In its 2003 report, *Making the Connections*, the UK's Social Exclusion Unit (SEU) proposed an accessibility framework derived from four core questions:

1) "Does transport exist between the people and the service?;
2) Do people know about the transport, trust its reliability and feel safe using it?;
3) Are people physically and financially able to access transport?;
4) Are the services and activities within a reasonable distance?"

This particular grouping identifies four elements of accessibility in relation to transport: *supply*; *competence* (knowledge, reliability, safety); *personal constraints* (physical ability, affordability); and *proximity* (reasonable distance) (SEU, 2003).

The SEU's accessibility-based transport evaluation framework (*supply; competence; personal constraints;* and *proximity*) provides a direct derivation of accessibility theory which, with minor variability, corresponds to wider accessibility interpretations in the literature (Geurs & Van Wee, 2004). For example, Halden et al. (2005) consider six principal parameters to define the ability of a transport system to connect people with opportunities (Figure 2.2). These six measures are: spatial, temporal, financial, physical, environmental, and informational (Halden et al., 2005). Each of these variables considers the interaction between factors acting at the individual level (user-based needs and abilities), and wider contextual factors (local infrastructure, land-use, and transport supply) (Halden et al., 2005). This interpretation mirrors and builds upon the approach adopted by Geurs and van Eck (2001), which employed similar parameters.

Figure 2.2: Accessibility Parameters in relation to Transport
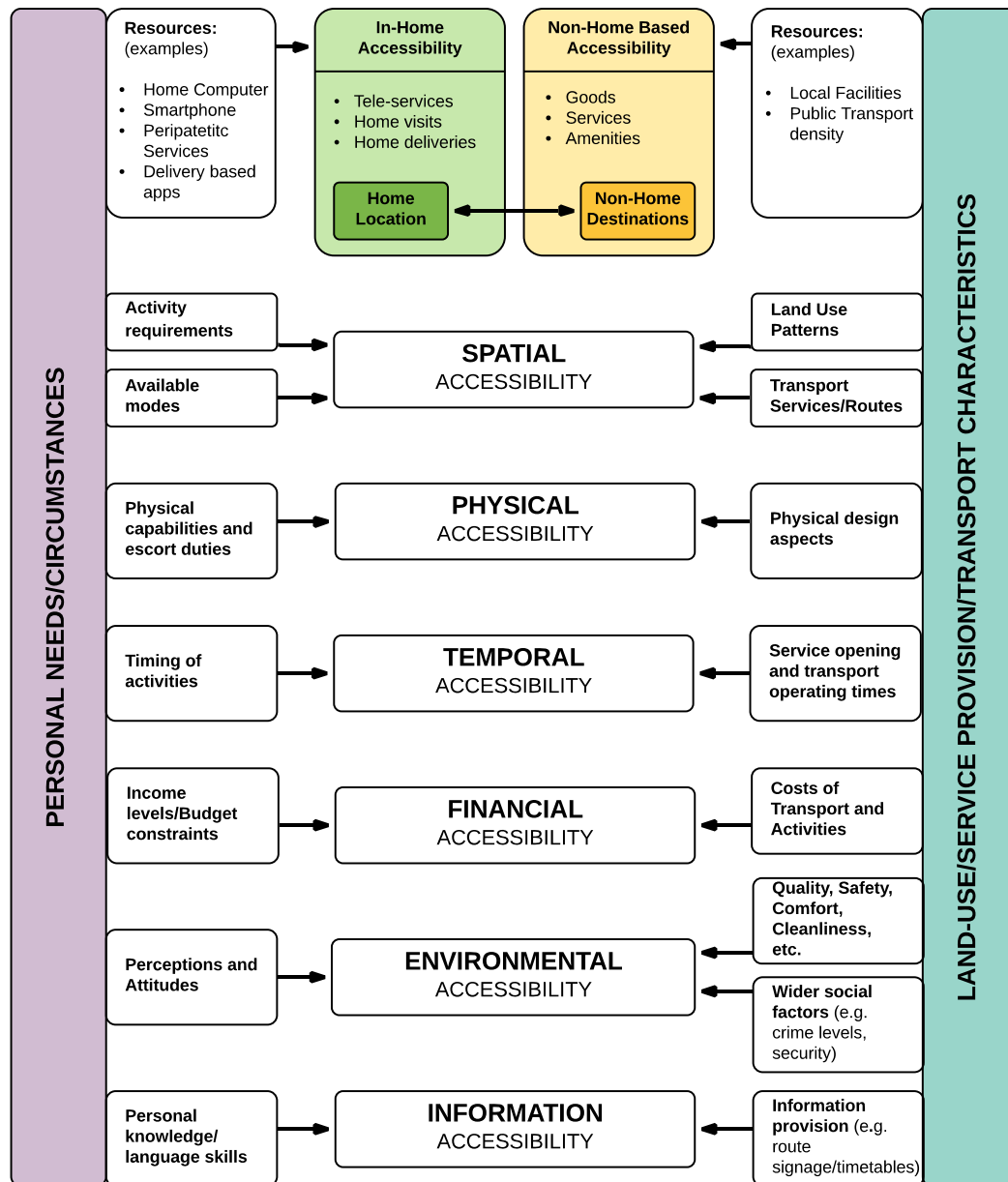
Adapted from Halden et al. (2005)

Both the SEU's (2003) and Halden et al.'s (2005) interpretations of accessibility in relation to transport build upon the four major determinants of accessibility (Table 2.1), and offer a framework for assessing transportation systems through an accessibility lens. This transcends prescriptive measurement methodologies and offers a new paradigm for identifying and solving local access problems (Halden et al., 2005; Banister, 2018; Abley & Halden, 2013). Examples of accessibility-based analysis in transport planning are provided in Table 2.2.

Table 2.2: Applications of Accessibility-based Analysis in Transport Planning

Access to opportunities	To consider the effects of changes in the transport system (i.e. covering all modes, interchanges, cost, time, reliability, and quality) on peoples' access to opportunities (i.e. employment, education, shopping, health services, social support networks, recreation, leisure, etc.).
Distribution of Transport impacts	When defining how transport impacts are distributed across geographical areas, population groups, trip purposes and modes of travel ensuring compatibility with equity objectives. This allows gaps in the public transport network to be identified and the contribution of new services to the overall utility of the network to be evaluated.
Travel options	When defining the travel options available to people including the changing contribution made by commercial public transport services, subsidised services, community transport, rail, walking, cycling, and private vehicle travel.
Consistency of transport	For ensuring consistency of transport with other public policy objectives including: land-use planning, housing, health, education, local regeneration, and regional development.
Linkages with other public policies	To make evident the transport implications of other areas of public policy decision making and service delivery, especially the opening, closure and relocation of facilities and in the scheduling of services.
Impacts of new developments	When assessing the impacts of new developments and the needs for development control decisions to improve access to the transport system.

Adapted from DHC and Transport Studies Group at the University of Westminster (2003)

2.4 Accessibility-based Planning

As a planning paradigm, accessibility promotes the integration of land use and transport. Applications of accessibility-based planning vary in their degrees of interaction with relative and absolute accessibility parameters, but across all categories, emphasis is placed on the needs of the transport user, the need for integration with other policy sectors, and recognition of land-use and urban-form.

2.5 Wider Applications of Accessibility-based Planning

Aside from improving transport systems, applications of accessibility-based planning relate to issues such as equity, urban expansion, and sustainability, and provide an opportunity to achieve broader societal benefit (Farrington & Farrington, 2005). These areas are associated with both accessibility-based transport system improvements and wider applications of accessibility-based planning. These intersections are touched on in the following sections to provide context to the outcomes of, and high-level motivations for, accessibility-based planning – although their in-depth examination falls largely out of scope for this thesis.

2.5.1 Equity

Accessibility's conceptual origins lie in post-war Britain, where the decline of bus and rail services was recognised to limit some groups in their ability to access key services (school, hospitals) despite an overall increase in private vehicle ownership and vehicle-based commuting (Thomas, 1976, as cited in Farrington & Farrington, 2005).

This was revisited in later decades and informed the establishment of the UK's Social Exclusion Unit (SEU) in 1997, which led to the commissioning of several studies evaluating the factors driving social exclusion. The SEU's (2003) seminal report, *Making the Connections* (the Report), examined the links between social exclusion, transport, and the location of services.

The Report's commission reflected an increasing awareness that transport problems could be significant barriers to social inclusion, an informed hypothesis subsequently corroborated by the Report's findings. Fol and Gallez (2014) assert that as a result, the

concept of accessibility has received renewed attention in studies aiming to understand the transport or, more generally speaking, spatial dimension of social exclusion.

Farrington and Farrington (2005) consider these issues to fall under a broader social remit, stating that "greater social justice cannot be achieved without greater social inclusion, which requires that people have access to a range of activities regarded as typical of their society; greater social inclusion requires greater accessibility which often (but emphatically not inevitably) implies mobility of transport use." This assertion outlines the broader equity implications of accessibility (or lack thereof), although Farrington and Farrington (2005) explicitly warn against inferences of causality, stressing that social inclusion in and of itself does not imply greater social justice, and nor does accessibility guarantee social inclusion.

Similarly, Rose et al. (2009) define transport-related social exclusion **(TRSE)** as "peoples' inability to participate in the routine, everyday activities of a society as a result of a lack of viable travel options". TRSE can occur when transport is routinely difficult, unsafe, or costly to the extent that people forgo opportunities for employment, education, and/or social participation (McCray & Brais, 2017, as cited in Rose et al., 2009). The ramifications of TRSE run the gamut of societal ills including health disparities, lower-incomes, educational and technical skill deficits, unemployment, poor-housing conditions, elevated crimes levels, and social relationship breakdown (Rose et al., 2009; SEU, 2003).

Recognition of transport's pivotal role in facilitating social inclusion (or perpetuating social exclusion) has informed an extensive body of accessibility-oriented studies within the context of social justice and inequality (Banister, 2018; Fol & Gallez, 2014; Farrington & Farrington, 2005; Lucas, 2006; Pyrialoukou et al., 2016; Rose et al., 2009). From an equity standpoint, accessibility-based planning can more effectively target transport inequalities resulting from past and present transport policy and planning practices. For example, access poverty may arise when individuals face significant barriers in owning or operating a private vehicle, and are situated in a transport system characterised by urban sprawl and auto-centric infrastructure (a common consequence of the mobility paradigm).

The SEU (2003) considers employing an accessibility-based framework equipped local authorities and agencies to systemically assess whether people could reasonably access key opportunities. These findings assisted in identifying disadvantaged groups or areas with poor access to key services, and informed the development of action plans to address the problems exposed.

2.5.2 Urban Development

> At a fine-grained scale, accessibility is affected by the quality of the pedestrian conditions and the clustering of activities within a site, mall or commercial centre. At the neighbourhood level, accessibility is affected by the quality of sidewalks and cycling facilities, street connectivity, transit service, geographic density and mix. Interregional accessibility refers to the quality of highways, air service, bus and train services, and shipping services to other regions (Litman, 2003).

While rural and urban residents share similarities in their desire for access (both are concerned with getting to key services and opportunities in reasonable time, at reasonable cost, and with reasonable ease), their relative valuations for what is "reasonable" are likely to differ. These disparities originate from mobility and land-use patterns.

Urban development often equates to higher land-use density, with opportunities clustered in close proximity. This contributes to shorter average travel times. Conversely, in rural areas the physical distance between goods and services is likely to be greater, corresponding to greater travel times and trip distances. This can reduce the practicality of using public and active transport in rural settings, and disincentivises their provision. Several studies demonstrate the high incidence of private vehicle in rural regions (Farrington & Farrington, 2005; Banister, 2018; Fitzgerald, 2012; MPI, 2019). For these reasons, applications of accessibility-based planning in relation to transport are fundamentally different within urban and rural contexts, and this thesis will focus on a case study in the urban context.

Urbanisation has steadily accelerated at both the domestic and global level. This represents a major challenge for policymakers as it signifies exponential increases in

infrastructure and service demand and natural resources (Boulange et al., 2017). Mitigating these challenges will require strategic urban and transport planning, and careful consideration of spatial characteristics. In light of these challenges, accessibility-based planning presents a viable paradigm to accommodate for future urban growth through its promotion of integrated land use and transport systems. This is substantiated by an emerging body of literature which chronicles the role of accessibility-based planning in urban development, ranging from urban and regional planning, spatial policy development, and urban land-use modelling (Hansen, 2009; Boulange et al. 2017; Litman, 2019). Such sources reveal how accessibility-based planning can be used to evaluate and evolve urban form at various geographic scales, with greater attention to improving access to key opportunities.

Interpretations of "ideal" urban form vary. However, the majority involve considerations of transportation in conjunction with land-use patterns, and support employing an accessibility-based planning approach (Litman, 2019; Mumford, 1968, as cited in Levison et al., 2005; Chapman, 2018). The OECD (2012) and Banister (2011) emphasise an urban form that facilitates access by walking, cycling, and public transport, linked by poly-centric networks in cities of appropriate scale (as cited in Chapman, 2018). Litman (2003) promotes multi-modal urban land-use: destinations clustered in walkable centres for maximum interaction over shorter distances; and public facilities located in areas with convenient proximity, roadway access, transit service, and walkability.

However, Chapman (2018) cautions against placing too much emphasis on accessibility in urban development, stating "accessibility is only one goal among many held by stakeholders in the evolving urban system" and adds that the complexity of the urban system can prove frustrating, although "policy experimentation and adaptive learning provide a hopeful and realistic way forward." Nonetheless, enhanced consideration of accessibility in future urban development can engender several co-benefits. Increased access by walking, cycling and public transport and reduced vehicle dependency can positively impact health (as a result of reduced exposure to air pollution and increased physical activity), general well-being (via increased social inclusion), and the environment (reductions in carbon emissions, noise, and air pollution).

2.5.3 Sustainability Agendas

Globally, transport is the least diversified sector in terms of end-use energy source, with 95% of its energy is derived from fossil-fuels (IEA, 2019; US EPA, 2015). This results in correspondingly high levels of global transport emissions. Additional, and often overlooked, sources of emissions are also embedded in the construction of transport infrastructure and its management (e.g. highway maintenance) (Banister, 2018). The World Energy Outlook (2011) forecasts that global fossil-fuel demand will remain principally driven by the transport sector, predominantly from passenger transportation (as cited in Girod et al., 2013).

Mitigating carbon-based transport demand is thus central towards achieving meaningful climate change mitigation. This mandates comprehensive measures to address the sector's carbon-based energy dependence and general sustainability, while managing ongoing growth in demand. In this regard, accessibility-based planning offers a paradigm for road emissions mitigation and a low-emissions transport sector transition (Chapman, 2018). Bertolini et al. (2005) theorise that "a shift of focus in urban transport planning from catering to mobility to catering for accessibility may help see how more sustainable travel options (e.g. walking, cycling, public transport, shorter car trips) can, under certain land-use conditions (e.g. higher densities, more finely-tuned functional mix), provide a degree of accessibility that matches less sustainable options". It is therefore important to recognise that land use remains a critical component of a sustainable transport system.

As discussed previously, accessibility-based planning values transport modes according to their ability to meet users' needs, and places less priority on longer trips or faster modes, particularly if shorter trips and slower modes provide adequate access (Litman, 2003). Integrated land use and transport development also encourages reductions in travel distance between key opportunities through the promotion of increased density, land-use mix, non-motorised conditions, and network connectivity (Litman, 2003; Hansen, 2009).

Such measures can promote shorter travel distances, greater ease of access by walking, cycling, and public transport, and reduced levels of private vehicle use, and are found to correspond with decreased energy consumption and emissions production (Girod et al.,

2013; Bertolini et al., 2005). These shifts are especially valuable in a climate change context, as studies increasingly find that changes to travel behaviour may contribute to climate mitigation (IEA, 2009; as cited in Girod et al., 2013). While technological advancements (e.g. teleconferencing, ICT) may reduce travel need, sources increasingly contend that the most effective measure to reduce transport sector emissions is by encouraging modal shifts to low-emitting transport modes by reducing private vehicle-based travel need (Chandra, 2005; Banister, 2007; GIZ, 2007).

Accessibility-based planning also aligns with the leading sustainable transport paradigm, *Avoid-Shift-Improve* (A-S-I), which promotes three principal measures to increase transport sector sustainability and emissions mitigation.

1) *Avoid* refers to the need to improve the efficiency of the system as a whole, and is predominantly concerned with integrated land-use planning and transport demand management to reduce travel need and trip distances.

2) *Shift* seeks to improve trip efficiency, primarily through encouraging modal shift from high energy-consuming vehicles to low-emitting or non-motorised alternatives (e.g. public and active transport) (GIZ, 2007).

3) *Improve* focuses on augmenting vehicle and fuel efficiency as well as the optimisation of transport infrastructure (GIZ, 2007).

Under this paradigm, *avoidance* measures are of greatest priority, followed by *shift* and *improve*. This challenges conventional – and often mobility-oriented – supply-side paradigms for transport demand (e.g. increased roading provision). Notable overlap occurs between accessibility-based planning and A-S-I. Each promote integrated land-use and transport planning, trip distance reductions, and multi-modal travel.

2.6 Governance and Policy Roles

Halden (2003) states that the potential role for accessibility-based planning "depends partly on the evolving policy and administrative approach to transport." Land use

institutions (e.g. housing and development agencies) also carry substantive influence given the strong mutual relationship between land-use patterns and transport systems, although their in-depth examination remains out of scope for this thesis.

In most nations, governments and other public sector governance institutions are responsible for both private and public transport systems, although to varying degrees. These institutions direct transport investment and infrastructure provision, as well as determine their characteristics and placement. Although generally vehicle acquisition and upkeep are privately funded, the government is usually responsible for developing, funding, and maintaining national roadways and roading infrastructure (e.g. traffic lights, road surfaces), and therefore retain a notable role in private transport development. Governing institutions are most often directly responsible for the bulk of public transport procurement and oversight, as well as some active transport infrastructure. Governance considerations (e.g. funding constraints) are consequently at the forefront of accessibility-based planning, and these roles and responsibilities carry significant implications transport supply, and for how, why, and to what extent people use certain transport modes and services.

Government institutions also retain significant responsibility in facilitating future transport sector transitions. Planning, procuring, and funding low-emissions transport infrastructure and services is economically unviable for most individuals. Facilitating "shifts" in public transport demand and promoting the maximisation of wider societal benefits is often, a primary government responsibility. Undertaking these is challenging, even more so in democratic societies where public support can influence the very composition of those tasked with directing and designing transport transition strategies.

Obstacles to accessibility-based planning also relate to conventional policy processes. Measures to promote integrated land use and transport systems, multi-modal land mix, and travel need reductions often require long-term implementation and oversight, which are often submerged under short-term economic priorities (Banister, 2018). Conventional policy analysis frameworks tend to outline impacts in the short- to medium-term and clash with accessibility-based planning measures that more effectively align with sustainable transport paradigms, such as A-S-I (see section 2.5.3), and which place greater weight on measures with long-term impacts.

Furthermore, with the price of non-action on climate change continuing to rise at an exponential rate, governments face increasing pressures to rapidly reduce transport sector emissions. This may conflict with the promotion of long-term over short-term transport sector sustainability measures, such as widespread EV roll-out (short-term) versus integrated land use and transport planning (long-term) (Sims et al., 2014). Qualitative studies examining the correlations between accessibility-based planning measures and emissions mitigation have recently emerged, although most modelling is approximate (Girod et al., 2013; Creutzig et al., 2015). Fewer studies provide quantitative measurements of accessibility-based planning generated emissions reductions. This paucity makes it difficult to signal the long-term emissions mitigation potential of accessibility-based planning, particularly as the emissions reduction potential of short-term policy levers, such as EVs, is well documented (MfE, 2018; Creutzig et al., 2015).

2.7 Accessibility Frameworks and Low-Emissions Transport Demand

In the United Kingdom, "the energy crisis of late 1973 provided an opportunity to question motorists as to how they planned to cope with petrol rationing, with surprising results. Two studies concluded that there would not automatically be a switch from car to bus/rail for all journeys. Most work journeys would divert to public transport, but a significant number of off-peak journeys would be suppressed. Even in London it was found that, for non-work trips, three existing car trips would be foregone entirely for every two which diverted to public transport. It seemed that people were more likely to reduce their level of trip making than change mode" (Jones et al.,1983)

As previously discussed, the literature routinely shows that the majority of low-emissions transport options, namely active and public transport, are optimal modalities for increasing sector sustainability, enhancing equity of access, and improving health outcomes with respect to increased physical activity (Banister, 2018; Chapman, 2018; Banister, 2005). Even so, uptake remains slow and several historic studies suggest that disincentives such as fuel price increases and rationing do not necessarily correspond to modal shifts to low-emitting transport modes (Jones et al., 1983). Predicting transport demand and travel behaviour in a future domestic transport sector decarbonisation scenario thus remains difficult.

Conventional evaluations of low-emissions transport demand predominantly assess modes and services in isolation, namely motorised vehicles and public transport. Such assessments predominantly focus on speed, cost, or efficiency factors (Manaugh & El-Geneidy, 2013). This overlooks the influence of personal values and motivations – such as attitudes towards exercise, social interaction, and the environment – which are increasingly recognised as central motivators for individual transport choice (Manaugh & El-Geneidy, 2013). Moreover, revealed behaviour may not always be a good measure of preferred behaviour (Halden et al., 2005).

Despite their *prima facie* desirability, it is also not enough to assume that the individual transport user will use a lower-emissions transport option simply because it is there, because they face fossil-fuel based travel constraints, or even because they hold altruistic environmental values; these additional characteristics must also be evaluated in order to provide a more holistic understanding of factors driving or constraining use of low-emissions transport modes and services. Instead, it is necessary to evaluate low-emissions transport options in relation to their ability facilitate access to opportunities in a practical, reliable, affordable, and safe manner as it exists today and in coming decades.

An accessibility-based framework is well placed to identify potential barriers preventing these shifts to low-emissions transport. An accessibility-based framework examines individual motivators of transport demand, the transport system itself, as well as external factors (land-use patterns, urban form, geography). This assesses a broader range of low-emissions modes and services (particularly non-motorised transport), and addresses transport behaviour –motivations for travel and individual attitudes – beyond traditional parameters (Litman, 2019). Identifying existing travel patterns and mode use; as well as user-based perceptions of available modes and services permits greater insight into potential barriers preventing shifts to low-emissions transport. This helps inform policy design to augment and expand low-emissions transport services, and therefore reduce travel emissions.

Given the role of government institutions in transport supply and land use planning, it is also necessary to identify internal policy attitudes towards accessibility-based planning

and existing transport sector objectives. Such insight reveals challenges in addressing low-emissions transport along accessibility-based lines. Consequently, this approach necessitates the collation of both quantitative and qualitative data.

2.8 Research Framework and Questions

As stated in Chapter One, the fundamental objective of this thesis was to identify drivers of GWR low-emissions transport demand so as to inform policies designed to promote a low-emission transport sector transition. This was predicated on the informed hypothesis that GWR residents diverge in their ability and desire to shift to low-emissions transport, and that auto-centric policy and planning has heavily skewed the GWR's transport supply. The research also aimed to assess the challenges of a low-emissions transport transition, and attitudes towards accessibility-based planning measures, within current transport policy and planning structures. Informed by an accessibility-based framework, four research questions have been designed to answer these aims:

1) *What factors influence existing patterns of travel and transport demand among Greater Wellington Regional residents?*

2) *Among Greater Wellington Regional residents, what explains ability to use low-emissions transport?*

3) *How do Greater Wellington Regional residents rate their ability to use low-emissions transport, and what factors influence their use of low-emissions transport?*

4) *What do key stakeholders perceive are the challenges of addressing GWR low-emissions transport demand, and what are their attitudes towards accessibility-based planning measures?*

Research question one aims to identify drivers of residential transport demand and travel patterns. This allows comparison between low-emissions and petrol-based transport, and reveals any links to accessibility-based parameters. Research question two thus analyses whether certain variables act as predictors of low-emissions transport use ability. Research question three aims to identify user-based attitudes towards GWR low-

emissions transport options and offers insight into a diverse range of user-based needs, abilities, and relative values. Lastly, research question four evaluates the role and capabilities of government institutions in relation to transport design, supply, and oversight. This provides insight into residential transport demand and travel patterns, and also captures the challenges of a low-emissions transport transition, and attitudes towards accessibility-based planning measures, within current transport policy and planning structures.

Further domestic context is provided in Chapter Three.

Chapter 3. Domestic Context

3.1 Accessibility and Transport in Aotearoa New Zealand

Accessibility was scarcely mentioned in official documents a dozen years ago, but strategic studies such as Future Demand (Lyons et al., 2014) have helped to popularise the idea that peoples' transport needs are more complex than simply physical mobility (Chapman, 2018).

Accessibility is often indirectly referenced in domestic policy, although increasingly recognised as a core strategic transport objective. One of the four strategic priorities of the 2018/19 Government Policy Statement on Land Transport **(GPS)** is "a land transport system that provides access to economic and social opportunities", and focuses on "transport and land use planning that improves access by reducing the need to travel long distances to access opportunities like employment, education and recreation" (New Zealand Government). The Ministry of Transport **(MoT)** (2018c) designates "inclusive access" as a core strategic outcome for the nation's transport system. The National Land Transport Programme **(NLTP)**, which gives effect to the GPS, states that ensuring access is critical for growing the economy and maintaining social wellbeing (NZTA, 2018b). The New Zealand Transport Agency **(NZTA)** (2018b) considers an accessible transport system should promote "safe, easy and affordable travel choices, ensuring the network is resilient at its critical points, keeping people and communities connected."

Differences in urban and rural access requirements are also acknowledged. The NZTA (2018b) asserts that the "NLTP has been developed in recognition that urban areas and regional New Zealand face different access challenges and require different investment approaches". The NZTA (2018b) also states that as an agency, it will take "a leading role in supporting urban growth and development by working with local government to expand public transport networks, increase the frequency and quality of services, and improve connections to public transport hubs," as well as guide investment to extend "existing walking and cycling networks, establish better connections to public transport hubs, and improve safety and accessibility for pedestrians and cyclists." The Urban Growth Agenda **(UGA)** – the central government's urban development strategy – also

references the need for strategic integrated land use planning and transport pricing (HUD, 2019).

Although without overt reference to accessibility-based planning, the NZTA (2018b) considers these measures will "help make towns and cities more accessible and liveable by reducing reliance on cars, providing more transport choices, easing congestion in urban areas, supporting people to be active, enabling people to get to their destinations more efficiently and decreasing the environmental impact of the transport system."

The NZTA's (2014) Accessibility Planning report summarises the benefits of accessibility-based planning and the associated strategic interventions required for implementation. This report drew considerably on Abley and Halden's (2013) New Zealand Accessibility Analysis methodology, which established the first domestic accessibility measurement methodology and developed a neighbourhood accessibility assessment tool that allowed for the calculation of an "accessibility score", which could then be incorporated into domestic policy and practice. Although influenced by European accessibility-based planning frameworks and accessibility parameters, Abley and Halden's proposed methodology is expressly designed for domestic application and builds upon research by Chapman and Weir (2008), which investigated the applications of accessibility-based planning as "a tool for assessing and improving personal access to essential services for all New Zealanders."

There are few explicit references to accessibility in the Greater Wellington Regional Land Transport Plan (RLTP), which sets out the strategic direction of land transport in the GWR over a ten to thirty year period. One such reference, "improved accessibility to public transport for all," is predicated on physical distance, e.g., "population living within 500m of any bus stop or 1km from a rail station" (GWRC, 2015). This bias towards physical transport system parameters suggests relative measures are relatively underused and/or underrepresented in current transport policy and planning.

The Wellington City Council's (WCC) *Urban Growth Plan*, which sets out the city's urban development and transport strategy over the coming years, stresses that the provision of "transport routes which provide choice" remains key to maintaining the city's

accessibility (2015). The creation of "accessible employment opportunities" is another long-term priority. Strategic land use and investment in housing, transport and other infrastructure is thus central to the WCC's planning. The *Urban Growth Plan* was influenced in part by the *Accessible Wellington Action Plan*, which set out a series of objectives aiming to support people with disabilities in accessing locations and services within the city (WCC, 2012). Although the latter provides a clear foundation for the improvement of absolute accessibility barriers, namely the physical ability required to access and use transport options, additional accessibility parameters are not addressed.

3.2 Low-Emissions Transport

Despite developments in transport technology (electric vehicle batteries, rail electrification) and renewable energy sources, sector dependence on carbon-based energy sources persists, with only gradual improvement in energy and CO_2 efficiency (energy use per passenger and per freight transport unit) in recent decades (IEA, 2018). This global trend is reflected domestically, with transport emissions constituting approximately 20% of total aggregate national emissions per annum, underpinned by the irrefutable dominance of carbon-based road transport (Rose et al., 2009; MoT, 2019a). Projections indicate that by 2020, transport emissions will be 58% above 1990 levels, which is a significantly higher forecasted increase than in any other sector (MfE, 2018).

3.2.1 Carbon-Based Transport Trends

Almost 90% of domestic emissions are produced by road transport, the majority from private passenger vehicles. Aotearoa New Zealand also has the second highest rate of vehicle ownership among Organisation for Economic Co-operation and Development (OECD) countries (OECD, 2017), and is characterised by low public transport use, a significantly aged vehicle fleet, and poor fuel economy standards (NZPC, 2018).

Historical measures to address these factors have proven largely ineffective. Inadequate pricing of vehicle externalities and a land transport funding system skewed towards roading has suppressed the potential for mode shifts, including the switch to low-emissions transport modes. This has resulted in the enduring dominance of private vehicle travel, comparatively low levels of public and active transport use and

procurement, and the proliferation of high-emitting vehicle options (NZPC, 2018; Rose et al., 2009).

New Zealand's auto-centric transport culture is also reflective of another core accessibility component – land use. A proclivity towards low-density development has contributed to the nation's existing levels of "sprawl", frustrated public transport use and funding, entrenched existing infrastructure patterns, and ultimately, existing levels of accessibility (Rose et al., 2009; Chapman, 2008). The reciprocity between land-use and transport development is notably evident. Fol and Gallez (2014) add that the distinct "technical cultures" of the transportation and urban planning fields act to constrain paradigm change. Historical orientation around the disciplines of economics and traffic engineering – which measure the functioning of transportation networks in relation to the short-term problem of urban traffic flows – has, in their opinion, failed to effectively facilitate the adoption of long-term planning perspectives and address "soft issues" such as land use, urban form, and social disparities (Fol & Gallez, 2014).

Entrenched mobility preferences also impede the use of accessibility-based frameworks. The advent of the "affordable" and modern private vehicle in the 1950s and 60s resulted in its rapid ascension and the importation of transport planning practices from the UK and the US, which were largely oriented around motorway development and vehicle movement (Pawson, 2014). High rates of private vehicle ownership have resulted in *and* from the dominance of auto-centric transport policies and the steady procurement of roading-oriented transport infrastructure (MoT, 2007). Adapting existing planning paradigms and infrastructure therefore requires tackling entrenched land use and transport policies and cultural attitudes, which often prioritise mobility over accessibility (Banister, 2018).

3.2.2 Low-Emissions Transport Policies

Proposed transitional strategies vary. The World Economic Forum (2017) and Santos et al. (2010) posit that continual advancements in low-emissions technology and ICT could increase connectivity, decrease carbon-based energy dependence, and curb transport emissions. However, a notable majority consider these singular measures remain inadequate (Sims et al., 2014; Banister, 2018; Bertolini et al., 2005). Most analysts now

concede that only aggressive low-carbon transition policies within both OECD and non-OECD countries could stabilise aggregate global light duty vehicle (LDV)[2] demand and associated emissions by 2050 (Sims et al., 2014; IEA, 2019).

EVs are seen as the leading option to reduce domestic transport emission levels (NZPC, 2018; MoT, 2019b; MfE, 2018), though achieving 2050 emissions targets via EV uptake alone seems unlikely. For the bulk of LDVs – 85% of which are private vehicles – to be electric by 2050, nearly all vehicles entering the fleet would need to be EVs by the early 2030s (NZPC, 2018; Mot, 2018a). Despite recent increases, EVs currently form less than one percent of the private vehicle fleet (MfE, 2018) and have contributed, at most, to 3.67% of annual private vehicle registrations (MoT, 2020).

In contrast, the NZTA (2019d) asserts integrated land-use and transport planning is pivotal, and supports mode shift from private vehicles to low-emissions public transport, active and/or shared modes. EVs also rank lower when assessed through the 2019 MoT draft Social Impact Assessment (SIA) framework, which recognises the broader social, economic, and environmental implications of transport policy (Parr, 2019; Rose et al., 2009). There is minimal data on emissions reductions rate projections relating to the promotion of EVs, public, and active transport, or their combination.

3.2.3 Low-Emissions Transport and Accessibility Policies

Although increasingly included in institutional and academic discourse, accessibility is rarely examined in conjunction with domestic sector sustainability and emissions mitigation policies. This is not exclusive to Aotearoa New Zealand and reflects wider international transport policy trends. Sector inertia is partially explained by accessibility's conceptual complexity, and the difficulties in its measurement and implementation in planning processes, particularly those concerning impacts on emissions levels (Chapman, 2018; Bertolini et al., 2005; Banister, 2018). This paucity makes it difficult to predict accessibility-based planning's future role in a low-emissions transport transition strategy.

In any case, transitioning to a low-emissions transport sector will be a high-cost, time-intensive process and require considerable government investment and direction.

---

[2] Passenger vehicles with a gross vehicle mass up to 3.5 tonnes (MoT, 2018a).

3.2 Transport Policy and Funding Structures

Government policy and funding directly influence domestic transport supply, which has indirect implications on transport demand. Evaluating intersections between transport policy and funding structures at the central, regional, and local levels is therefore essential. These interactions matter for how, and to what extent, existing governance institutions can influence a low-emissions transport transition, and the extent to which accessibility-based planning is involved in the GWR. Figure 3.1 presents a diagram of these multi-level structures.

3.2.1 National

National transport funding is primarily supplied by the National Land Transport Fund **(NLTF)**, which is generated by the public's payment of fuel excise duties, road user charges, motor vehicle and driver registration, licensing fees, and other Crown revenue (New Zealand Government, 2018; NZTA, 2019a, 2019b). The NLTF is presently projected to raise approximately $3.7 billion NZD in the 2018/19 financial year, increasing to $4.2 billion NZD in 2027/28 (New Zealand Government, 2018). This total is supplemented by approximately $1 billion NZD per annum of local government transport funding, in the form of a local share (New Zealand Government, 2018).

The GPS governs how the NLTF is spent and determines the direction of land transport policy and government expenditure within a ten-year period. The most recent 2018/19 GPS sets funding allocations for 12 activity classes[3] (New Zealand Government, 2018). These allocations are set by Ministers and signify NLTF investment priorities (New Zealand Government, 2018). The specific detail of which projects and programmes will receive funding is determined the NZTA.

Funding allocations are developed by the National Land Transport Programme **(NLTP)** and the Investment Assessment Framework **(IAF)** (NZTA, 2018a, 2018b). The IAF is used to "assess and prioritise business cases, programmes, plans, projects and other activities to be submitted for funding consideration" (NZTA, 2018a). The IAF also aids in developing

---

[3] The twelve activity classes are: public transport, walking and cycling improvements, local road improvements, regional improvements, state highway improvements, road policing, promotion of road safety and demand management, investment management, state highway maintenance, local road maintenance, rapid transit, and transitional rail (MoT, 2019).

the NLTP – a three-year programme that determines activities eligible for NLTF funding under the Land Transport Management Act 2003 – and informs investment decisions during the three-year NLTP period (NZTA, 2018b). Both the NLTP and IAF must give effect to the GPS. Consequently, different types of "activity classes" are funded by separate NLTF funds (GWRC, 2015).

3.2.2 Regional

Regional transport policy is directed by Regional Land Transport Plans (**RLTPs**), which are developed by local government (NZTA, 2019a). An RLTP is a statutory document that must be prepared every three years as required by the Land Management Act 2003 (GWRC, 2015). The RLTP comprises two main parts: *the strategic context*, which supplies the policy framework and strategic case for developing and investing in the region's land transport network; and *the regional programme*, which sets out the programme of proposed land transport activities over a six year period and includes a 10-year financial forecast (GWRC, 2015).

The GWR's RLTP is prepared by the Regional Transport Committee (**RTC**), a joint committee comprised of two GWRC representatives, regional local council mayors, and the NZTA's regional director (GWRC, 2015). The RLTP is required to contribute to the purpose of the Land Transport Management Act 2003 – achieving "an effective, efficient, and safe land transport system in the public interest" – and remain consistent with the overarching GPS (GWRC, 2015).

The RLTP also informs the creation of Regional Public Transport Plans (**RPTPs**), which are governed by the Public Transport Management Act 2008. The RPTP must give effect to the RLTP and in turn, informs the creation of the Regional Rail Plan, the overarching guideline for the long-term development of the region's rail network (GWRC & KiwiRail, 2009).

The GWR's RLTP does partially inform the NLTP's development by "identifying the priorities and key improvement projects for the Wellington region proposed to be funded or co-funded from the NLTF" (GWRC, 2015). However, although the NZTA is required to take account of the RLTP when preparing the NLTP, "it does not have to include any [regional] activities or projects in the NLTP nor is it bound to follow the RLTP when

considering detailed funding applications" (GWRC, 2015). Regional transport funding is therefore predominantly dictated by central government, as the RTC cannot reallocate funding from one activity class to another (GWRC, 2015). Moreover, an activity must be in the RLTP to be considered for funding from the NLTF (GWRC, 2015).

All state highways are fully funded by the NLTF. This means that the NZTA is responsible for the maintenance of State Highways 1 and 2, the GWR's primary roadways.

3.2.3 Local

Mirroring regional procedure, at the territorial authority (local) level, Long-Term Plans (**LTPs**) dictate the area's overall strategic direction, including the projects and initiatives requiring investment and their objectives. LTPs are prepared by each district/city council on a three-year basis and provide a ten-year outlook for the area. Although LTPs address multiple sectors (e.g. housing, arts and culture), transport planning is central to all local LTPs.

Local-level transport systems can also be influenced by additional policies. For example, the *Let's Get Wellington Moving* programme – a joint initiative between WCC, GWRC, and NZTA – is targeted at improving the region's public and active transport and liveability, principally in Wellington City (MoT, 2019c).

The NLTF provides partial funding for local transport operation, maintenance, and project planning. However, this contribution meets, at most, 50% of the costs of approved activities. Local share funds make up the remainder, usually a combination of local council rates, user charges (e.g. public transport fares), and other district funding sources (GWRC, 2015; NZTA, 2019a).

Local funding is significantly influenced by district/city LTPs and Annual Plans (city/district council produced annual reviews of LTPs) (WCC, 2019). This includes budget proportions, end-point allocation, timeframes, and assigned investment prioritisation (GWRC, 2015). Local transport funding is predominantly dedicated to the management and operation of local roads, bus priority lanes, and facilities along the local road network (GWRC, 2015).

In addition to the Land Transport Management Act 2003 and Public Transport Management Act 2008, local transport policy and funding is also indirectly guided by the Local Government Act 2002, which sets out the statutory requirements for the purposes, roles and responsibilities of local and regional government.

GWR transport projects and planning initiatives are thus influenced by a complex hierarchy of central, regional, and local level transport policy and funding decisions.

Figure 3.1: GWR Transport Policy and Funding
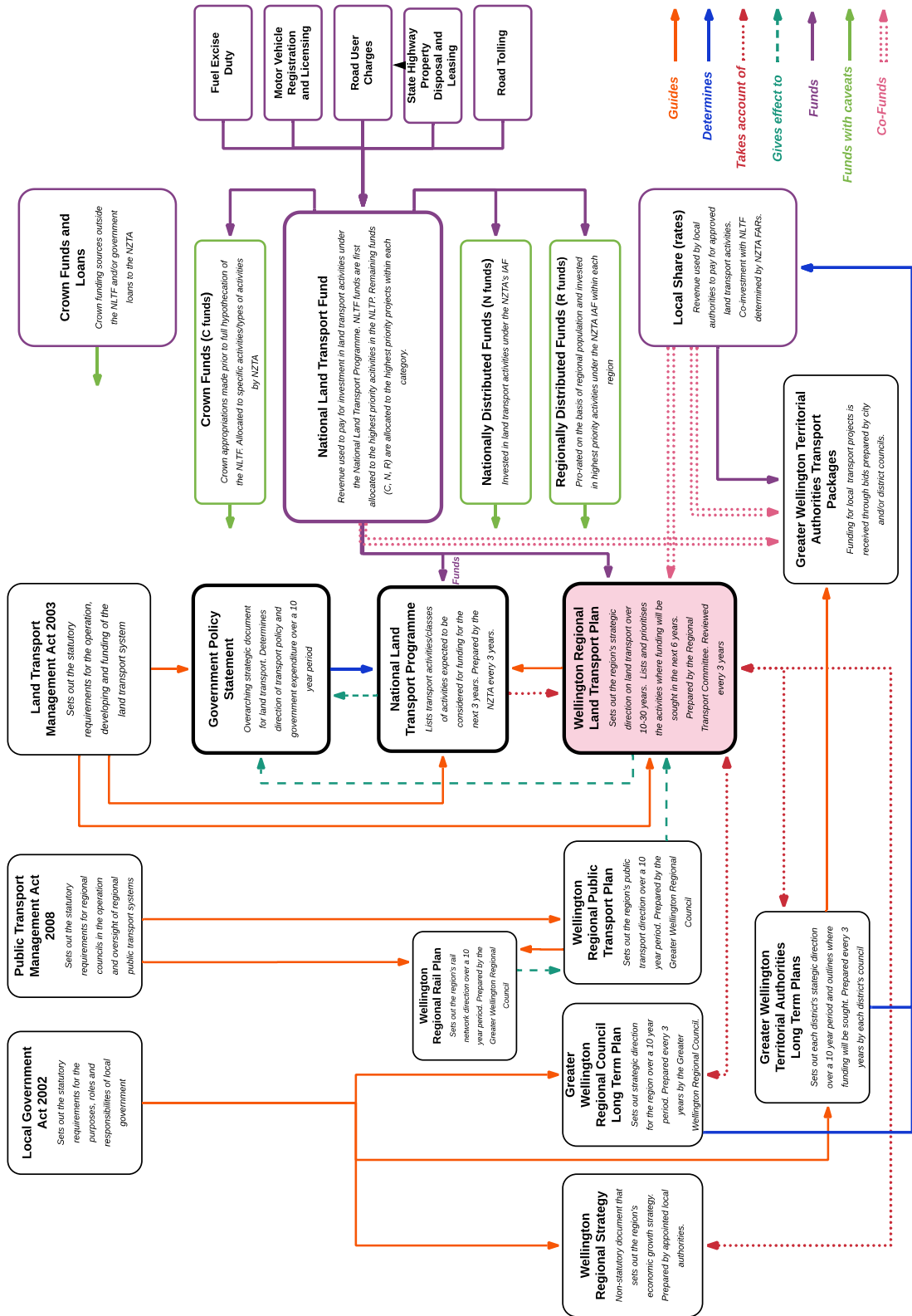
The author's diagram (2020)

3.2.4 Primary GWR Funding Stakeholders

In most instances, the funding and delivery of transport projects relies on a partnership between multiple parties. There are three principal organisations involved in the planning, funding and delivery of the GWR transport system:

1. **The New Zealand Transport Agency (NZTA):** As noted above, the NZTA is tasked with managing and operating the state highway network, including walking/cycling facilities along and across the state highway corridor, and any bus lanes/facilities on the state highway network (GWRC, 2015). Its portfolio also extends to public transport, walking and cycling paths, and local roads, with any investment being required to give effect to the GPS (GWRC, 2015).

2. **The Greater Wellington Regional Council (GWRC):** The region's principal governance authority, the GWRC services the Regional Transport Committee (RTC) and therefore has a strategic transport planning and coordination role (GWRC, 2015). It is also responsible for funding and managing public transport services, including network and service design, the vehicle fleet (i.e. public buses), stops and stations, park-and-ride, information and ticketing (GWRC, 2015). The GWRC, however, does not own the bus fleets or provide bus priority lanes on the road network; nor does it manage the rail track infrastructure, which remains the responsibility of KiwiRail (GWRC, 2015; GWRC & KiwiRail, 2009).

3. **GWR City/District Councils:** City/district councils are responsible for managing and operating their relevant local road networks. This includes walking/cycling facilities along and across local roads and bus priority lanes/facilities on the local road network (GWRC, 2015). The present study predominantly focuses on WCC due to high regional commute rates in and out of Wellington City (see section 1.2).

These three primary organisations significantly impact whether GWR residents can access key destinations and opportunities in reasonable time, at reasonable cost, and with reasonable ease using low-emissions transport. Their fragmentation risks creating inefficiency or inefficacy.

The 2018 redesign of the GWR public bus network is a salient example. Despite aiming to address issues such as bus-related congestion and poor network connectivity, several factors, namely insufficient planning and poor transitional levers, contributed to its ostensible failure. Public backlash was severe, and included allegations of rampant service unreliability, poor quality driving, and insufficient network connectivity. An independent review later revealed a series of internal planning failures at the regional council level, largely the result of miscommunication with contracted bus companies (Dooney, 2018).

An overview of the existing structures governing funding and planning for transport infrastructure and services is a critical prerequisite to understanding transport demand, as the nature of transport supply is strongly influenced by government policy and funding. This also highlights the challenges of promoting an accessibility-based paradigm shift in transport policy and planning. Doing so will require substantive stakeholder alignment across central, regional, and local levels, relationships which are complicated by outside parties and multi-level funding and policy structures.

Chapter 4. Research Design and Methodology

This chapter outlines the methods used to address the research aims of this thesis. Both quantitative and qualitative methods were employed for data collection, a form of mixed methods research operating under the paradigm of pragmatism. A pragmatic research approach allowed for alignment with the conceptual accessibility-based framework used, and which accommodated for the evaluation of relative and absolute transport-related accessibility factors both endogenous and exogenous to the GWR.

Quantitative data on GWR transport use and travel patterns was collated through an online survey questionnaire targeted towards GWR residents and analysed through IBM's SPSS program. Semi-structured interviews were conducted with a range of stakeholders with knowledge of transport policy and planning and/or emissions mitigation policies at the local, regional, and/or central levels. Thematic analysis was used to identify, analyse, and interpret patterns and themes emerging from qualitative data, including interview transcripts and written survey responses. The following sections will provide thorough explanations of the methods employed and the rationale for their use.

4.1 Research Approach: Pragmatism

This research is conducted through a pragmatic worldview, the primary epistemology and philosophy associated with mixed methods research – that is, the combination of qualitative and quantitative research methods (Feilzer, 2010; Tashakkori & Teddlie, 1998). Ontologically, pragmatism postulates that reality is actively created as individuals act in the world and is therefore eternally changing. There are thus infinite avenues for empirical inquiry (Feilzer, 2010; Creswell & Plano Clark, 2007; Dewey, 1925; Rorty, 1999).

In acknowledging reality's non-static nature, pragmatism recognises the influences of historical, social, and political context (Creswell, 2013). This understanding of "layered reality" translates to a problem-centred research approach, which seeks to find solutions based on the goal of better understanding the problem instead of possessing the ideal method for inquiry. This allows researchers to select from a variety of methods, techniques, and research procedures (Weaver, 2018; Feilzer, 2010). Pragmatism

therefore accommodates for the innate complexity of reality through the promotion of integrated research.

Mixed methods research works fluidly within the pragmatic research paradigm due to its promotion of integrated inquiry through the active mixing of quantitative and qualitative research methods. Employing a pragmatic worldview more readily accommodated for the complex intersectionality between relative and absolute accessibility-based factors as well as physical and non-material contextual influences. This supported the conceptual accessibility-based framework used and enabled the collation of both quantitative and qualitative data through methods best aligned with the nature of the research inquiry.

4.2 Positionality

The notion of positionality – the idea that the researcher's characteristics, primarily those of biographical and geographical orientation, exert influence on the nature of the data produced and the manner in which it is analysed — illuminates an underlying tension between objectivity and subjectivity. The recognition of imperfect objectivity aligns with the philosophical worldview espoused by pragmatists, one primarily guided by the researcher's desire to produce socially useful knowledge as opposed to the establishment of conclusive fact. In this sense, pragmatists consider a researcher's positionality can influence how and to what extent the research is deemed "socially useful."

For my own research, what I considered to be a socially useful causal relationship or finding was influenced by my cumulative personal experiences, education, and upbringing. My unique positionality as a 26-year-old biracial female postgraduate student could have thus resulted in research findings that differed from those of another, particularly if our respective research objectives and contextual environments diverged significantly. My research area and aim were influenced by my positionality, particularly prior experiences commuting and travelling within the GWR and my broader education.

Acknowledging this positionality, I endeavoured to minimise bias when conducting and communicating my research. Though semi-structured in nature, interview questions were carefully worded to avoid "leading" the interviewee, and open-ended questions

limited potential bias in the survey design while facilitating greater freedom for participant responses.

During the research process, I was aware of the sensation of being both an "outside" and "insider" (Bourke, 2014; Jensen & Glasmeier, 2010). Working as a policy advisor in a Wellington-based central government institution had increased my familiarity with the procedural practices governing meetings between internal employees and external individuals. This personal occupational experience, coupled with subject matter knowledge, provided for a semi-insider status. However, this was ultimately superseded by the fact that I was not employed by any of the respective agencies my interviewees represented and thus, could not be privy to any publicly unavailable information, particularly policies in development. This firmly cemented my outsider status and influenced the manner in which interviewees responded to my questions and the extent to the information they opted to disclose.

I felt a greater sense of "insider" status when formulating my survey questionnaire targeted towards GWR residents. Living in the region and being a regular user of local public and active transport allowed me to build a credible and contextually appropriate survey. Additionally, my awareness of high-traffic local social media groups and platforms and physical community hubs assisted in participant recruitment.

My postgraduate student status and subject matter knowledge also allowed for greater legitimacy and credibility during the initial interview and survey participant recruitment phase.

4.3 Research Design

A mixed methods research approach accommodated for the inherent complexity of an accessibility-based conceptual framework. Incorporating dual qualitative and quantitative research techniques allowed assessment of relative and absolute user-based and contextual factors influencing GWR low-emissions transport demand and transcended the limitations of a mono-method research approach (Brierley, 2017; Feilzer, 2010).

Teddlie and Tashakkori (2009), among others, maintain that an integrated research approach offers greater opportunity to attain a more complete understanding of the research topic and in turn, enhance theory development and practice (Brierley, 2017; Johnson & Onwuegbuzie, 2004). While purists commonly stress the paradigmatic incompatibility of the qualitative and quantitative data, this research upholds the fundamental principle of mixed research – that qualitative and quantitative data are complementary if the researcher follows proper research technique and procedure (Teddlie & Tashakkori, 2009). This research collates primary data using two methods: an online survey questionnaire and semi-structured interviews.

Quantitative data was collated through an online survey questionnaire, allowing insight into existing travel patterns, mode use and frequency, and user-based needs and abilities. Participant ratings of GWR low-emissions transport modes and services allowed the collation and comparison of relative values.

Semi-structured stakeholder interviews allowed insight into transport policy and planning, and revealed the challenges associated with incorporating accessibility-based planning measures. Written survey responses provided additional qualitative data on low-emissions transport demand and travel patterns, particularly relative accessibility parameters.

In technique and procedure, this research follows the convergent model of mixed methods research – quantitative and qualitative data are collected during the same phase of the research process and findings are eventually merged in the interpretation of the overall results (Creswell & Clark, 2007). An accessibility-based conceptual framework informed both the survey questionnaire and guided the focus of the semi-structured interviews. This method of "triangulation" allowed for the direct comparison and contrast of seemingly distinct data (Creswell & Clark, 2007). Furthermore, this approach promoted efficient data collection within a limited period while still permitting any dissonance or contradiction to be addressed at the time of interpretation (Creswell & Clark, 2007; Fetters et al., 2013).

4.4 Online Survey Questionnaire

4.4.1 Rationale

Pragmatism's promotion of a "what works" research approach offered greater freedom in the survey design process, leading to an online questionnaire rather than a paper-based survey (Brierley, 2017; Johnson & Onwuegbuzie, 2004). This decision reflected the flexibility, cost-effectiveness, and "reach" associated with virtual platforms. For example, question branching – a design technique where pre-determined sets of relevant questions appear based on a response to a preceding question – is only possible through an online survey. Benefits also included enhanced efficiency (paper-based surveys require more resources, such as printing supplies and physical distribution) and minimisation of unintentional research bias (online surveys can overcome limitations of the researcher's geographical access, locational knowledge and outreach limitations and provide access to a larger, more diverse audience range). With a research area encompassing 813,500 hectares, it was crucial to select a platform that maximised access within each GWR district (GWRC, 2019).

The survey design was predicated on the implicit assumption that survey respondents could comprehend the questions in a similar manner to the researcher, that they held attitudes on all issues raised, and that they were willing to share these views with the researcher (Feilzer, 2010). To counteract potential interpretive dissonance, the survey incorporated several open-ended responses options, which enabled a greater freedom in participant responses and for the researcher to engage with unexpected data and analytical material.

Using an online survey questionnaire also constrained the sample size. Only those with online access, basic computer literacy, and admission to the websites where the survey link was promoted could participate. Moreover, online surveys are generally associated with a lower response rate than their physical counterparts (de Bernardo & Curtis, 2013). The ebb and flow of online communities can also lead to difficulty in establishing an accurate sampling frame (Wright, 2005). Participation can thus be overrepresented by those with strong personal feelings on the subject matter.

Despite these limitations, the virtual reach of an online survey provided greater opportunity to recruit a larger, diverse sample size, supported by the fact that over 77.2% of GWR households have internet access (.id, 2019a).

4.4.2 Survey Design

The end survey design was formulated with Qualtrics, an online survey software platform accessed through the Victoria University of Wellington's **(VUW)** licensing agreement. Qualtrics programming allowed respondents to complete the survey through a greater range of viewing formats and modes (computers, smart phones), promoting increased access flexibility and survey completion probability rates.

The survey consisted of both closed-ended and open-ended responses. A range of question formats and response options were employed to target specific data and reduce survey fatigue. Close-ended responses were comprised of "tick-box" formatting and sliding-scales. Sliding, or Likert-scales, were used to elicit attitudinal participant responses and were ideal for evaluating relative variables (Barua, 2013). Open-ended comment boxes were also included to permit participants to write additional commentary, particularly if they considered the provided range of response options insufficient or unrelated to their preferred answer.

The final survey comprised of 32 questions. However, question branching meant some participants were presented with a different total in accordance to their individualised responses. These groupings and flow order were programmed into the Qualtrics questionnaire during the design phase of the survey. For example, if the answer to "Do you own or have regular access to a private car?" was yes, only then would the participant be shown the following question, "On average, how much per week do you individually spend on petrol or diesel?". This helped to create a streamlined user experience which minimised the presentation of inconsequential questions. This reduced survey fatigue and gathered information most relevant to the participant.

4.4.3 Survey Questions

The final survey design was formulated following an extensive literature review, a series of preliminary tests, and a pilot study. Participants were notified of the survey through

either an online or paper-based publicity post. Once accessed, participants were required to read an information section (Appendix B) which outlined the survey's intent and the nature in which responses were used, recorded, and stored. Only after indicating they had read and agreed with this information, were they permitted access to the full survey questionnaire (Appendix C).

The survey opened with two screening questions designed to identify whether the participant was a) over 18 years of age and b) resided in the GWR. Responses failing to satisfy these two parameters were eliminated from the final survey data spreadsheet. Following a series of mandatory, close-ended preliminary demographic questions, participants were asked about their transport use and travel patterns.

This next series was designed to gather detailed data on participant's travel patterns, transport modal use, and transport costs. This included their main mode of transport to work or study and for used for all other activities; average commute distances and time; average transport costs; and whether they owned or had regular access to a private car.

The next section introduced the first series of accessibility-based questions and focused on participant perceptions of and/or experiences with GWR low-emissions transport options. This included the reliability their main mode of transport to their work or place of study (1 = low reliability, 5 = high reliability), with a "not applicable" option for those who did not participate in work or study; their current access to public transport options (listed as bus, ferry or train) (0 = no access, 5 = high access); and aside from those who indicated no access in the previous question, the practicality of using public transport (1 = low practicality, 5 = high practicality). Practicality was broadly defined to the participant as if a transport option allowed the user to get to where they needed to go at a reasonable cost, in reasonable time, and with reasonable ease.

Perceived levels of access to active transport option, such as pedestrian walkways or bicycle lanes (0 = no access, 5 = high access); and the practicality of using active transport (1 = low practicality, 5 = high practicality) were measured. All participants were also asked to rate their current ability to access their desired destinations on average, specified as those other than their daily commute to work or study (1 = low ability, 5 = high ability).

The penultimate portion of the survey assessed participant attitudes and experiences with low-emissions transport options. This included rating their current ability to use low-emissions transport (0 = no ability, 1= low ability, 5= high ability); and how important it was for their transport options to be low-emissions (1 = extremely important, 5 = not at all important). Low-emissions transport was defined as: if the transport mode used less fossil fuel or emitted less carbon emissions. Examples were also provided (electric vehicles, buses, railways, walking, and cycling). This aimed to clarify low-emissions transport for the participant.

Participants with responses in the 0 (no ability) to 3 (average ability) range were then presented with an immediate follow-up question: "Why do you consider your ability to be limited? (you may select more than one answer)." Participants could then select one or more options and/or provide written input if they considered their answer fell outside of the provided responses.

The survey concluded with questions on general mode preference and attitudes towards transport costs and carbon emissions. Using a drag and drop format, participants ranked their preferred modes of transport (from nine provided options); and deciding factors for transport choice according to a three-tier hierarchical order (1 = first choice, 2 = second choice, 3 = third choice). For both questions, if participants selected the "other" option, they were asked to supply brief written input. The final question, "Would you pay more for a mode of transport if it produced less carbon emissions?" was purposefully separated from an earlier question, "How important is it to you that your transport option be low-emissions or sustainable?" in order to minimise bias and/or a potential "leading" question scenario.

A full copy of the survey is presented in Appendix C.

4.4.4 Preliminary Survey Testing

Before live publication and distribution, the survey was tested for any potential inaccuracies in survey layout, compatibility errors, and/or access barriers through five separate beta-tests conducted by the researcher, the researcher's supervisor, and three others. Feedback was subsequently used for revision.

4.4.5 Recruitment Methods

Practicality, cost-effectiveness, and audience reach influenced the choice of recruitment methods. This predominantly occurred through snowball sampling – participants were recruited from their acquaintances – and intercept recruitment – participants were recruited through publicity posts (online ads, physical posters). These methods provided access to the wider GWR population in a cost-effective and efficient manner.

The researcher utilised existing social media membership to access known and unknown GWR community contacts. The survey link and a short description of the survey's nature and purpose was published on several social media groups and community pages with GWR membership bases (e.g. Facebook: Wellington Live, Kāpiti Coast Community Page, Upper Hutt Community Page, Instagram: the researcher's personal followers). Respondents were asked to forward the link to relevant friends and associates and/or publish the survey link on their social media platform and/or social media group page. A public Facebook page was also created in order to use a *suggested post* (a form of paid advertising) to access wider GWR residents and to help diversify the sample. This ran over a two-week period.

Intercept recruitment involved the distribution of physical posters outlining the survey's nature and purpose. Viewers were encouraged to access the survey link through the provided survey URL or by scanning a QR code. This facilitated ease of access while accommodating for those without smartphones or QR code scanning technology. Posters were placed in high-traffic locations throughout the GWR (e.g. transport hubs and community centres).

The researcher also used an incentive-based recruitment prize to attract participants. Participants were only able to enter the prize draw after the survey was complete, encouraging a higher completion rate.

4.4.6 Survey Response

Measuring the overall survey non-response rate was difficult due to the self-selecting nature of the recruitment methods employed. Response rates for both the online social media snowball recruitment method and intercept poster recruitment could not be quantified, as total viewership for each could not be tracked.

439 participants entered the survey in total. 391 responses were considered complete, corresponding to a 79.3% completion rate. Of these, 24 respondents indicated they did not reside within the GWR, and their responses were deleted to avoid skewing any later analysis. This gave 380 final responses.

Qualtrics survey software prevented any "ballot-stuffing" (multiple survey entries). A manual review of IP addresses was also conducted to identify any double entries. None were identified. IP addresses were subsequently deleted to maintain participant confidentiality.

4.4.7 Data Analysis

Survey data was analysed using the statistical programme SPSS, which allowed for all dependent and independent variables to be compiled into a codebook. Where necessary, response questions were recoded to ensure that all variable options were correctly aligned. This predominantly involved recoding questions with multiple response data sets into separate variables, including: average frequency of modal use (Q10), limited ability factors (Q26), three preferred modes of transport (Q28), and deciding factors in transport choice (Q29). Non-applicable values were replaced with a neutral response value of (88) and missing values – where the participant did not supply a response— were designated as (99).

Bivariate correlation analysis examined the relationships between designated independent variables[4]. Correlation was found significant if at the 0.01 level (2-tailed). Pearson's correlation coefficient evaluated the degree to which variables found to be significantly correlated were related.

A regression model was used to identify any predictive relationship(s) between selected independent variables and the dependent variable (participants' ability to use low-emissions transport for their travel purposes). SPSS UNIANOVA was used to estimate standard errors and confidence intervals. A 95% confidence interval was used to assess

---

[4] Designated independent variables: number of household members, age group of participant, approximate household income, approximate household weekly income, average weekly household transport costs, average distance for daily commute to work or study, rated practicality of using public transport, rated practicality of using active transport, and current GWR residence district.

upper and lower bounds of independent variables. Statistical significance applied to P values below 0.05.

Qualitative written survey responses were analysed using thematic analysis (see section 4.5.4).

4.5 Stakeholder Interviews

4.5.1 Rationale

Government institutions principally influence the development of land-use and transport systems, each a critical component of accessibility. The purpose of conducting semi-structured interviews was to gather insight from a range of stakeholders associated with transport policy and planning and/or emissions mitigation policies. This provided perspectives on governance roles and capabilities, past and present transport planning paradigms, and attitudes towards accessibility-based planning measures. Participants were selected based on their occupational experience and subject matter knowledge. Local, regional, and central level government institutions were all targeted due to the multi-level nature of transport policy and funding.

4.5.2 Interview Structure and Guide

The VUW Human Ethics Committee granted ethics approval for this research on 6 June 2019 (Appendix A). Prior to the interview, participants were supplied with an information sheet (Appendix E) and consent form (Appendix F), which outlined the research aims and interview structure, and permitted the use of interview content in this thesis. Interviewees were notified of their right to respond at their discretion, and of the confidential and anonymous nature of the interview.

Interviews were conducted from June to August 2019, each averaging at around 45 minutes. All interviews were conducted in person within Wellington City limits, however interview locations varied in accordance to the participant's request and individual constraints. With their permission, participants were audio-recorded. Interview questions were purposefully open-ended but followed an interview guide (Appendix G). This semi-structured approach ensured responses aligned with key subject areas enough

to facilitate later comparison while still allowing enough structural flexibility for the conversation to diverge in a productive manner. This permitted unexpected information to emerge unprompted.

If requested, a summary and/or audio file of the interview was provided to the participant.

4.5.3 Recruitment Methods

Interviewees were primarily recruited through snowball sampling and in one instance, through a mediator. Interviewees were sampled from local, regional, and central level government institutions as well as external academic institutions. A list of individuals and government institutions related to the research area was first established and used to narrow the direction of recruitment. Snowball sampling was used to contact government officials due to difficulties in identifying and contacting persons most relevant to the research area as a result of institutional privacy restrictions. A total of 11 participants were interviewed. Interview participant information is summarised in Table 4.1.

Table 4.1: Stakeholder Interviewee Information

Organisation	Number of Participants
The Greater Wellington Regional Council (GWRC)	2 officers, 1 councillor
Ministry for the Environment (MfE)	1 official
Ministry of Transport (MoT)	2 officials
The New Zealand Council of Trade Unions (NZCTU)	1 official
Victoria University of Wellington- School of Government (VUW)	2 academics
Wellington City Council (WCC)	1 councillor, 1 officer
Total	11

4.5.4 Data Analysis

Semi-structured interview data were evaluated using thematic analysis. A set of key themes was established following extensive appraisal of the interview transcripts. These themes were developed based on their frequency and comparative weight within participant responses, as well as from the researcher's own knowledge of the subject

gained from experience throughout the research period. In keeping with the approach of Argyous (2009), themes facilitated cross-comparison between interviews and permitted patterns, relationships, and explanations to emerge from a large quantity of qualitative data.

4.6 Methodology Summary

The nature of the research questions this thesis sought to explore facilitated the use of a pragmatic research approach, primarily because of a desire to produce socially useful knowledge as opposed to establishing conclusive, solution-driven findings. A mixed methods research approach arose organically from the pragmatic paradigm and aligned with the researcher's accessibility-based conceptual framework.

An online survey collected data from GWR residents, focusing primarily on their transport demand and travel patterns as well as their attitudes towards low-emissions transport. Semi-structured interviews were simultaneously conducted to facilitate the researcher's access to, and exploration of, both horizontal and vertical governance structures, producing data from representative stakeholders in relation to accessibility, transport policy and planning, and emissions mitigation policy. Using thematic analysis, qualitative data was analysed to provide important contextual information about the use of accessibility-based planning in relation to low-emissions transport within local, regional, central domestic government institutions.

Following a convergent mixed methods approach, quantitative and qualitative data, while collected and analysed independently via a parallel-database approach, were then merged and subsequently analysed. Integrated data provided greater insight into GWR residential transport behaviour and low-emissions transport demand, and their alignment with accessibility-based variables. It also revealed the challenges associated with incorporating accessibility-based planning measures to address low-emissions transport at the local, regional, and central government level. The next chapter provides a full outline of these results.

Chapter 5. Results

This chapter discusses findings of this research, with respect to the four research questions described in Chapter Two. Sections 5.1 and 5.2 address research questions 1 and 2, presenting the quantitative data collected in an online survey questionnaire circulated to GWR residents. Following a summary of the data (section 5.1), a series of bivariate correlations and a regression analysis are presented (section 5.2).

Section 5.3 addresses research question 3, and presents both quantitative and qualitative data findings using an integrated approach. An overview of low-emissions transport related survey response data is provided and augmented by qualitative findings from written survey responses. Survey response quotations supply detailed user-based insight into factors influencing low-emissions transport use.

The final section (5.4) addresses research question 4 with qualitative data collated from interviews with key stakeholders at local, regional, and central government level transport-related institutions, as well as with academics. As described in Chapter Four, thematic analysis is used to identify and analyse the patterns and themes in the data.

5.1 Research Question 1

> *What factors influence existing patterns of travel and transport demand among Greater Wellington Regional households?*

As discussed in Chapter Two, patterns of transport use are significantly influenced by the user's personal needs and ability. From an accessibility standpoint, infrastructural supply or physical access to low-emissions transport are insufficient explanations of modal uptake; many contextual factors may facilitate or constrain transport behaviour.

This section explores factors motivating residential transport behaviour and travel patterns in three parts. The first part (section 5.1.1) presents survey response data using frequency tables, which report on the main mode of transport used for: work or study; non-work or study related activities (collectively known *as all other activities*); and average weekly use. The second part (5.1.2) reports on specific aspects of low-emissions

transport demand, with frequency tables presenting modal use by emissions intensity and frequency. Following this, in the third part (5.1.3), factors influencing modal choice are presented in order of highest reported frequency by first, second, and third choice rankings, allowing insight into transport demand.

5.1.1 Survey Sample Characteristics

Socio-demographic comparisons between the 380 total survey respondents and 2013 Census data for the GWR are outlined in Figures 5.1 to 5.5.

Figure 5.1 shows that the majority of respondents identified as being from Wellington City (74.7%), Kāpiti Coast (10.3%), Porirua (7.4%), and Upper Hutt (3.4%). Lower Hutt, Masterton, Carterton, and the South Wairarapa had low participation levels. Figure 5.2 shows the majority of respondents were female (76.0%). Male (23.0%) and non-binary (1.1%) respondents were underrepresented in the sample size. In terms of household member size (Figure 5.3), two-person households represented the majority (29.5%), followed by one-person (27.1%), and four-person (17.6%).

Due to differences in categorical definition, exact comparisons with 2013 Census data were unavailable for participant age group (Figure 5.4) and approximate household annual income (Figure 5.5). However, approximate corresponding categories allowed for some comparison.

Figure 5.4 shows that the majority (41.6%) of survey respondents were aged between 31 to 50 years, followed by those aged between 24 to 30 years (27.4%), with those aged over 70 years notably underrepresented (2.9%). Figure 5.5 shows that the majority of respondents (35.5%) had an average annual household income of between $62,401 and $130,000 NZD, with the second highest majority (23.2%) between $130,001 and $260,000 NZD.

These figures demonstrate that the study sample is not representative of the GWR population. This could have arisen from the sampling strategy used and from specific demographic constraints and avenues available to the researcher. The significance of this limitation is considered further in Chapter 6.

Figure 5.1: Place of Residence
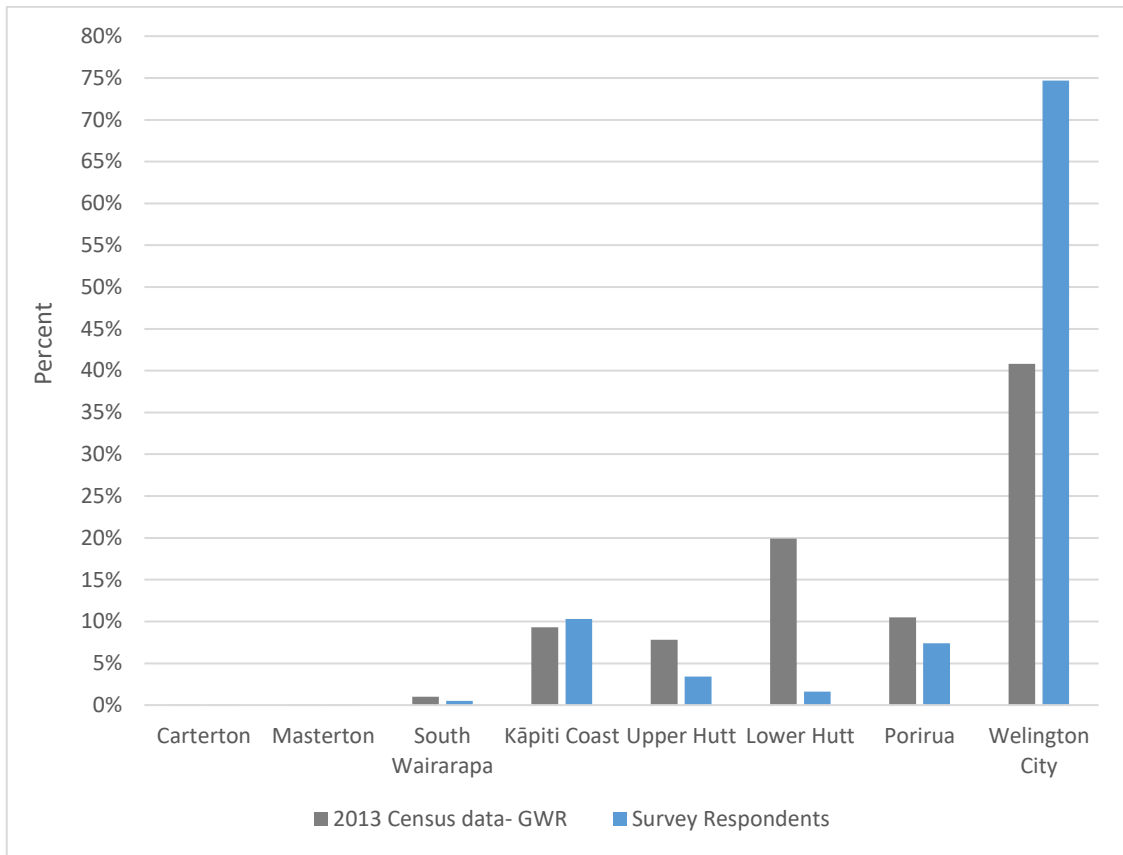
Sourced from 2013 StatsNZ Census data and the author's online survey questionnaire of GWR residents (2020).

Figure 5.2: Gender
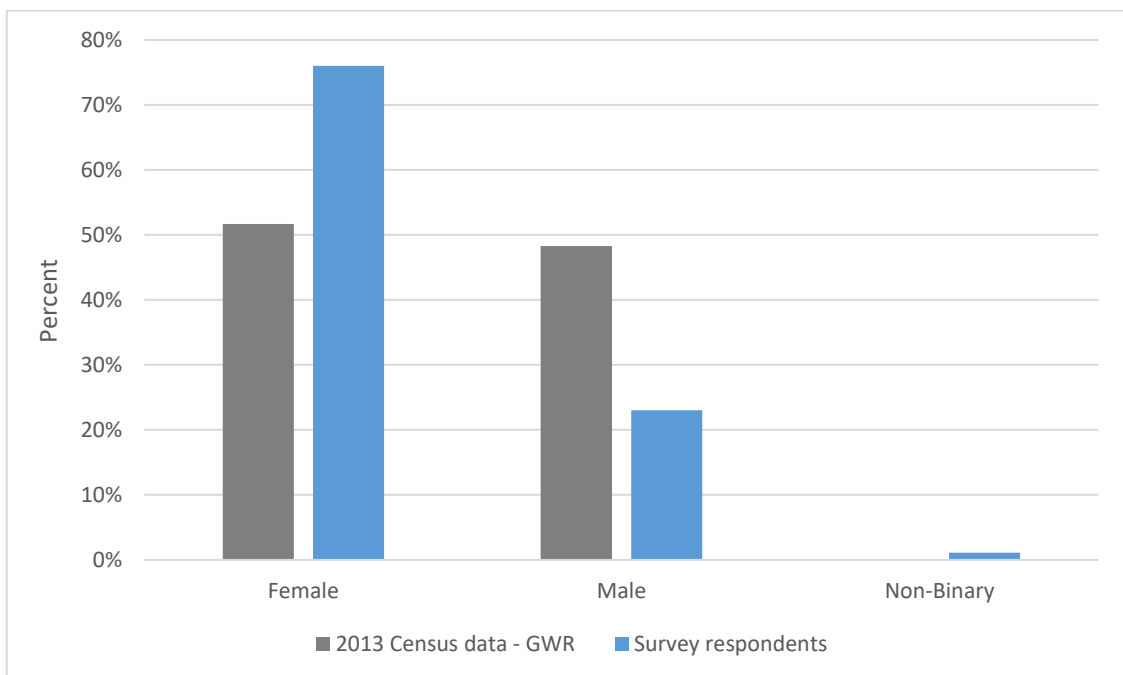
Sourced from 2013 StatsNZ Census data and the author's online survey questionnaire of GWR residents (2020). Note: the option to select "non-binary" was not available in the 2013 Census.

Figure 5.3: Household Member Size
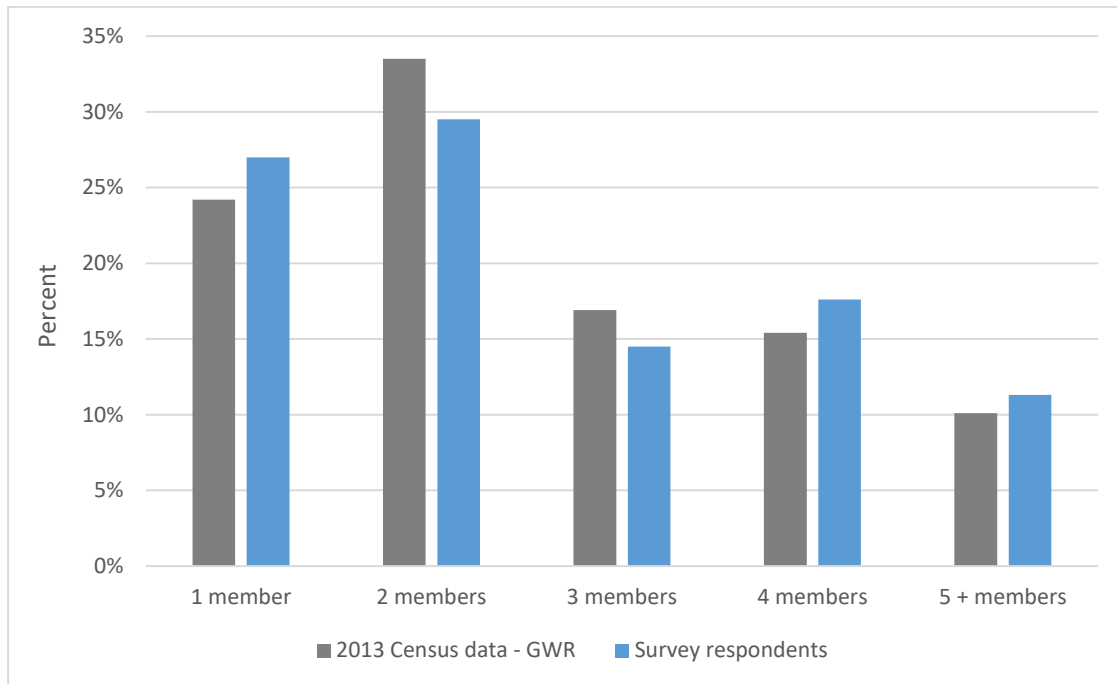
Sourced from 2013 StatsNZ Census data and the author's online survey questionnaire of GWR residents (2020).

Figure 5.4: Age Group
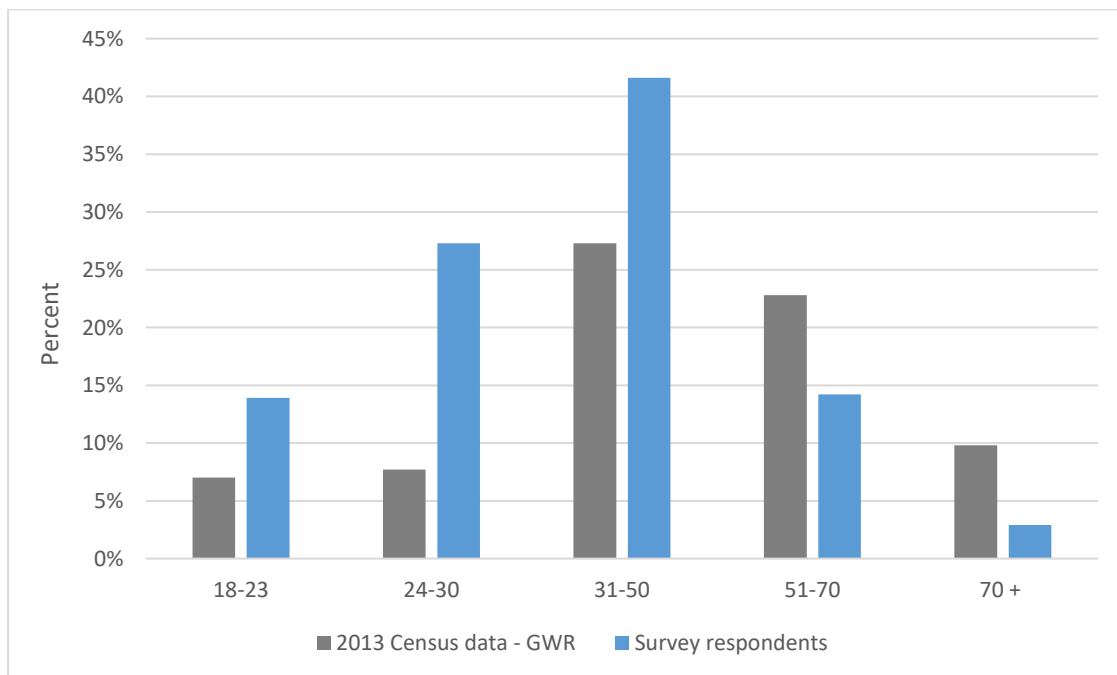
Sourced from 2013 StatsNZ Census data and the author's online survey questionnaire of GWR residents (2020).

Figure 5.5: Household Income
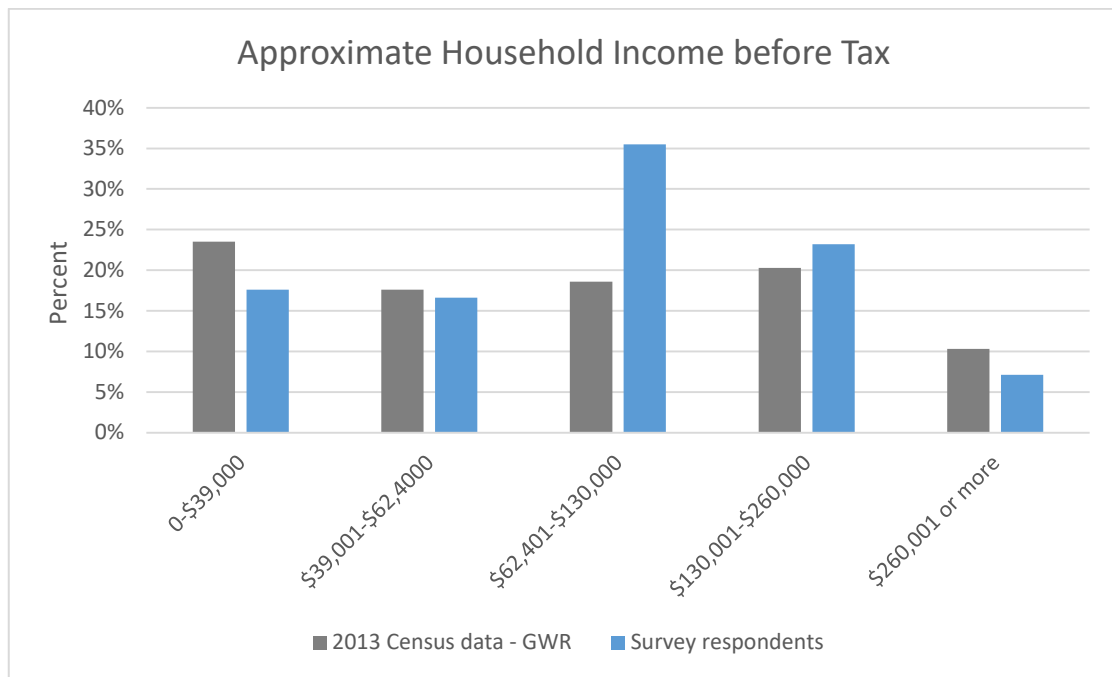
Sourced from 2013 StatsNZ Census data and the author's online survey questionnaire of GWR residents (2020).

5.1.2 Transport Demand by Trip Purpose and Average Weekly Use

Reported modal use frequency by travel purpose and average weekly use are presented in Tables 5.1 to 5.3. In terms of 'typical' daily commute to work or study (Table 5.1), respondents travelled most frequently by private vehicle (29.7%)[5]; walking or cycling (29.5%); and public bus or ferry (20.5%). When accessing non-work or study destinations (*all other activities*) (Table 5.2), a majority travelled by private vehicle (62.9%)[6], followed by walking or cycling (25.0%), and public bus or ferry (7.1%). In terms of dominant modalities, these responses mirrored those of the average daily commute to work or study; however there was notable variance in private vehicle use between travel purposes, with a significantly higher percentage of respondents driving to all other activities by private vehicle (56.8%) as opposed to work or study trips (28.4%).

Table 5.3 presents reported modal use frequency in an average week, ranging from no use to daily use. In terms of average daily use, the majority (37.1%) of participants walked or jogged, 30.0% drove or travelled in a private vehicle, followed by a sharp decline to the next highest frequency mode, public bus or ferry (5.0%). The next the highest use frequencies by descending order of days were: 18.2% (public bus or ferry: 4-5 days a week), 23.4% (private vehicle: 2-3 days a week), and 19.2% (passenger in a private vehicle: 1 day a week). In terms of cumulative modal use, the majority (75.3%) of participants walked or jogged between one and seven times in an average week, closely followed by those (73.9%) who drove a private vehicle between one and seven times a week.

---

[5] This figure includes both drivers (28.4%) and passengers (1.3%) of private vehicles.
[6] This figure includes both drivers (56.8%) and passengers (6.1%) of private vehicles.

Table 5.1: Main Transport Mode to Work or Study

	Frequency	Percent of Total Responses
Walk/Jog	85	22.4%
Bicycle/Non-Motorised Scooter	27	7.1%
Motorbike/Motorised Scooter	5	1.3%
Public Bus/Ferry	78	20.5%
Train/Rail	43	11.3%
Drive a Car/Truck/Van	108	28.4%
Passenger in a Car/Truck/Van	5	1.3%
Taxi or Similar Service	1	0.3%
Other	8	2.1%
I do not work or attend school	20	5.3%
Total Responses	380	100.0%

Sourced from the author's online survey questionnaire of GWR residents (2020).

Table 5.2: Main Transport Mode for All Other Activities

	Frequency	Percent of Total Responses
Walk/Jog	83	21.8%
Bicycle/Non-Motorised Scooter	12	3.2%
Motorbike/Motorised Scooter	4	1.1%
Public Bus/Ferry	27	7.1%
Train/Rail	7	1.8%
Drive a Car/Truck/Van	216	56.8%
Passenger in a Car/Truck/Van	23	6.1%
Taxi or Similar Service	5	1.3%
Other	3	0.8%
Total Responses	380	100.0%

Sourced from the author's online survey questionnaire of GWR residents (2020).

Table 5.3: Transport Mode Use by Average Weekly Frequency

	Walk/Jog	Bicycle/ Non-Motorised Scooter	Motorbike/ Motorised Scooter	Public Bus/Ferry	Train/ Rail	Drive a Car/Truck/ Van	Passenger in a Car/ Truck/ Van	Taxi or Similar Service
1 Day	11.3%	7.6%	2.4%	14.5%	8.2%	11.8%	19.2%	17.6%
2-3 Days	15%	5.8%	1.3%	14.7%	5.8%	23.4%	19.2%	6.6%
4-5 Days	11.8%	2.9%	1.6%	18.2%	9.2%	13.2%	6.1%	0.5%
Daily	37.1%	3.2%	0.5%	5.0%	1.8%	25.5%	4.5%	0.3%
None	24.7%	80.5%	94.2%	47.6%	75%	26.1%	51.1%	75%
Total Weekly Modal Use	75.3%	19.5%	5.8%	52.4%	25%	73.9%	48.9%	25%
Total Responses	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Sourced from the author's online survey questionnaire of GWR residents (2020).

5.1.3 Low-Emissions Transport Use

Calculating average emissions intensity by transport mode is challenging, given that emissions output is a function of multiple variables including energy consumption, trip distance, and modal efficiency. Transport modes are thus presented according to an approximate estimation of average emissions intensity[7](Table 5.4), in order of low-to-high emissions intensity. However, survey data does not consistently include measures of associated trip distance, so estimating comparative emissions among modes - and hence mode ordering by emissions intensity - remains approximate.

For interpretive clarity, the category *passenger in a private vehicle* in Table 5.4 combines participant responses from both *passenger in a car/truck/van* and *taxi or similar service* as both categories referred to approximately the same type of transport mode. Responses recorded as *other* were also eliminated given the difficulty in collating a meaningful average emissions intensity across a number of potentially differing modes.

The majority of respondents drove to work or study (28.4%) and all other activities (56.8%). Combining both trip types constitutes 'aggregate mode use' (n=760), for which driving a private vehicle represented 42.6% of trips. Walking or jogging represented the second highest majority, constituting 22.1% of all trips. Thus, the two most frequently used modes in aggregate were also the highest and lowest emitting in terms of carbon emissions output intensity. Public bus or ferry (11.8%), train or rail (6.6%), and bicycle or non-motorised scooter (5.1%) followed in terms of aggregate use, although bicycle or non-motorised scooters produced zero emissions and as such ranked lower in terms of emissions intensity than public bus or ferry and train or rail.

Table 5.4 Low-Emissions Transport Demand by Frequency and Percentage

---

[7] Approximate average emissions intensity was informed by Sims et al. (2014) and included estimations of: average trip distance, energy consumption, average fuel type used, and energy efficiency.

Modes by Emissions Intensity	Frequency: Daily Commute to Work or Study (n=380)	Percentage: Daily Commute to Work or Study	Frequency: All other activities (n=380)	Percentage: All other activities	Total Aggregate Responses (n=760)	Percentage of Aggregate Responses
Walk/Jog	85	22.4%	83	21.8%	168	22.1%
Bicycle/Non-Motorised Scooter	27	7.1%	12	3.2%	39	5.1%
Motorbike/Motorised Scooter	5	1.3%	4	1.1%	9	1.2%
Public Bus/Ferry	78	20.5%	27	7.1%	90	11.8%
Train/Rail	43	11.3%	7	1.8%	50	6.6%
Passenger in a Private Vehicle*	6	1.6%	28	7.4%	34	4.5%
Drive a car/truck/van	108	28.4%	216	56.8%	324	42.6%

*Combination of passenger in a car/truck/van and taxi/similar service

Sourced from the author's online survey questionnaire of GWR residents (2020).

5.1.3 Determining Factors in Transport Mode Choice

Participants were also asked to rank the top three factors they considered most important in determining their mode of transport from a total of eight deciding factors[8]. Participants could also select a ninth option, *other*; if they did, they were asked to specify that factor. This provided behavioural insight into modal use and travel motivations.

Table 5.5 shows the majority of respondents selected *speed and/or travel time* for both the most important (26.1%) and second most important (23.2%) determining factors among the survey's eight listed options. *Speed and/or travel time* also featured as the most commonly selected third factor, though ranked equally with the additional determining factor, *ability to take to desired end destination*.

In terms of aggregate selections (Table 5.6), with 66.6% of total responses, *speed and/or travel time* was the most frequently selected factor. *Ability for the transport mode to take the user to their desired end destination* ranked second (51.8%), followed by *proximity to the transport option* (46.1%), *cost* (42.6%), *reliability and/or safety* (33.9%), *sustainability and/or environmental impact* (26.1%), *health benefits* (15.2%), *physical ability required* (6.6%), and other (3.4%).

Table 5.5: Top Three Determining Factors in Transport Mode Choice

Ranking	Factor		Percentage of Total Responses (n=380)
Most important factor	Speed/Travel Time		26.1%
Second most important factor	Speed/ Travel Time		23.2%
Third most important factor	Speed/Travel Time	17.4%	34.8%
	Ability to take to Desired End Destination	17.4%	

Sourced from the author's online survey questionnaire of GWR residents (2020).

Table 5.6: Determining Factors for Transport Mode Choice

---

[8] These eight factors were: *sustainability and/or environmental impact*; *proximity to the transport option*; *reliability and/or safety*; *speed and/or travel time*; *ability for the transport option to take the participant to their desired end destination*; *health benefits*; *cost*; and *physical ability required to use the transport mode*

Deciding Factor	Most important factor	Second most impt factor	Third most impt factor	Total Selecting this factor	Did Not Select this factor	Aggregate Percent (n= 380)
Speed/Travel Time	99	88	66	253	127	66.6%
Ability to take to Desired End Destination	79	52	66	197	183	51.8%
Proximity to Transport Option	53	70	52	175	205	46.1%
Cost	55	53	54	162	218	42.6%
Reliability/Safety	27	51	51	129	251	33.9%
Sustainability/Environmental Impact	32	30	37	99	281	26.1%
Health Benefits	14	19	25	58	322	15.2%
Physical Ability Required	6	7	12	25	355	6.6%
Other	9	2	2	13	367	3.4%

Sourced from the author's online survey questionnaire of GWR residents (2020).

5.2 Research Question 2

> *Among Greater Wellington Regional residents, what explains ability to use low-emissions transport?*

This section provides a two-part presentation of the results emerging from statistical analysis of the quantitative survey data. Both bivariate correlation analysis and a regression model are used to analyse the data and assist in answering research question 2. The findings are examined in greater depth in the following sections.

5.2.1 Correlation Analysis

Correlation analysis can illuminate the relationship (if any) between variables hypothesised to impact the ability to use low-emissions transport. Table 5.7 presents a correlation matrix summarising the results of a bivariate correlation analysis, reporting Pearson's correlation coefficient measuring correlations across various factors hypothesised to relate to the participant's ability to use low-emissions transport. Correlations are asterisked (* or **) if statistically significant – p values fell below 0.05 or 0.01. Nominal variables – *gender*[9] and *residence district*[10] – were recoded with dummy variables to differentiate between responses.

---

[9] Reponses were recoded as female = 1, male = 2, and non-binary = 3.
[10] Responses were recoded as Carterton = 1, Masterton = 2, South Wairarapa = 3, Tararua = 4, Kāpiti Coast = 5, Upper Hutt = 6, Lower Hutt = 7, Porirua = 8, Wellington City = 9.

Table 5.7: Variables Influencing Ability to Use Low-emissions Transport: Correlations

		M	SD	N	1	2	3	4	5	6	7	8	9	10
1	Number of Household Members	2.57	1.35	380										
2	Gender	1.25	0.46	379	-.091									
3	Age Group	2.65	0.98	380	.164**	-.030								
4	Residence District	8.2	1.66	380	-.059	.040	-.277**							
5	Household Weekly Income	2.77	1.21	377	.379**	.001	.293**	-.005						
6	Household Annual Income	2.86	1.17	380	.418**	.016	.302**	.007	.851**					
7	Average Weekly Transport Costs	2.87	1.66	380	.529**	-.041	.195**	-.237**	.337**	.371**				
8	Average Distance to Work or Study	1.45	0.73	380	.139**	-.068	.196**	-.367**	.068	.070	.379**			
9	Average Time to get to Work or Study	2.84	1.38	380	-.004	-.004	.002	-.119	.079	.062	.290**	.522**		
10	Practicality of Public Transport	3.11	1.05	370	-.057	.062	-.055	.098	-.054	-.019	-.082	-.073	.056	
11	Practicality of Active Transport	3.05	1.36	364	-.175**	.073	-.220**	.177**	-.161**	-.193**	-.342**	-.303**	-.157**	.257**

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Sourced from the author's online survey questionnaire of GWR residents (2020).

Variable 1. Number of Household Members

The strongest positive association with the respondents' reported household size is with *Average Weekly Transport Costs* (.529), followed by *Approximate Household Annual Income* (.418), *Approximate Household Weekly Income* (.379), *Age Group* (.164), and *Average Distance for Daily Commute to Work or Study* (.139). In general, as household size increases, there is a significant increase in average weekly transport costs. This could reflect that often smaller households include people not in the workforce (for example retired people living alone), whose transport costs may be low. Some small student households may also spend less on transport, as they tend to walk or cycle.

There is also a small negative correlation between household member size and *Practicality of Using Active Transport* (-.175), indicating that the reported practicality of using active transport decreases slightly as household member size increases.

Variable 2. Gender

No significant correlations between gender and other variables were found.

Variable 3. Age Group of Participant

The strongest positive correlation involving age group of the participant is with *Approximate Household Annual Income* (.302). This suggests that as the participant's age increases, so too does their household annual income (as approximately reported). Positive correlations are also found between *Age* and *Household Weekly Income* (.293), *Average Distance for Daily Commute to Work or Study* (.196) suggesting older people live further from their place of work on the whole, *Average Weekly Household Transport Costs* (.195), and *Number of Household Members* (.164).

Negative correlations are evidenced between *Age* and *Residence District* (-.277) as well as the *Practicality of Using Active Transport* (-.220), suggesting that as the participant's age increases, they more often view it as impractical to use active transport.

Variable 4. Residence District

A slight positive correlation is revealed between GWR residence district and *Practicality of Using Public* Transport (.177). Negative correlations are found with *Average Distance to Work or Study* (-.367) and *Average Weekly Transport Costs* (-.237).

Variable 5. Approximate Household Weekly Income

Unsurprisingly, *Approximate Household Weekly Income* demonstrated a strong positive correlation with *Approximate Household Annual Income* (.851). [11] Additional positive correlations included *Number of Household Members* (.379) and *Age Group of the Participant* (.293).

A slight negative correlation is present between *Approximate Household Weekly Income* and *Practicality of Using Active Transport* (-.161). This suggests a slight decrease in the perceived practicality of using active transport occurs as approximate household weekly income increases.

Variable 6. Approximate Household Annual Income:

Significant correlations are found between approximate household income and the following variables: *Number of Household Members* (.418), *Average Weekly Household Transport Costs* (.371), *Age Group of Participant* (.302), and *Practicality of Using Active Transport* (-.193).

This suggests that as approximate household income increases, household size is likely to be greater, along with household average weekly transport costs and participant age. In addition, an increase in approximate household annual income correlates to a slight decrease in the perceived practicality of using active transport.

Variable 7. Average Weekly Household Transport Costs

Average Weekly Household Transport Costs demonstrates positive correlations with the following: *Number of Household Members* (.529), *Approximate Household Annual Income*

---

[11] One would not expect a correlation coefficient close to 1.00 because both income variables are estimated with error. Annual income in particular is likely to be estimated with error because of one-off additions to or gaps in earnings, etc.

(.371), *Approximate Household Weekly Income* (.337), *Average Time to get to Work or Study* (.290), and participant *Age Group* (.195).

A negative correlation occurs with the *Practicality of Using Active Transport* (-.342). The last correlation suggests that respondents living farther from town centres and facing higher transport costs also find it impractical to walk or cycle.

Variable 8. Average Distance for to Work or Study

Average Distance to Work or Study has the strongest positive correlations with *Average Time to get to Work or Study* (.522) and *Average Weekly Household Transport Costs* (.379). Additional positive correlations include participant *Age Group* (.196) and *Number of Household Members* (.139). A strong negative correlation is present between *Average Distance for Daily Commute to Work or Study* and *Rated Practicality of Using Active Transport* (-.303).

Variable 9. Average Time to get to Work or Study

Positive correlations are found between average commute times to work or study, *Average Distance to Work or Study* (.522), and *Average Weekly Transport Costs* (.290). This positive correlation between transport time and cost is unsurprising.

A negative correlation between *Time* and *Practicality of Active Transport* (-.157) suggests that as the average time to get to work or study increases, the practicality of using active transport decreases in at least some cases (access to cycling or a train service can complicate this relationship).

Variable 10. Practicality of Using Public Transport

A paucity of significant correlations between *Practicality of Using Public Transport* and other variables suggests that there were **no** clear deterrents (such as age) to using public transport (unlike for example, active transport). The positive correlation with active transport (.257) is likely to reflect the natural association between using a bus or train and walking.

Variable 11. Practicality of Using Active Transport

The *Practicality of Using Active Transport* revealed statistically significant relationships with all tested variables. Positive correlations are found between the practicality of using active transport and *Rated Practicality of Using Public Transport* (.257) and participant *Residence District* (.177). All remaining correlations are negative, with the strongest being *Average Weekly Transport Costs* (-.342), followed by *Average Distance to Work or Study* (-.303), *Age Group* (-.220), approximate *Household Annual Income* (-.193), *Number of Household Members* (-.175), approximate *Household Weekly Income* (-.161), and *Average Time to get to Work or Study* (-.157).

Clearly use of active transport is seen as cost saving by many respondents, but impractical by those further from centres where they work or study. Also, for some respondents, having a higher income could mean they feel they can afford to drive, rather than walk or cycle.

5.2.2 Regression Analysis

Correlation analysis revealed a mixed set of variables related to the ability to use low-emissions transport. For consistency, the majority of the independent variables whose associations were explored in Section 5.2.1 are used in the regression model. Standard multiple regression analysis is used to ascertain the independent effect of such variables (Table 5.8) in explaining the ability to use low-emissions transport to fulfil average participant travel needs.

Table 5.8: Independent Variables

Gender	Residence District
Household Members (Size)	Age Group
Approximate Household Weekly Income	Approximate Household Annual Income
Average Daily Commute Distance to Work or Study	Rated Practicality of Public Transport
Rated Practicality of Public Transport	Rated Practicality of Active Transport
Weekly Transport Costs	

Table 5.9 below summarises the results of this analysis, in which *Ability to use low-emissions transport* is the dependent variable.

When interpreting the table, B represents the estimated raw or unstandardized regression coefficient for the independent variable in question, and is interpreted as the change in the predicted value of the dependent variable for a one unit increase in the independent (explanatory) variable (Nichols, 1995). In the presence of multiple independent variables, B is a partial regression coefficient and represents the predicted change in the dependent variable when an independent variable is increased by one unit while holding all other independent variables constant.

SE represents the standard error of the regression and provides an absolute measure of the typical distance that the data points (for that independent variable) fall from the regression line (Frost, 2017). SE is measured in the units of the dependent variable.

P represents the significance level of the independent variable, and is the probability of seeing a result similar to the t-value (t) produced in another collection of random data. A P value of 0.05 (5%) or less; 0.01 (1%) or less; and/or 0.001 (0.1%) or less is considered to reveal a significant relationship because there is a small chance that the results produced would also arise in a random distribution. There is thus a 95% (or greater) probability of being correct that the independent variable has some effect on the dependent variable.

t represents the P value divided by its standard error (SE). The t distribution describes how the mean of the sample size (n=380 responses) is expected to behave. The model also uses a 95% confidence interval to calculate the range of values that can be 95% certain to include the sample's true mean.

Table 5.9: Regression Model for Ability to Use Low-Emissions Transport

Independent Variable	B	SE	t	P	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	1.619*	.718	2.256	.025	.207	3.031
Gender 1: Female	-.737	.651	-1.132	.258	-2.018	.543
Gender 2: Male	-.887	.665	-1.334	.183	-2.195	.421
Gender 3: Non-Binary	Oᵃ	.	.	.	.	.
RD 1: Carterton	-.014	1.259	-.011	.991	-2.491	2.463
RD 2: Masterton	-1.405*	.575	-2.443	.015	-2.537	-.274
RD 3: South Wairarapa	-1.077	.902	-1.193	.234	-2.852	.699
RD 5: Kāpiti Coast	.131	.257	.511	.610	-.374	.637
RD 6: Upper Hutt	.757	.388	1.951	.052	-.006	1.521
RD 7: Lower Hutt	.003	.579	.005	.996	-1.136	1.142
RD 8: Porirua	-.081	.280	-.289	.773	-.631	.469
RD 9: Wellington City	Oᵃ***	.	.	.	.	.
Household Members (Size)	.044	.062	.707	.480	-.079	.167
Age Group	-.103	.078	-1.323	.187	-.256	.050
Weekly Income	.074	.111	.666	.506	-.144	.292
Annual Income	.024	.118	.200	.841	-.208	.256
Distance to Work or Study	-.041	.112	-.370	.711	-.262	.179
Practicality of Public Transport	.232***	.068	3.429	.001	.099	.366
Practicality of Active Transport	.484***	.057	8.479	.000	.372	.596
Weekly Transport Costs	-.160**	.054	-2.931	.004	-.267	-.052

a= parameter is set to zero because it is redundant; *P<.05; **P<.01; ***P<.001.

Sourced from the author's online survey questionnaire of GWR residents (2020).

Statistically significant variables were those with P values less than 0.001***,0.01**,

0.05*. Qualifying variables included, *GWR District 2* (Masterton); *GWR Residence District*

9 (Wellington City); *Rated Practicality of Public Transport*; *Rated Practicality of Active Transport*; and *Weekly Transport Costs*.

A one-unit increase in the *Rated Practicality of Public Transport* – for example, from a three (Average) to four (Average-High) practicality rating – corresponded to a slight (.232) increase in the participant's ability to use low-emissions transport. This demonstrates a positive association between the rated practicality of using public transport and low-emissions transport use ability.

Similarly, a one-unit increase in the *Rated Practicality of Active Transport* – for example, from a two (Low-Average) to three (Average) practicality rating – corresponded to a moderate (.484) increase in the participant's ability to use low-emissions transport. This revealed a strong positive relationship between the participant's rated practicality of using active transport and overall low-emissions transport use ability. To illustrate, a separated cycle lane might significantly improve the perceived practicality of cycling, generating an increase in the perceived ability to use such a mode.

A one unit increase in average *Weekly Transport Costs* – for example, from $0-30 to $31-60 –
corresponds to a slight (-.160) decrease in the ability to use low-emissions transport. This suggests that higher average weekly transport costs negatively impact low-emissions transport use ability. Alternatively, this could mean that participants with poor ability to use low-emissions transport have higher weekly transport costs because they have higher fuel costs and/or drive longer distances in conjunction with petrol-based private vehicle dependency.

Lastly, participants residing in Masterton (GWR Residence District 2), had a comparatively lesser ability to use low-emissions transport by a measure of -1.405 than their Wellington City (GWR Residence District 9) counterparts.

5.3 Research Question 3

5.3.1 Reported Low-Emissions Transport Use Ability

Table 5.10 below presents a frequency tabulation of participant responses to the survey question, "Overall, considering both your commute and other day-to-day destinations, how would you rate your current ability to use low-emissions transport options (e.g. electric vehicles, buses, railways, walking, cycling)?" Respondents ranked their ability on a five-point Likert scale (no ability = 0, high ability = 5).

A plurality (23%) of responses fell at the "average ability" mark, followed by "low ability" (20.5%), and "low-average ability" (19.9%). 53% of respondents reported average to high low-emissions transport use ability. However, 19.1% of these 'average to high ability' respondents also reported using a private vehicle as their primary daily commute transport mode, suggesting that the ability to use low-emissions transport modes does not translate directly to uptake and use. An obvious interpretation is that there is some sort of barrier, or lack of motivation, standing between stated ability and actuality of behaviour, for this 19%.

Table 5.10: Reported Low-Emissions Transport Use Ability

	Frequency	Percent	Valid Percent	Cumulative Percent
No ability	24	6.3%	6.6%	6.6%
Low ability	75	19.7%	20.5%	27.0%
Low-Average ability	73	19.2%	19.9%	47.0%
Average ability	84	22.1%	23.0%	69.9%
Average-High ability	55	14.5%	15.0%	85.0%
High ability	55	14.5%	15.0%	100.0%
Total Responses	366	96.3%	100.0%	
Did not respond	14	3.7%		
Total Participants	380	100.0%		

Sourced from the author's online survey questionnaire of GWR residents (2020).

5.3.2 Reported Barriers to Low-Emissions Transport Use

Although section 5.2.2 estimated the impact of several independent variables, respondents who reported a below average low-emissions transport use ability (i.e., low-average, low, or no ability), were asked to indicate why they considered their ability to be limited, in order to gain more specific insight on potential constraints. Participants were given a series of four options (Table 5.11). A fifth, *other* option was also provided for, allowing participants to explain their selection, and accommodating a greater range of responses.

These responses were integrated with additional qualitative survey responses[12], many of which pertained to low-emissions transport uptake barriers categories. This permitted input from a wider participant range, including those who reported an above-average ability to use low-emissions transport. Several of these responses corresponded to the survey's four provided options. The remainder were classified into two primary themes: *convenience and practicality*, which incorporated reliability, frequency, transport function times/hours of availability, physical ability, childcare responsibilities, distance/proximity, hours of work/employment requirements; and *external environment*, which incorporated perceived safety, weather, and topography.

This section is structured according to these six primary thematic groups, presenting an integrated outline of qualitative and quantitative results. Quotes from survey respondents and stakeholder interviews provide qualitative insight into key details and perspectives.

Table 5.11: Reported Constraints of Low-Emissions Transport Use

---

[12] The final survey question invited all participants to provide further comments or questions in relation to the survey.

	Frequency	Percent out of Total Responses (n=251)
Limited or No Access to Low-Emissions Transport Options	144	57.4%
Doesn't Take to Desired End Destination	97	38.6%
Cost of Low-Emissions Transport is Too High	72	28.7%
Speed of Low-Emissions Transport is Too Slow	62	24.7%
Other	45	17.9%
Total Responses	251	
Not Applicable	113	
Did Not Respond	16	
Total Participants	380	

Sourced from the author's online survey questionnaire of GWR residents (2020).

Access to Low-Emissions Transport Options

The majority (57.4%) of respondents with a self-reported below-average low-emissions transport use ability cited limited or no access to said modes as a reason for their restricted ability. This points to the issue of infrastructure provision. Multiple respondents specifically cited the absence of adequate cycling lanes and bus services near their area of residence, with one participant noting a lack of "sufficient infrastructure (for biking mainly/limited bus lines)".

Another respondent noted that despite strongly wanting to use an EV, the characteristics of their area of residence, namely lack of off-street parking or nearby public EV charging facilities, acted as indirect barriers to access.

Route Connectivity

38.6% of respondents indicated route connectivity – the ability of low-emissions transport modes to take them to their desired end destination – significantly influenced their general ability to use low-emissions transport. This response reveals the disparity in connectivity levels between private vehicles and existing GWR public transport and active travel infrastructure (e.g. cycle lanes).

Qualitative participant responses reinforce this contrast, and reference the inconvenience and impracticality of using GWR low-emissions transport, in particular

public and active transport. For instance, one participant (residing outside Wellington City) noted that it would take three buses for them to reach their desired end destination, which resulted in their using a private vehicle to access all other activities on average.

The contrast in public transport services between peak-commute and non-peak commuting hours, was also cited. Non-peak public transport was seen as particularly impractical and inconvenient:

> I rent in Ngaio, so getting the train to and from work in the Wellington CBD is easy. But then three nights a week I do sport in Lower Hutt. Getting public transport from Ngaio to Lower Hutt is a pain (two trains and two fares each way, waiting for the connection, late at night when they don't go often and it's freezing) so I drive from Ngaio to Lower Hutt for that instead (Participant).

Respondents were dissatisfied with the range and diversity of public transport access destinations, and noted their limited hours on weekends and holidays. One participant felt that current public transport services and planning tended "to look at point to point rather than how people can travel from where they live to where they want to get to," adding that the prioritisation of commuting and commuter needs failed to accommodate for other transport users and trip purposes. It was clear that many respondents considered private vehicles to facilitate superior connectivity over publicly available low-emissions transport alternatives.

Cost

28.7% of respondents stated that cost factored into low-emissions transport use. Several stated that their financial circumstances prevented them from purchasing an EV, despite a strong desire to use the mode. Others noted the comparative costs of petrol-based private vehicle use and public transport fares, stating that even after accounting for petrol and parking costs, carpooling was less expensive than public transport (including public buses and rail services):

> Wellington public transport, particularly trains, are far too expensive. For myself, as a couple, it would be cheaper to travel by car and pay for parking (given we still pay all fixed costs associated with a car) (Participant).

Most (83.7%) respondents stated they would pay more for a given transport mode if it produced less carbon emissions. However, practicality and convenience as well as equity considerations factored into the majority (91%) of these responses. The relationship between transport costs and equity was of particular concern to a number of respondents, e.g. "We should have more environmentally friendly transport options, but they need to be affordable for people on all income levels", and, "increasing prices for lower carbon options or penalising high carbon options is not equal. I.e. it allows the richer people to continue to pollute, while reducing the choice for the more disadvantaged in society". Some respondents proposed that subsidised low-emissions transport fares could allow them to overcome cost barriers.

While significant, for many respondents cost was not an isolated barrier, and additional factors, such as practicality, convenience, and even physical ability, factored into their ability to use low-emissions transport.

Speed/Travel Time

The speed and travel time characteristics of low-emissions transport options factored into 24.7% of responses for those with a reported below-average low-emissions transport use ability. In contrast, for *all* respondents, as shown in Table 5.6, speed/travel time was considered both the first and second most important factor, as well as tying for third choice in influencing ability to use low-emissions modes; 66.6% of all respondents cited it as one of the three most important factors in determining their transport mode. The lesser concern with speed/travel time among the low-ability group could partially result from a greater concern with alternative factors (e.g. route connectivity, cost). Having already categorised themselves as less able to use low-emissions options, they are thus more likely to emphasise the practical barriers to such mode choices.

Among the 24.7% group, many considered private vehicle travel as the fastest transport mode with respect to overall journey times, and this influenced their preference for private vehicle use over low-emissions transport alternatives (e.g. public bus services). For instance, one participant stated, "I bought a car because public transport isn't super reliable and it's very time consuming". Another participant reported, "Time is the biggest issue for my family. I have a window of 50 mins to get 3 kids to trains, college and kindy

before I start work. Public transport could never meet these needs". These responses suggest that speed and overall travel time interact with additional factors to influence transport demand.

Convenience/Practicality

Many participants, among both those who selected *other* and the wider body of survey respondents, emphasised factors broadly classifying as convenience and/or practicality. These included *childcare responsibilities*; *transport functioning times, hours of availability and/or reliability*; *employment responsibilities; physical ability*; and *distance or proximity to transport services.*

Childcare responsibilities were repeatedly noted as the most or second most important factor in determining the respondent's choice of transport mode, with multiple participants citing the inconvenience or impracticality of using low-emissions transport – particularly public buses, walking, and cycling – to carry out necessary childcare duties (daycare, school pick-up and drop-off). Most considered private vehicles the most convenient mode to carry out these responsibilities.

Having *young* children also substantially factored into private vehicle use, despite numerous respondents indicating that they would otherwise use low-emissions transport:

> I have a toddler so can't walk or cycle long distances, and we have no buses or other transport near our house. I would catch the train more except there are so few carparks available (Participant).

Respondents' perceptions of convenience and practicality ascribed to using low-emissions transport remained inextricable from additional variables, including infrastructure provision and the perceived quality, reliability, and safety of using low-emissions transport. Despite having high access to or living in close proximity to bus stops, many stated that infrequent and unreliable nature of the GWR bus network severely lowered its practicality and deterred their uptake.

Proximity constraints contributed to perceived impracticality. Participants referenced both proximity to low-emissions transport modes and services, "the nearest public

transport is 1.5 km away," and trip-distance requirements (particularly active transport), "Older people may not be able to walk as far as they age".

Employment responsibilities also acted to lower the practicality of using low-emissions transport, although rationale varied. Incongruity between workplace hours and the frequency and/or hours of availability of low-emission transport services acted as barriers for some respondents. Private vehicles were not perceived to present the same challenges due to their effectively unlimited hours of availability and comparatively high levels of reliability. Occupational requirements also factored into private vehicle dependency, "I work across the region and need to drive, a lot."

Others were deterred from travelling to work via active transport specifically , "I could bike but it's dangerous and I would have to shower and change clothes," and, "Have to turn up at specific time looking well presented, easiest with my car". The latter comment reinforces the broad role convenience plays in determining transport choice, with the private vehicle again perceived as being of greater convenience.

Physical ability also factored into perceived practicality. This was related to physical fitness levels for some, "Not fit enough to bike." For others, however, physical disability severely curtailed their active or public transport use, and private vehicles were considered essential:

> I am disabled so require own transport for door to door transport. Walking causes chronic pain. I drive a van, it has a bed in the back allowing me to lay down as required due to pain (Participant).

External Environment

Respondents referenced several aspects of the external environment – safety concerns, weather, and topography – factored into their use of low-emissions transport.

Multiple dimensions of safety, including the overall safety of the transport mode itself and the characteristics of their wider environment, were referenced. Cycling was commonly cited as an unsafe transport option, although many respondents stated they could and/or would bike if it were safer. The region's external transport culture also

factored these safety perceptions, "If Wellington was more cycle friendly, I would happily use a bike as my main method of transport". Insufficient (i.e. disconnected and unprotected) infrastructure provision also factored into perceived cycling safety.

Weather and topography (e.g. steep hills and rain) also factored into the perceived safety of using low-emissions transport modes. Cycling featured prominently, "I am scared to bike down the steep hills on wet days with lots of traffic," and, "There are too many hills for cycling".

Responses also revealed uneven safety concerns, which corresponded to reported participant gender. Only female respondents stated that their gender resulted in higher perceived safety concerns, which in turn, deterred their use of low-emissions transport, particularly late at night:

> I'm not confident walking, public transport, cycling or scootering are sufficiently safe transport methods for many women at night time (Participant).

5.4 Research Question 4

What do key stakeholders perceive are the challenges of addressing Greater Wellington Regional low-emissions transport demand, and what are their attitudes towards accessibility-based planning measures?

Survey data revealed low-emissions transport use was influenced by several transport supply parameters. A preliminary analysis of the domestic transport policy and planning system revealed the multi-level nature of transport policy and planning. Interviewing stakeholders conversant with the planning, provision, and oversight of low-emissions transport services and infrastructure thus helped provide further context to participant responses.

Guided by a semi-structured interview framework, interviewees spoke to the challenges of addressing GWR low-emissions transport use and their associated perceptions of using accessibility-based planning measures. Stakeholder insight is classified into four primary themes:

(i) land-use and urban development;

(ii) transport policy and funding structures;

(iii) governance roles and capabilities; and

(iv) broader sustainability objectives.

5.4.1 Land-Use and Urban Development

Historic land-use patterns and urban development strategies were perceived to have influenced existing levels of low-emissions transport use, and existing private vehicle dependency:

> Historically, New Zealand is like the [United] States, developing with the motor car. New Zealand beforehand did have a large public transport network and there were large tram systems in most cities. But it brought about a particular form of development as the private car increased. Land is cheaper *per se* than in Europe. Obviously, cars became the most dominant (MoT official 2).

Augmentation of GWR public and active transport services was also considered constrained by lack of foresight in land use planning, largely attributed to a failure to accommodate for the incorporation of rail, bus, cycleway corridors, and other related

facilities (MfE official). High, land-use related low-emissions transport infrastructure costs (particularly public and active infrastructure) seemed to be contribute to central level interviewees' resistance to public and active transport expansion (MfE official, MoT official 2).

Interviewees were more optimistic about increased EV charging infrastructure provision, which several respondents (section 5.3) had reported as a barrier to using low-emissions transport. WCC officer 2 noted that due to historic land-use developments, 30% of Wellington City households were without off-street parking, which meant that those households were reliant on the public provision of EV charging infrastructure. A forthcoming WCC-led EV charger rollout programme was designed to surmount this physical access barrier (WCC councillor, WCC officer).

Several interviewees noted the relationship between land use density and transport need and ability. MoT official 2 considered that higher density urban development would reduce travel need:

> It's important to think about place. It's putting the money in X and putting facilities close to you, so you can access them more easily; and we need that; that's because the current development model we have is biased towards carbon-based activity. Even if you go back 40 and 50 years, facilities may have been smaller, but they were more numerous and allowed people to access them and that again links to land-use and transport.

This highlights the linkages between transport policy, urban form, and housing development and suggests favourable attitudes towards integrated land use and transport planning.

Alignment between these transport and land-use development objectives across different government institutions was, however, a major challenge to integrated planning (MoT officials 1 & 2). High associated infrastructure and urban form adaption costs also acted to deter efforts to increased density development (MfE official). Promoting increased land use density was considered less essential in the Wellington City area, and more so in surrounding regional suburbs and districts (WCC officer).

5.4.2 Transport Policy and Funding Structures

Regional and local level interviewees considered funding considerations principally constrained their ability to augment low-emissions transport within their respective remits. This was seen to result from overarching policy and funding structures:

> We [the GWRC] only fund a small part of [transport]. We pay for the public transport part, the city pays for all the city streets and city shaping and the NZTA pays for the state highway parts (and contributes to public transport, about 50% I think). So the NZTA only does half of the public transport funding (GWRC councillor).

Policy and funding frameworks were seen as pivotal because they ultimately dictated organisational roles and capabilities in relation to transport (GWRC officer 1). As evidenced in Chapter Three, regional and local level transport proposals thus required alignment with central level transport policy objectives:

> So NZTA exerts a lot of influence over WCC in terms of their availability of money for different types of projects and in terms of the subsidy rate, which changes as well with the GPS cycles. And then the other thing that happens in terms of funding our projects is our spending gets approved through the Regional Land Transport Plan. So that's how things get out from the NLTP, they need to get into our RLTP first. So that's a region-wide determining of our regional strategic priorities (WCC officer).

GWRC officer 1 noted that despite emerging policy shifts away from private vehicle prioritisation, change was - in their opinion - frustratingly slow. Similarly, large-scale infrastructure change was also considered non-conducive towards achieving short-term modal shift, as most significant public transport projects required decades of implementation and construction (MfE official). This suggests that aggregate installation timeframes factored into overall costs of PT provision in central level planning evaluation processes, with long-term benefits outweighed by concrete, short-term costs.

Local level interviewees noted policy and funding structures limited their avenues – namely pedestrian walkways, cycle and bus priority lanes – to address Wellington City's low-emissions transport, and revealed the limitations of local government entities (WCC Councillor, WCC officer). For example, improving the practicality of public bus services, which many respondents considered impractical and inconvenient, could only be directly

improved through bus priority corridor provision as route direction and bus station placement were outside of the WCC's remit. Policy "lock-in", where transport objectives from prior decades could still hold considerable sway in existing transport project investments, presented another challenge towards increasing low-emissions transport supply.

Funding alignment was also considered a challenge at the regional level:

> Our land transport management team talk about the priority of investment through the Land Transport Management Act and how those decisions are made and again that power is largely out of our hands as we're receivers of that funding. So we can say, well, we want to get everyone who comes into Wellington CBD [coming] via public transport, but the funding that drives that has to be conducive to achieving that. And that's set at the national level. So if you don't have alignment it's very hard (GWRC officer 1).

Even with alignment achieved, the financial burden of low-emissions transport infrastructure investment was considered significant, and to require a long-term institutional vision (VUW academic 2, GWRC officer 1). GWRC officer 2 considered this would be challenging as it would run counter to the predilections of central government institutions, which they considered experienced greater political pressure to deliver concrete results in a short timeframe. Institutional resistance to large-scale public transport projects was also seen as a product of central government agendas, i.e. decreasing national debt (GWRC officer 2). These cautionary tendencies were then reflected in regional council strategies, which acted to constrain investment in large-scale and/or long-term low-emissions transport infrastructure (GWRC officer 1).

Augmenting the route connectivity of existing low-emissions transport, namely bus and rail services, was considered especially challenging by regional and local governance interviewees. GWRC officer 1 stated that funding off-peak public transport services would require a significant influx of budget funding, which could not be procured through the GWRC alone. Interviewees also conceded that while providing greater connectivity (e.g increased service hours and access areas) was desirable, supplementary oversight and extension costs were largely incongruous with actual rises in patronage. MfE official noted that it remained difficult to predict and/or accurately measure how many

additional people would benefit from and/or uptake public or active transport services if they were procured, and thus these costs outweighed the perceived benefits of increased public and active transport expansion.

5.4.3 Governance Roles and Capabilities

Several interviewees acknowledged affordability could present a barrier to low-emission transport use, although levers to address cost constraints varied according to governance level. Interviewees recognised purchase price barriers could constrain domestic EV uptake, but stated direct central government subsidisation of EVs was unlikely (MfE official, MoT officials 1 & 2). Instead, indirect policies (e.g. the MoT's proposed vehicle fuel economy standard and a vehicle "feebate" scheme) were thus considered as primary levers for influencing the private vehicle market; the feebate scheme would operate as an effective subsidy for EVs (MfE official). MoT official 1 felt that EVs would become cost-effective in the long-term due to parallel trends in alternative technology (e.g. mobile phones) and technological improvements (e.g innovation in EV battery technology and design); this would thus incentivise EV uptake and overcome affordability barriers (MoT officials 1 & 2). Local governance interviewees had limited avenues to address cost barriers, although the installation of public EV charging infrastructure, was considered one such option as their use would be cost-free (WCC councillor, WCC officer).

At the regional level, reducing public transport costs ran counter to alternative agendas, such as the expansion of the GWR electric bus fleet, and addressing affordability was complicated by transport policy and funding hierarchies:

> Our aspirations here with the GWRC are to have a fully electric bus fleet, but we don't own the buses, they're owned by the operators who win contracts and therefore we have to negotiate, the contract has to cover the cost of their buying those electric buses which are more expensive than diesel buses. And if we pay more, nearly twice as much, where do we get that money from? Therefore, we have to increase rates which affects everybody but obviously those who are lower-paid are affected more than those who are higher paid. And we're trying to encourage people to use PT, but if we put the fares up we will discourage them from using PT (GWRC councillor).

Several interviewees discussed the need to consider convenience and practicality in low-emissions transport policy and planning. For instance, public EV charging structures were developed in part with the recognition that it was less practical for renters to install personal EV charging stations as opposed to homeowners (WCC officer). Another interviewee spoke to the challenges facing shift or service workers for whom public transport services would likely be considered impractical and unreliable given that their travelling would fall outside peak-time commute hours (NZCTU officer). Increasing the frequency and hours of availability of public low-emissions transport services, however, was clearly limited by governance capabilities and transport funding allocations as discussed in section 5.4.2.

Limited oversight capacity also presented a barrier to addressing relative factors, such as supply quality. GWRC councillor explained that, despite being tasked with overseeing the region's public bus services, the buses themselves are owned by operators with contracts with the GWRC. This means that a number of factors involved in the day-to-day operation of the buses fall outside regional council control. Therefore, the desire to increase the quality, reliability, and thus the practicality of using public bus services - including for those with young children - cannot be addressed through a single entity. On the whole, adapting services for the unique needs of particular demographics was not seen as desirable, as this could potentially alienate or negatively impact others (GWRC officer 2, WCC officer, MoT official 2, MfE official).

Historic cultural attitudes were seen to influence existing low-emissions transport demand. Achieving substantive behavioural shifts was seen to require considerable time and effort:

> Also, the cultural change, you know, you spoke about California's car culture and New Zealand is similar, we love cars, you know, we're very reliant on our cars and I think about the cultural transition that we had, say, away from smoking. Where, you know, smoking is seen as not cool anymore. But it took thirty years and a dedicated public health campaign, with concerted effort that was agreed by both political parties (MfE official).

In this sense, attitudes towards certain transport modes, such as familiarity, were seen to influence pre-existing tendencies towards private vehicle usage over public and active transport. There was no related discussion of how land-use and transport policy development could have influenced these cultural attitudes.

Most were unsupportive of increasing public involvement in policy design and decision-making, although one interviewee (VUW academic 2) felt this could provide an opportunity to incorporate diverse user-based needs and abilities in the transport policy process. This aversion seemed to arise from procedural complexity and resource constraints.

Another interviewee noted the tension between balancing community objectives and needs with overarching transport funding dynamics:

> A big part of the design is also the community objectives, so with the cycleway programme, to unlock funding with the NZTA, we need to follow NZTA's business approach and their evaluation of the costs and benefits using their methodologies. But then, just as important for us is actual alignment with the community's desired outcomes and objectives so all the options are scored against those as well, or at least after we've developed those objectives with community stakeholders (WCC officer 2).

5.4.4 Broader Sustainability Objectives

Pressure to rapidly reduce road emissions was widely acknowledged (MfE official, MoT official 2, WCC officer, WCC councillor, VUW academic 1). While several stakeholders cited the importance of addressing low-emissions transport along accessibility parameters (e.g. improving their practicality and promoting integrated land-use development), there was a notable tension seen between environmental and accessibility objectives (MoT officials 1 & 2, MfE official).

EVs were seen to present a tenable solution for maintaining accessibility while simultaneously contributing to emission reduction targets. Several stakeholders cited the overall efficiency of EVs – short-term transition times, high substitutability, and relative cost – which made them (in their view) the most effective low-emissions transport mode

to decarbonise the GWR transport sector (MfE official, MoT officials 1 & 2, WCC officers 1 & 2). In the context of climate change, public and active transport were considered less effective:

> It's one of those things where I would love to make greater use of PT and we will, but I feel we've missed the boat to do it as well as other countries have… I think about the cultural transition that we had say, away from smoking where you know smoking got to be seen as not cool anymore. It took thirty years and our dedicated public health campaign… We don't have thirty years, we need to reduce our transport emissions quicker than that (MfE official).

MoT officer 1 supported promoting accessibility in transport policy and planning but stated there needed to be moderation in the degree to which it was considered (i.e. the desire for paradigm shift should not preclude the addressing of additional factors, such as economic prosperity and resilience, and security). Some interviewees also noted that a preoccupation with accessibility-based planning could lead to significant policy delays and/or the inability to adequately facilitate a transition to a low-carbon transport sector and wider economy (VUW academic 1).

5.5 Results Summary

Both quantitative and qualitative data collected in this study revealed a range of factors influencing low-emissions transport provision and use in the GWR. While some influencing factors were particular to individuals and/or to minor subsets of GWR transport users, common themes emerged from survey participant responses and stakeholder interviewees. These predominantly fell under the following:

(i) access to low-emissions transport options;

(ii) route connectivity;

(iii) cost;

(iv) speed/travel time;

(v) convenience/practicality; and

(vi) external environment.

Transport demand and travel pattern survey data suggest that endogenous factors, such as user-based needs and abilities and trip purpose, strongly influence modal use and frequency. For example, practicality – the ability of the transport option to provide access in reasonable time, at reasonable cost, and with reasonable ease – was the strongest predictor of low-emissions transport use ability. Speed and/or overall travel time was also a principal determining factor in participants' transport choice.

Among stakeholder interviews, thematic analysis revealed transport policy and funding frameworks and historic land use patterns and urban development significantly constrained the ability to address low-emissions transport. The limitations of governance roles and capabilities, as well as the potential tension between broader sustainability agendas were also characterised as primary challenges. These barriers contributed to a notable resistance to and/or only partial endorsement of accessibility-based planning measures.

Comparisons of qualitative and quantitative data findings reveal the intersections between transport users and suppliers, and their linkages to several accessibility parameters. For example, land-use factors (e.g. topography, historical urban development and transport planning) were characterised as a significant impediment to both low-emissions transport use and provision.

The following chapter offers as a subsequent discussion of these results, as well as the limitations of this research and its contributions. Recommendations for future research and policy development are also included.

Chapter 6. Discussion and Conclusion

The purpose of this research was to investigate factors influencing GWR residential low-emissions transport use. Informed by an accessibility-based framework, the research aimed to address the following four research questions:

(i)   What factors influence existing patterns of transport demand among GWR households?

(ii) Among GWR residents, what explains ability to use low-emissions transport?

(iii) How do GWR residents rate their ability to use low-emissions transport, and what factors influence their uptake of low-emissions transport?

(iv) What do key stakeholders perceive are the challenges of addressing GWR low-emissions transport demand, and what are their attitudes towards accessibility-based planning measures?

This chapter is structured in order of the four research questions listed above, in parallel to Chapter Five. The research questions are addressed by discussing the most pertinent results presented in Chapter Five, in conjunction with the relevant literature and conceptual framework as presented in Chapter Two. The consequent limitations of this thesis are then addressed, and avenues for future research considered. This chapter concludes with some insights that may be useful for policymakers to consider.

6.1 Summary of Research Findings

6.1.1 GWR Transport Demand and Travel Patterns

Modal Use and Frequency

Several quantitative findings relate to modal use and travel patterns outlined in regional transport studies. The majority of respondents travelled to work or study by private vehicle, which is consistent with 2015-2017 New Zealand Household Transport Survey and 2013 Census JTW data (MoT, 2018a; GWRC, 2013). However, participants were twice

as likely to access activities outside of their daily commute by private vehicle. This factor of two suggests trip purpose plays a significant role in transport modal choice.

This challenges conventional transport planning paradigms – namely mobility— which have prioritized analysing patterns of movement between trip origins and destinations (Halden et al. (2005). This finding acknowledges the importance of understanding user-based needs and travel motivations, and conforms with studies which assert identifying key opportunities is a necessary prerequisite in the transport policy and planning process (Litman, 2019; Banister, 2018; SEU, 2003). It is worth noting that surveying modal use across a wider range of trip purposes (e.g. leisure, sport, and medical needs) could have resulted in different data findings.

Participants were almost four times as likely to travel to work or study via public transport than for trips outside this daily commute. Qualitative survey data provided additional insight into linkages between trip purpose and modal characteristics. For example, respondents considered bus services were more reliable during peak-commute hours (they ran more frequently and consistently), than during non-peak hours. Bus services were also perceived to facilitate better direct access during peak commute hours. This trend is reflected in the literature, particularly case studies on the linkages between reduced public transport access and dependence on private vehicles to access to desired destinations during non-peak travel hours (Rose et al., 2005; SEU, 2003).

Almost a quarter of respondents reported walking or jogging to all activities on average. As the majority of respondents resided in Wellington City, this would suggest the influence of Wellington City's compact urban form. This is consistent with Litman (2003) and Ding et al. (2017), who assert the positive influence of connective urban geometries on walking. It is expected that greater representation from other GWR districts – with less concentrated urban form—could have resulted in lower reported levels of walking or jogging.

Determining Factors for Transport Choice

The highest percentage of participants reported that speed/travel time factored into transport choice. This would suggest participants are more likely to use low-emissions transport if modes and services satisfied certain speed and travel time requirements; and

signifies the influence of spatial and temporal factors in transport demand and travel patterns (SEU, 2003; Halden et al., 2005).

However, respondents might react differently if each variable was presented separately, as opposed to treating speed and travel time as a combined factor. This makes it difficult to assess whether respondents considered speed, travel time, or both, as having equal or varying importance in their transport decision-making process.

If a majority considered modal speed more important, this data might – at least superficially – support the continued use of conventional mobility evaluation paradigms, which promote efficiency gains through measures such as highway expansion. In contrast, if travel time factored more highly into transport choice, this would support including temporal assessments – an accessibility parameter – in transport policy and planning. For instance, the Spatial Network Analysis for Multi-Modal Urban Transport Systems uses contour catchments – the geographical range which users can cover by public transport within a particular time frame – as a primary method to evaluate regional public transport network performance (as cited in Litman, 2019). These efficiency measures also risk the "rebound" effect, whereby travel speed improvements engender corresponding increases in travel demand, eventually leading to increased congestion and travel speed reductions.

Studies consistently find that perceptions of travel are often informed by time, as opposed to speed (Litman, 2003; Boulange et al., 2017; Chapman, 2018; Manaugh & El-Geneidy, 2013). Walking to the local dairy may well be more attractive than driving across town to a supermarket. For these reasons, participant responses could also be interpreted as suggesting the significance of overall travel time in transport choice. This would favour considerations of overall travel time over speed and support the application of an accessibility-based framework, particularly as this approach prioritises analysis of whether or not people can get to key services in a reasonable time and does not necessarily favour longer trips with faster modes if shorter trips and slower modes provide adequate access (Litman, 2003).

While the data could be interpreted to suggest that participants considered driving a private vehicle as the best means of accessing their desired end destination within a

reasonable time, it is ambiguous as to how the appetite for private vehicles would be affected if alternative, lower-emitting transport modes provided access in similar time. The data does not reveal whether participants would rank factors differently if two or more variables were combined (e.g. cost and reliability; route connectivity, emissions-intensity, and travel time). In this sense, an accessibility-based planning is well suited to address this complexity in its accommodation of singular and composite transport demand factors.

Over a third of respondents who ranked sustainability and environmental impact among the top three deciding factors in their choice of transport nevertheless drove a private vehicle to work or study and other activities. This suggests that pro-environmental behaviour and/or personal altruistic desire does not correspond directly to the use of low-emissions transport modes or services. This is consistent with the value-action gap as evidenced by Nilsson & Küller (2000), who found that environmentally sound travel behaviour is one of the most difficult pro-environmental values to promote.

The survey findings also indicate an influence from additional variables – route connectivity, cost, reliability, safety – on transport choice. This suggests that it will remain insufficient to improve low-emissions transport modes and services according to singular measures, such as increased supply or speed, and supports the need for a multi-dimensional approach to transport service provision. Transport behaviour is patently informed by more than one factor.

These findings suggest that any increase in uptake of GWR low-emissions transport is unlikely if existing or introduced services are unable to facilitate access to key opportunities in accordance with multiple accessibility parameters. This accords with the literature (Banister, 2018, Halden et al., 2005; Handy, 2002; Litman, 2003).

6.1.2 Predictors of Low-emissions Transport Use Ability

The strongest positive predictors of an above-average ability to use low-emissions transport were the practicalities of using both public and active transport. The more positive their perceptions of active and public transport practicality, the more participants were likely to have a greater overall ability to use low-emissions transport.

Practicality was defined as "if it gets you to where you need to go at reasonable cost, in reasonable time, and with reasonable ease" which was informed by the SEU's (2003) definition of accessibility. Findings here suggest:

(a)   that whether the GWR's low-emissions transport facilitated access along these three principal parameters factored significantly in the respondent's perceived ability to use these services; and

(b)   by extension, the converse, whereby lesser perceptions of practicality are associated with a lesser ability to use low-emissions transport.

These findings applied to all respondents, and so can be extrapolated to the wider case study area. This provides policymakers with a targeted measure that could indicate improved access ability across a wider range of user-needs and contextual factors.

These findings support the need to address the practicality of existing and future low-emissions transport services (Banister, 2018; Pyrialakou et al., 2016; SEU, 2003). This predictive relationship is consonant with a pre-eminent transport sector emissions reduction strategy, Avoid-Shift-Improve (see section 2.5.3), encouraging, first, trip avoidance and then modal substitution, or shifts to low-emissions transport modes and services. An accessibility-based transport planning approach supports this by prioritising improvements to the quality of available modes and services to increase their overall practicality and uptake (Deakin, 2001; Banister, 2018, SEU, 2003).

Area of residence was also found to directly affect low-emissions transport use ability. Participants from the Masterton district generally had comparatively lesser abilities to use low-emissions transport than their Wellington City counterparts. Any additional factors contributing to this relationship are unclear. Variable transport service distribution, modal use, and population density throughout the GWR could suggest these differences result from inter-district variance in land-use and transport development. This finding aligns with literature maintaining the importance of land use and modal integration for transport demand and travel patterns, particularly distances to low-emissions transport modes and services and between opportunities (Litman, 2003; Banister, 2018; Deakin, 2001).

Cost barriers are commonly framed as a transport demand and travel constraint, with implications for transport disadvantage and social exclusion. The wider literature maintains that household income can significantly restrict individuals in their choice of transport, particularly among low-income households (Berry et al., 2016; Mullen & Marsden, 2016; Banister, 2018).

However, regression analysis did not elucidate any predictive significance between the respondent's reported ability to use low-emissions transport and their level of weekly or annual household income. The conforms with regional travel perception data, which found that the cost of running a private vehicle did not appear to be a significant trigger for modal shift, and that there were other factors involved rather than solely economic ones (Horizon Research, 2019).

This variance could arise from a lack of specificity in regard to the survey category, "low-emissions transport." Participants may have responded differently if asked to separately rate the affordability of different low-emissions transport modes and services. Doing so could have clarified the impact of cost. Mullen and Marsden (2016) found socio-economic status to constrain EV use. Here the dependence on self-reported data may have skewed the accuracy of participant responses, which may not be particularly reliable when it comes to cost barriers.

Bivariate analysis also revealed correlations underscoring the importance of the diversity of personal constraints across GWR households.

(a) A weak negative correlation between approximate household weekly income and rated practicality suggests that the practicality of using active transport decreases with income level. This could partly reflect the fact that participants with higher household incomes tend to have larger household sizes, which often include children.

(b) A slight negative correlation between the respondent's household member size and the practicality of using active transport suggests that the practicality of using active transport has an inverse relationship with household size. Both correlations (a and b) are consistent with Ding et al. (2017), who found that Baltimore

travellers from households with more members and higher incomes tend to travel longer distances, and travel by private vehicle.

(c) A strong negative correlation between average daily commute distance and the rated practicality of using active transport is consistent with studies demonstrating the influence of travel distance on travel mode choice (Ding et al., 2017; Litman, 2003). It remains inconclusive whether additional variables influence this relationship, although related factors are discussed in section 6.1.3. It can likely be inferred that slower average travel speeds and greater physical ability requirements, when compounded with a longer travel distance, correspond to lower use of active transport, in part due to the inability to facilitate access to work or study in reasonable time.

(d) A weak negative correlation between the rated practicality of using active transport and participant age suggests that as age increases, the overall practicality of accessing opportunities by walking or cycling decreases. This is congruent with *Travel Perceptions Survey 2019* data*,* which found perceptions of walking as a viable transport option tended to decline with increasing age (Horizon Research). In contrast, Ding et al. (2017) found that compared to middle-aged travellers, older travellers are more likely to choose transit, walking, or cycling. This dissonance could arise from the GWR's steep topography and higher average physical ability requirements for walking and cycling compared to the relatively flat Baltimore metropolitan area in the case study of Ding et al. This suggests land use, particularly land-use mix and walking conditions, influence transportation system performance and user uptake (Litman, 2003). Furthermore, this supports the need to consider age and physical ability in a low-emissions transport sector transition (Banister, 2018; SEU, 2003).

6.1.3 Primary Factors Influencing Low-Emissions Transport Use

As discussed in the Chapter Five, six primary factors were seen to influence respondents in their ability to use low-emissions transport:

(i)   access to low-emissions transport options;

(ii) route connectivity;

(iii) cost;

(iv) speed and overall travel time;

(v) convenience and practicality; and

(vi) The external environment.

This section discusses each theme in turn, although some overlap among variables is addressed. It should be recalled that survey participants were only asked to select whether or not each factor influenced their use of low-emissions transport. Given that barriers were not comparatively ranked, a higher selection rate does not suggest a higher relative importance, only a greater response frequency.

Access to Low-Emissions Transport Options

Access to low-emissions transport is critical: limited or no access was the most frequently cited variable reported to influence respondents' ability to use such transport. Despite Wellington City having a greater supply of low-emissions transport services than other GWR districts, the majority (70.8%) of those who indicated limited or no access to low-emissions transport resided in the City. This is not necessarily in contradiction to Horizon Research's (2019) survey finding that bussing and walking were more frequently used to get to work or study in Wellington City than other parts of the region. A more detailed survey of the respondents' residence locations – that is, their neighbourhood or residential address – could provide further insight into these factors as it would allow assessment of public and active transport modes, services, and infrastructure in respondents' immediately surrounding area.

It is perhaps surprising that most respondents with high reported access to active transport options nevertheless drove a private vehicle for their average access needs, although a significant proportion walked to work or study. However, land use and physical transport infrastructure, including the absence or limited availability of pedestrian walkways and cycle lanes, clearly matter for active transport uptake and wider perceptions of low-emissions transport use ability. Qualitative responses make clear that perceptions of limited access to low-emissions transport services are associated with

both the existence *and* nature of infrastructure and other supply factors. This is explored further in the *external environment* section.

Limited or non-existent EV charging infrastructure was also reported as a significant constraint. It may be that technology (or lack thereof) functions as an access-related factor in low-emissions transport use, although several responses signify that affordability factors significantly into GWR EV access. Jing et al. (2017) find that EV requirements, such as the location of public charging stations, clearly affect transport behaviour and travel patterns. de Hoog et al. (2013) found that in Melbourne, increased EV uptake resulted in significant demand on low voltage (LV) distribution systems, which suggests that insufficient grid capacity could limit low-emissions transport access in a (likely) future scenario of GWR EV expansion, unless, for instance, rooftop solar photovoltaic expands along with EV uptake.

Access constraints also relate to the nature of public versus private transport infrastructure and service provision. The distribution of public buses, trains, and ferry services is contingent on procurement and oversight, predominantly by central government institutions. It is reasonable to expect that inadequate infrastructure supply or service limitations would inhibit an individual's overall use of low-emissions transport: private citizens have little control over the provision and distribution of public transport services. This suggests the importance of increasing public involvement in transport policy and planning in order to more effectively recognise the population's diverse needs and abilities, supporting Hickman and Banister's (2014) argument for greater public participation in the development of "new types of travel futures."

Route Connectivity

Insufficient route connectivity was another commonly reported barrier. This suggests that street and service network connectivity plays a critical role in GWR transport demand. Connectivity between user origins and end destinations was considered adequate for daily commuting to work or study but largely insufficient for access to destinations and opportunities outside of work or study. This is consistent with research on network connectivity and land-use mix. Litman (2003) found that an increase in roads or paths that connecting geographic areas allowed more direct travel, and that locating different

types of activities close together, such as shops and schools contiguous to residential neighbourhoods, reduced the amount of travel required to reach common activities. Ding et al. (2017) found that that mixed development was substantially correlated to more travel by public transport or walking and cycling. These patterns are consistent with the 'avoiding (vehicle) trips' part of the Avoid-Shift-Improve hierarchy identified above.

This also suggests that problems of low-connectivity result in higher levels of private vehicle use, implying a higher perceived connectivity for the latter, partially due to fewer transfers and less fragmented travel. This aligns with studies on automobile-oriented land use, which find that destination dispersal results in increased dependence on private vehicles (Bertolini et al., 2005; Litman, 2003; Ewing et al., 2011). Ding et al. (2017) also found that private vehicle use has an inverse relationship with street network connectivity. This may arise from increased connectivity providing a better walking and cycling environment; and/or because households living in well-connected neighbourhoods own fewer private vehicles on average.

Many respondents reported that low connectivity decreased the overall practicality and ease of using public and active transport services. This is consistent with Rose et al. (2009), who found that domestic public transport was primarily designed to run radially between city centres and peripheral suburban locations, and that this compounded access difficulties for people travelling to cross-town destinations. This suggests the influence of historic land-use development and urban transport planning, which is explored further in section 6.1.4.

Cost

Cost concerns stimulated a diverse range of survey responses. Several participants noted that existing public transport fares were approximately equal to, if not more expensive than private vehicle petrol costs (e.g. if the participant car-pooled). These responses are consistent with regional survey data showing that residents travelling to work or study by private vehicle regarded the cost as cheaper than or similar to public transport (Horizon Research, 2019). This suggests that factors other than cost also motivate transport choice.

However, these findings could have resulted from a lack of specificity around cost considerations. Rodrigue and Notteboom (2017) find that motorists have a bias toward

focusing on short-run marginal costs. It is therefore possible that survey respondents responded solely with short-term cost considerations in mind (e.g. petrol costs, public transport fares). If asked to consider long-term costs (e.g. upfront vehicle costs, ownership and registration fees, depreciation and maintenance), it is likely that private vehicle costs may have been understood as higher (Litman, 2019).

Although income was not found to be a significant predictive factor in low-emissions transport use ability, several participants noted that combined characteristics, such as physical ability and the external environment, also influenced their perceptions of affordability. One participant's desire to cycle to work was limited by steep topography and low physical fitness. Electric bicycles were considered a viable option to overcome these limitations, consistent with findings from Lovejoy and Handy (2012). However, high purchase costs deterred this participant from making this modal shift. Subsidies of active transport modes or rental schemes could assist in overcoming cost-barriers and encourage shifts towards modes perceived to give relative ease of access.

While the majority of survey respondents stated that they would be willing to pay more for transport if it produced less carbon emissions, most were only willing to do so if the service was both practical and convenient and the cost burden was shared equitably. This is congruent with Bertolini et al. (2005), who found that while travel costs significantly influenced transport behaviour, the number and diversity of places or activities that could be reached within a given travel time was equally influential.

Speed/Travel Time

As discussed in section 6.1.1, speed and travel time were consistently reported to significantly influence participants' transport choices, but their combination for purposes of the survey left ambiguous their individual influence.

Qualitative survey responses allowed greater insight into whether speed or travel time was more significant in guiding decision-making. Many responses consistently referenced the average speeds of low-emissions transport modes and services, yet speed was seen as a function of travel time as opposed to an isolated variable. Overall travel time factored more into transport choice and travel behaviour.

This is consonant with behavioural research by Bertolini et al. (2005), which found that travel time, rather than travel distance, acted to significantly influence transport demand, particularly in the form of total daily travel time budgets and travel-to-work time budgets. An isochronal map of the Greater Wellington transport system could supply insight into the time needed to travel from particular origins using low-emissions transport; however this was not readily accessible at the time of this research.

Convenience/Practicality

Supplementary written responses revealed that inconvenience and impracticality of access to opportunities by low-emissions transport weighed heavy in transport choice. This aligns with the findings in section 6.1.2 and studies confirming the significance of "reasonable ease" in influencing transport choice and behaviour (Halden et al., 2005; Banister, 2018; SEU, 2003; Litman, 2003; David Simmonds Consultancy et al., 1998; Ross, 2000, as cited in Halden et al., 2005).

Perceptions of convenience and practicality stem from individual needs and abilities. While several participants considered public and active transport as impractical, their rationales differed. Service reliability and route connectivity were of greater priority among respondents with young children, who were less likely to use public and active transport, due to their perceived lower practicality. This is in keeping with the conclusions from Ding et al. (2017), who found the number of household children to have a significant negative effect on the use of public transport, walking, and cycling. *A fortiori,* the Joseph Rowntree Foundation's research (2012) found that, irrespective of residential location, UK families with children perceived car ownership as essential, due to specific access needs as well as inflexibility and unaffordability of public transport (as cited in Mattioli, 2016).

Specific employment responsibilities also influenced perceptions of practicality. For these respondents, reliability factored heavily in transport choice, although service frequency was considered more important than connectivity (reported among those with young children) due to higher values ascribed to predictability and consistency of timings. Some respondents also felt that external appearance requirements precluded cycling to work, despite their desire to do so. This is consistent with the finding by Simons et al. (2013)

that many Belgian commuters opted out of cycling because they did not want to arrive sweaty to, and/or did not have showers at, their offices (as cited in Ryan, 2018).

Across both groups, private vehicles were considered more practical and convenient, although their relative utility derived from differing user-based needs and abilities. Private vehicles accommodated multi-trip travel and allowed access to several destinations for participants with young children (school drop-off zones, day-care services, after school activities), in less time than alternative modes. For those with employment responsibilities, private vehicles offered greater reliability and consistency of arrival time. This accords with findings from Badland et al. (2010), that work-related travel behaviours are strongly associated with convenience and practicality. Further, it seems that for *non*-work trips, GWR residents usually see private vehicles as more convenient and practical. A related but larger issue is whether using vehicles leads to an increase over time in expectations of access to more distant services.

In the present study, additional variables, such as proximity and the external environment, also influenced perceptions of practicality and convenience. Longer distances between transport origins and destinations lowered the perceived practicality of certain modes. This suggests that convenience and practicality depend on multiple and often overlapping external contextual factors as well as unique user-based needs and abilities. This is consistent with the findings of Manaugh and El-Geneidy (2013) and Boulange et al. (2017), that factors including the personal characteristics of households and individuals, neighbourhood layout and dynamics, and the built and natural environment, all influenced transport behaviour.

Moreover, it is a reasonable conclusion from the literature (SEU, 2003; Banister, 2018; Litman, 2019) that transport behaviour in the GWR is ideally addressed by improving access to key opportunities in terms of reasonable ease, reasonable time, and reasonable cost. Policymakers must consider whether modes and services will facilitate access in a practical, convenient and affordable manner. This necessitates detailed distributional impact assessments and public consultation and/or participation in the policy design process.

External Environment

Several external environmental factors were reported to influence low-emissions transport use ability. A number were endogenous to land-use patterns and conform to studies recognising the influence of the built environment and land use patterns in transport choice and travel behaviour (Litman, 2003; Banister, 2018; Ding et al., 2017). Common sub-themes included perceived safety, topography, and weather conditions.

Most respondents reported above-average access to active transport infrastructure, but many found walking and cycling conditions to be inimical to reasonably safe and convenient use of active transport. Cycling itself is not intrinsically dangerous, so this finding likely speaks to the influence of external transport behaviours, such as motorists' attitude towards cyclists. This would be congruent with research by Jacobsen and Rutter (2012), who found that the danger arising from motorised traffic was the principal deterrent to cycling.

Several respondents indicated that they would be more likely to take up cycling to work if safety conditions improved. Safety perceptions loom large in extant literature; for example, Holman et al. (1996) found that the lack of continuous footpaths and cycleways in Perth, Australia was a notable deterrent to their usage (as cited in Ryan, 2018). Interestingly, a 2019 GWR transport survey stated that perceptions of cycling safety rose by 8% over approximately a 15-year period (Horizon Research). This change could arise from the (modest) improvements in cycling infrastructure across the GWR, but also random variance, given survey sample sizes. Although the GWRC RLTP aims to improve and provide more cycle lanes, infrastructure improvements remain fragmented, with limited route connectivity and limited protection from motorists, particularly along State Highways 1 and 2.

Qualitative survey responses also revealed that participants would be more likely to walk if walking conditions (e.g. pedestrian walkways, external amenities) were improved. Similarly, Litman (2003) found that walking conditions have a major impact on perceptions of the transportation system, and that walkability can positively influence the perceived accessibility of a transport mode. Improvements in walkability are also found to positively correlate with uptake of public transport generally (Boulange et al., 2017). This suggests that walkability improvements are a relatively direct (and

accessibility-aligned) solution to increase uptake of active *and* public transport, with measures including increased street-lighting, foliage, and amenities. However, despite their simplicity, these measures are often costly. For example, Gunn et al. (2014) found that the cost of retrofitting sidewalks was 50% higher than the initially installation, although average roading installation and maintenance costs often prove equally, if not more, expensive (as cited in Boulange et al., 2017). Litman (2003) cautions against skewed comparisons of cost efficiency between road and active and/or public transport improvements, arguing for the need to estimate the full incremental costs of each option. This suggests policymakers are more likely to accept the high-upfront costs of urban sidewalks and/or public transport services if roadway expansion costs are comprehensively evaluated – that is, the additional costs of motorised transport are adequately considered (e.g. parking spaces, road maintenance, and traffic oversight).

Gender also factored into participants' transport behaviour. Female respondents more commonly reported that safety concerns deterred their use of public and active transport, particularly at night. This finding could have resulted from an uneven survey response sample. The majority (76%) of respondents identified as female, as opposed to male (23%) and non-binary (1%). These findings are nonetheless consistent with studies on the gendered dimension of transport choice. Ng and Acker (2018) found that in eight different cities, gender factored more into modal choice than age or income; and the International Transport Forum (2020) explicitly states that women often prefer driving, where available, over walking, cycling, and public transport, for safety reasons.

Topographical constraints were also reported, often in conjunction with issues relating to physical ability. Even if treated as wholly orthogonal, these factors were significant. Their combined influence on perceptions of reasonable ease attributed to low-emissions modes, namely active transport, was major. This is consistent with studies demonstrating that the realities of transport behaviour complexity demand planning frameworks capable of addressing composite variables, as opposed to singular measures (e.g. speed and/or service frequency) (Litman, 2019; Ding et al., 2017; Mahmaud & El-Geneidy, 2013; Boulange et al., 2017).

Possible solutions involve promoting land-use and mobility developments designed to increase land-use mix, network connectivity, and density., These measures can address

both topographical constraints and limited physical ability, by reducing the need to travel longer distances. Such policies support the use of an accessibility-based planning framework. However, certain barriers, such as severe physical limitations and topographical factors, can present insurmountable access challenges to those without private vehicles or motorised assistance.

6.1.4 Challenges of Accessibility-Based Planning

The literature indicates that different perspectives produce different conclusions on transport issues (Litman, 2003; Boulange et al., 2017). In the present study, stakeholders raised four primary challenges associated with using accessibility-based planning measures to address low-emissions transport demand in the GWR:

(i) *land use and urban development*;

(ii) *transport policy and funding structure*s;

(iii) *governance roles and capabilities*; and

(iv) *broader sustainability objectives*.

Although several challenges raised by stakeholders aligned with participant responses, there were notable differences. This hints at a disconnect between user-based and supply-side access objectives. While most respondents noted the need for more practical low-emissions transport modes and services tailored to their particular needs, stakeholders made clear their desire for increased uptake across the wider regional population, as opposed to specific groups.

Stakeholders consistently referenced the influence of land use and urban development on existing levels of low-emissions transport use. This aligns with studies outlining the impact of land use planning on transport demand and travel patterns (Litman, 2003; Banister, 2018), and the sustainability of the transport sector (Chapman, 2018; Banister, 2005). Several stakeholders argued that historic discrepancies between land use and mobility development constrained their ability to augment low-emissions transport via accessibility-based measures (e.g. increasing the number of available low-emissions transport services and modes, improving route connectivity, and increasing proximity to goods and services).

At the central level, many stakeholders perceived infrastructure costs associated with the supply and expansion of low-emissions transport to be high, due to a need to address existing land-use constraints. This was one of the reasons underlying stakeholders' focus on increasing EV provision as opposed to alternative modes. This suggests that mobility-based augmentation of low-emissions transport is still preferred over accessibility-based measures, as policy choices are often informed by a relative cost-benefit calculus, however roughly estimated. This apparent institutional attitude is congruent with findings on transport funding in the UK, where fiscal allocation to rail was consistently framed differently ("expenditure") compared to the roading sector ("investment") (Vigar, 2002).

It may also reflect a short-term cost-benefit approach to transport planning. Evaluated over a longer period, with a lower discount rate, the potential long-term benefits of accessibility-based planning measures are more likely to equate to or outweigh the short-term high costs of capital expenditures. Moreover, with the exception of rail, the infrastructure costs of active modes may well be lower than those of roading expansion, which EV investment may entail. This aligns with research by Rein and Schon (1993) which demonstrates that fundamental conflicts between frames of reference occur as the frames themselves determine validity in policy discussions (as cited in Vigar, 2002).

Interviewees also stated that changing GWR transport behaviour would require shifting land use towards higher density development, and that these measures would require alignment with agencies external to transport. Without explicitly mentioning any specific sector(s), several officials acknowledged the need for coherence between transport, land use, and housing development. There was little discussion of tangible cross-sectoral engagement (e.g. with the new (2019) Ministry of Housing and Urban Development) or solutions for consensus and partnership.

This suggests that the need for trans-sectoral alignment detracts from the feasibility and/or appeal of accessibility-based planning measures. Research on governance barriers to policy and planning complementarity supports this inference. Banister (2005) states that many policies designed to encourage shifts towards low-emissions transport relate to a single sector, rather than to more general policy objectives or cross-sectoral

implementation. The UK's Integrated Transport Policy White Paper (1998) found that cross-sectoral alignment was stymied where individuals and organisations had conflicts of interest, objectives, and time-scales, and communicated ineffectively (as cited in Banister, 2005). Vigar (2002) also found that a failure adequately to integrate policy communities meant that land use planners seemed equivocal about the design and implementation of transport policy, and undermined decisions made within their own policy community. Achieving greater complementarity would require re-designing aspects of the current policy and resource allocation process. This could prove challenging, although more meaningful promotion of cross-sectoral policy integration could promote more consistent and efficient decision-making across the wider public sector.

As outlined in Chapter Three, the transport policy and planning process is hierarchical, and it was clear that misaligned policy objectives across governance levels deterred regional and local policymakers from incorporating accessibility-based planning measures. This is consistent with studies outlining the crucial need for alignment between government transport strategies and funding, as well as, in practice, their frequent fragmentation (Halden et al., 2005; Rose et al., 2009; Banister, 2005).

Halden et al. (2005) found that applied accessibility measures must be closely related to relevant policy decisions at each administrative level, which underscores the multi-level nature of transport policy and planning. Banister (2005) concluded that effective implementation of sustainable urban transport policies requires improvements in institutional co-ordination and co-operation, so that decision-making can take place vertically (between all levels of government) and horizontally (between sectors: land-use, urban development, transport), and that consistent and integrated frameworks are essential for finance and investment issues and the fair allocation of funding.

Regional stakeholders supported expanding the route connectivity, reach, and frequency of public and active transport services, but perceived any extension of service hours (for off peak commuters) as neither desirable nor feasible. Cost considerations seemed to underlie this stance, mirroring central-level perspectives. Efficiency concerns also

contribute to this resistance. If insufficiently used, the additional cost of newly extended services could outweigh their marginal benefits.

This could explain interviewees' perceptions of high risk associated with incorporating accessibility-based planning. Such measures often require multiple developments in order to have a tangible impact on transport behaviour. Sustaining the operation of bus services during non-peak hours could necessitate increased land-use density and composition diversity, to increase the reach and proximity of extended mobility services and encourage uptake. This is consistent with Banister's (2007b) conclusion that sustainable accessibility-based policies require combined measures to achieve greater success.

While many stakeholders characterised the costs of expanding and improving low-emissions transport infrastructure and services costs as substantial, regional and local policymakers expressed the most frustration with the hierarchical nature of transport policy and funding procedure. They explained that bids for new transport-projects and/or regional and local-level infrastructure improvements were required to adhere to the central level funding framework, the NLTP Investment Assessment Framework (IAF). Because the 2018-21 NLTP IAF must give effect to the 2018 GPS on Land Transport, funding allocation ultimately conforms to targets and investment priorities dictated by the central government's overarching transport policy strategy (NZTA, 2018a; New Zealand Government, 2018).

While improved urban access to opportunities is a core strategic priority in the 2018/19 GPS (see Chapter Three), local stakeholders noted that proposed transport projects and funding bids had to demonstrate commitment to three additional objectives: safety, cost-effectiveness, and environmental sustainability. Consequently, accessibility-based development priorities may be diluted by the GPS' additional objectives. This would echo Banister (2005), who states that differing agendas and priorities can mean that certain issues, such as the needs of transport users with young children, are deemed unworthy of individualised action. Moreover, this finding points to the fundamental conflict between evaluative frameworks. Meaningful promotion of inclusive access entails the use of an accessibility-based planning framework, but economic considerations would

likely require cost-benefit analysis. Environmental sustainability could require yet another evaluative framework.

This issue has previously been noted by Hajer (1995), who found that a partial absorption of "new" or non-traditional transport objectives (accessibility-based planning measures) into existing UK policy paradigms failed to cohere into anything meaningful (as cited in Vigar, 2002). Bertolini et al. (2005) found that integrating accessibility objectives required signifying overt connections to national policy goals. This meant, for example, signalling their ability to fulfil or contribute to 'economic functionality', such as granting firms greater access to potential employees and customers, or citizens with increased jobs and services, and 'equity' (ensuring a more equitable distribution of access to opportunities). Future policy complementarity between GPS objectives and accessibility parameters, as opposed to trade-offs, is thus desirable.

Interviewees also expressed that the GPS' accessibility-oriented objective represented a significant, but notably recent, shift in transport policy and planning prioritisation. Prior policy inertia may have resulted partially from institutional reluctance to break from traditional planning paradigms, particularly at the central level. This is congruent with Vigar (2002), who found that resistance to transport planning shifts often arose from entrenched policy practices and the traditional framing of transport problems.

Local-level interviewees supported enhancing the GWR's multi-modal land mix through railway or cycle lane expansion. However, entrenched policy practices meant certain aspects (e.g. health and safety benefits) were valued over others (e.g. local amenity and walkability improvements). This indicates a difficulty in shifting policy practices and framing at the local and regional levels, with institutions often required to sacrifice small-scale or community needs in order to adhere to central policy objectives.

Conventional cost-benefit frameworks were seen to run counter to several accessibility-based planning parameters. This could explain why several stakeholders considered EVs to be the principal low-emissions transport option – EVs score "higher" under such evaluation. This is consonant with Rein and Schon (1993), who found that fundamental conflicts between evaluative frameworks arose because the frameworks themselves were determinative of validity in policy discussions (as cited in Vigar, 2002). This

argument would rationalise the deflection of accessibility-based measures which may appear comparatively less cost-beneficial.

High-capital transport investment cost perceptions were also seen to underlie a general inertia in the sector, and to influence transport policy, funding frameworks, and governance roles and capabilities. In contrast, under wider frameworks, such as the Wellbeing Budget (The Treasury, 2019) or Living Standards Framework (The Treasury, 2018), and giving precedence to accessibility, health and climate change considerations, public transport services could score comparatively "higher" by improving access to a wider range of transport users, and offering more equitable and sustainable alternatives.

Banister (2005) asserts that effective governance requires a strategic framework within which long-term objectives can be pursued at all levels of decision-making, by all actors, with all necessary powers and resources. Yet several interviewees reported that short-term policy agendas and governance procedures made it difficult to achieve long-term outcomes. Accessibility-based planning might run counter to existing policy procedure, as such measures are distinctly long-term, involving adapting land use and large-scale infrastructure. Political factors, such as a three-year election cycle, were referenced as a related constraint. An independent entity, mimetic of the Climate Change Commission, was suggested as a possible solution.

While several stakeholders considered that improving low-emissions transport services in line with an accessibility framework could reduce private vehicle dependency, others were less enthusiastic. A notable tension arose from the pressure for rapid mitigation of road transport emissions. Even those supportive of accessibility-based planning felt that such measures (expanded public and active transport services, integrated land-use) would generate insufficient short-term reductions. (The rapidly rising value of such reductions was not, however, noted). These concerns linked to those previously noted, particularly on land use and urban form, many of which required long-term interventions. This was seen to lower the overall efficiency of accessibility-based, low-emissions transport promulgation.

EVs were seen as an ideal road emissions mitigation solution. EVs were considered more efficient in terms of cost, maintenance of existing mobility, and emissions output. This is

reminiscent of broader hypermobility arguments (Adams, 2001, as cited in Banister, 2005), and suggests that this perspective is the logical extension of the endemic prioritisation of mobility-based transport, and the assumption that EVs are entirely emissions-free.

Negative externalities, such as traffic congestion, motor vehicle accidents, and the rebound effect, were not discussed. This is consistent with findings from Lah (2015) that transport sector policies typically ignored or underestimated these effects. A focus on improved vehicle efficiency often fails to significantly reduce energy consumption, as per the rebound effect. This challenges the valence of a widespread EV rollout, and supports the need for additional policy levers and planning approaches, in order to achieve meaningful sector reductions. Moreover, Lah (2015) found that EV-centred projections generally produced inaccurate forecasts, unrealistic outcome expectations, and significant errors in the calculations of policies' payback periods.

Most central-level stakeholders were less supportive of increased public and active transport provision, despite facing less policy and funding constraints than their regional and local counterparts. It may be that EVs are considered superior substitutes for existing petrol-based private vehicles, which would provide a smoother transition by allowing the effective continuation of current activities, with little or no change in behaviour.

This is consistent with research on transport choice and behaviour which shows that people tend to adopt modes with which they are most familiar (Jones et al., 1983). Even so, qualitative survey responses indicated that if supply conditions improved, several participants would shift to alternative transport modes, such as walking or cycling, over EVs. This would challenge stakeholder perspectives and support the positions of Cervero (2011) and Metz (2008), who emphasise that individuals and societies value access over mobility (as cited in Chapman, 2018). Banister (2005) asserts that conventional beliefs can result in an erroneous belief that no other actions need to be taken. Regional- and local-level interviewees were more supportive of promoting transport behavioural change. Such attitudes conform with Banister's discussion (2005) of institutions' role in encouraging shifts in public behaviour.

Strategies to encourage EV uptake were variegated. Widespread EV charging infrastructure installation was seen as a feasible measure, particularly to supply cost-free access for residents without off-street parking. This aligns with quantitative survey data, which demonstrated that insufficient charging infrastructure acted as a barrier to EV uptake. Alternative measures included a vehicle feebate scheme (which would either apply a fee or rebate to vehicle purchases according to their emissions profile) and vehicle fuel standards (which would prevent vehicle imports of high-emitting vehicles) and would apply to future vehicle purchases. There was no support for additional fiscal and regulatory measures, such as carbon or fuel pricing. This runs counter to the wider literature, which considers strong regulation and fiscal-based measures essential levers for modal shift and behavioural change (Banister, 2007b; Santos et al., 2010; Sims et al., 2014).

Several stakeholders stated that equity concerns discouraged use of fiscal measures, particularly fuel pricing, as this could disproportionately burden low-income households. This is consistent with studies on domestic fuel pricing and distributional equity (NZPC, 2018; Blick et al., 2018). However, few discussed the potential equity implications of upfront EV costs. Those without the income to readily transition to EVs could face access challenges, particularly if alternative low-emissions options are insufficiently developed and/or supplied. Mullen and Marsden (2016) found transport disadvantage arose from limited transport choice, which occurred for several reasons: increased time required to access services (e.g. hospitals, education, employment opportunities); physical difficulties: difficulties in negotiating public transport, severance caused by busy roads, relatively high risks and safety fears associated with some non-car modes, insufficient public transport and lift services; and exposure to polluted and unpleasant environments (such as high traffic environments).

An EV-oriented emissions reduction strategy validates traditional road-oriented investment and disincentivises investment in alternative low-emitting transport modes and services. This suggests public and active transport, which are predominantly reliant on Government funding and management, could face future funding limitations.

6.2 Research Contributions

Aotearoa New Zealand has seen a heightened interest in accessibility-based planning, in step with a growing concern over transport sector sustainability. This thesis has contributed to the literature through its accessibility-based evaluation of GWR low-emissions transport use. These research findings offer policymakers at the central, regional, and local levels insight into the factors affecting demand for low-emissions transport, and their intersection with accessibility parameters.

Firstly, quantitative data reveals six common factors influencing GWR low-emissions transport use:

    (i)   access to low-emissions transport options;

    (ii) route connectivity;

    (iii) cost;

    (iv) speed and travel time;

    (v) convenience and practicality; and

    (vi) the external environment.

These themes encompass both individual and structural variables, and highlight the influence of the four core accessibility parameters – land-use, transport supply, time, and user-based constraints.

These findings challenge conventional transport policymaking and signify the need for planning and policies which accommodate complex motivators of transport demand and travel patterns. Such policies would promote an integrated view of transportation and land-use systems, reflecting the connections among modes and between transport and land-use conditions, as well as individual user needs and characteristics.

Transport planning has historically favoured addressing low-emissions transport through quantitative terms, supply side policies such as increasing minimum supply and service proximity levels. Such methods can attract policymakers with the comfort of tangible projections – (as to vehicle speed, cost per kilometre travelled, etc.). However, this research indicates that other variables, often on the demand side, represent equally important considerations, and are at risk of neglect due to their seeming poorly defined

or inchoate. Yet the superiority of 'hard projections' and tangible measures is illusory. The findings of this research point to an accessibility-based evaluation framework as providing a critical part of a robust overall planning approach. The data reaffirm the significance of accessibility-based parameters, and suggest that consideration of the full range of factors influencing low-emissions transport demand can provide the best basis for policy interventions to encourage greater uptake of low-emissions transport and corresponding reductions in road emissions.

This research elucidates that, across a diverse range of demographic factors (e.g. income, race, gender, and district of residence), practicality – access with reasonable ease, in reasonable time, and at reasonable cost – was a significant determinant of low-emissions transport use. Perceptions of what is "reasonable" vary according to user-based needs and abilities, and are challenging to address. However, the complex nature of practicality suggests that measures to improve uptake of low-emissions services must take a multivariate approach (e.g. attention to travel time, affordability, and reliability). Singular, easily quantified measures such as speed augmentation or fare reduction will in practice prove insufficient without addressing a wider range of factors.

Assessing *and* accommodating heterogeneity may be resource intensive, and demands a comprehensive evaluation and planning framework. Stakeholder interviews revealed that transport policymakers and planners often have limited means to provide more bespoke services, particularly where their choices would address only a minority of transport users.

Low-emissions transport practicality improvements need not be overly complex, however. Simple, accessibility-based policies targeting specific issues, such as the reliability and comfortability of public bus services, could prove eminently justifiable even in the short term, with benefits accruing to the wider populace, despite its panoply of needs and abilities.

Long-term accessibility-based planning measures could also alleviate user-based access constraints. Integrated land-use and transport planning can cut trip distances and improve the feasibility and safety of using active transport. These improvements can

redress a number of low-emissions transport barriers applicable to a cross-section of the population. Decreased trip distances and increased density of services and opportunities would facilitate greater ease of access for demographics such as families with young children, the elderly, and those with lower physical fitness levels. This would maximise the utility of accessibility-based planning in the longer-term. Multi-modal transit and non-motorised modes could also increase the practicality of using public and active transport services by counteracting problems of unreliability, poor connectivity, and safety. An accessibility-based planning approach also prioritises improved network connectivity and walking conditions. This would address the concerns of survey respondents who reported that insufficient route connectivity and/or poor or unsafe walking conditions constrained their ability to use non-motorised transport.

Survey responses and stakeholder interviews both underscored the private vehicle's dominance in the GWR transport sector. This research shows that historic land-use and transport planning, which has skewed towards mobility over accessibility, are among the authors of private vehicle dependence. The supremacy of the private vehicle is not grounded in any particular superiority to other modes, but rather, enjoys greater functionality due to existing transport system infrastructure and planning policies. Moreover, survey responses indicate there is a real desire to use alternative forms of low-emissions transport, non-motorised modes especially, among GWR residents. Accordingly, a predominantly EV-oriented transition strategy risks perpetuating the present unfounded presumption in favour of private vehicles, while hindering modal shifts towards non-motorised and/or public transport modes and services.

EVs have emission-reducing advantages but would entrench mobility-based transport planning, which predominantly focuses on increasing motor vehicle system capacity and speed, and would perpetuate dispersed urban form and sprawl, risking disconnection and fragmentation between land uses. Moreover, improving the private vehicle's emissions profile will not address the mode's negative externalities (traffic congestion, motor vehicle accidents and fatalities, roading infrastructure emissions). Conventional yardsticks, such as cost-benefit and mobility, have had a chilling effect on investment in public and active transport, as they are perceived as less efficient. In contrast, the survey participants' clear preference for reduced travel time militates for an accessibility-based

planning approach, which can shorten trip distances by placing a higher premium on multi-modal travel and proximate land-use composition, through the integration of transport and land use.

Stakeholder interviews point to the barriers to greater uptake of low-emissions transport in the short term, and the limitations of institutional capability. Transport policy and funding structures hamstring governing institutions' ability, particularly at regional and local levels, to improve the practicality of low-emissions transport modes and services. At present, the linkages between central, regional, and local level transport policy and funding are a barrier to the very transformations these existing governance structures must undergo in order to reflect an accessibility-based transport planning perspective.

Historic land use also acts to influence transport strategy and supply. Such challenges are checks on the feasibility of accessibility-based planning policies in the GWR. At the same time, the pressures to mitigate emissions are becoming more intense. Such tensions mean that policymakers must review and adapt existing policy and funding frameworks, for example encouraging greater experimentation in low-emissions transport policy proposals at the regional and local level.

The findings of this study suggest that each GWR district faces unique challenges in the transition to low-emissions transport. Stark differences in residential density, and associated differences in ability to use low-emissions transport, call for creative strategies to increase the practicality of low-emissions transport use. The hope that that EV uptake will simply solve current challenges is no basis for less dense areas to be forgotten.

More creative public transport practices, combined with gradual land use intensification of suburbs around village centres, could be among the solutions considered. Greater autonomy for local policymakers may be conducive to improved transport planning. On the other hand, measures of that kind will be nugatory without coherence and direction from the central level.

6.3 Limitations of this Research

While constrained primarily by scope and allocated time, this research faced some limitations which deserve mention. Firstly, although representatives from the GWRC and WCC were interviewed, offering direct insight into regional and local level transport policy and planning processes, representatives from additional GWR residential districts were not interviewed due to overall timeframe constraints. Interviewing representatives from additional local councils would have been beneficial to gain an understanding of the specific challenges associated with low-emissions transport use and provision within their various districts, particularly relating to the local councils' interactions with central and regional level governance institutions and policy frameworks.

Nonetheless, given Wellington City's centrality in terms of regional commute patterns and economic activity, the current research offers insight into transport policy and planning within the most significant district in the region. In addition, although repeated contact was made, NZTA representatives were not available to be interviewed. While the MoT provided important insights, perspectives from NZTA would have helped illuminate the agency's primary role in transport funding at the central, regional, and local levels.

It is also worth noting that while interviewees were specifically selected for their primary role and/or skill and expertise in their respective institutions, the comments made came ultimately from the individual interviewee. As such, the information provided could reflect personal biases and might well not accurately represent the organisation which interviewees came from.

An additional research limitation was the survey recruitment mode employed. While the survey was open to all GWR residents 18 years of age and older, participation relied heavily on individual self-selection. While the two recruitment techniques (snowball-sampling and intercept recruitment) allowed for a greater proportion of the region's population to be reached, self-selection bias ultimately resulted in an unrepresentative study sample, with a notable majority of participants from the Wellington City area. Residents from the Kāpiti Coast, Upper Hutt, and Porirua were relatively well-represented. However, Carterton, Masterton, South Wairarapa, and Lower Hutt residents were under-represented. Although residents of these low-participation districts were contacted

through community groups in their respective areas and able to freely access the survey questionnaire online, fewer residents were participants of these online social media community forums, which could explain the lower levels of participation.

Survey advertisement posters were primarily placed in the main community and transport hubs in the Wellington City, Upper and Lower Hutt, and Porirua districts. This could explain why, in addition to their comparatively greater social media forum groups and population sizes, residents of these districts had greater levels of representation in the study sample. Moreover, there was a notable paucity of participant data from those within the "Over 70" category. This could be due to the online dissemination method of survey recruitment. This reflects StatsNZ data on the demographic breakdown of household internet access and use, which found that those over 75 years of age used the internet the least among all age groups (2012). Despite these limitations in sample representativeness, the questionnaire captured a significant range of views and characteristics across a diverse range of regional residents, providing valuable insight GWR low-emissions transport use across the GWR.

The 'self-report' design of the survey questionnaire meant collated data was susceptible to under- and over-reporting. Respondents could have under-reported behaviours they deemed inappropriate or over-reported behaviours they considered more appropriate (Allen, 2017). For instance, when asked about their desire to use low-emissions or sustainable transport, participants could have answered more positively than their true perception in order to present a greater level of altruism and/or environmental consciousness. In short, there may have been a degree of social desirability bias in the results. However, despite the inability to unconditionally prevent misrepresentation, survey questions were carefully worded and revised to minimize any potential survey "leading" (Allen, 2017).

A final limitation of this research was revealed by participant feedback: the omission of a response option for those participants who drove or regularly used a low-emissions and/or electric private vehicle. Participants noted that this meant that while they still selected private vehicle as their primary and/or preferred mode of transport, there was no avenue for them to differentiate the low-emissions status of their private vehicle, potentially influencing data interpretation. However, only two out of the 380 participant

responses noted this factor, which allowed for an efficient correction at the data analysis stage. There is a low probability that this could have applied to additional participant responses.

6.4 Future Research

This thesis has addressed a significant research gap through its exploration of the drivers of and constraints on low-emissions transport use in the Greater Wellington Region. Nonetheless, five primary areas for further research have emerged as a result of the findings of this thesis.

1. It could be beneficial, from a policy perspective, to explore in the GWR, the impact of future domestic transport emissions reduction policies, such as the implementation of a fuel economy standard or private vehicle feebate scheme, in relation to transport modal choice and low-emissions transport uptake. A before-and-after study could be conducted to assess whether, and to what extent, such policies influenced GWR private vehicle use. [13]

2. Survey respondents and interviewees both identified limited access to EV charging stations as a barrier to low-emissions transport use. Given the existing roll-out of EV charging stations in the Wellington City area, it could be useful to conduct further analysis of perceived barriers once a minimum level of installation and physical access was established in the GWR. This could provide clarification into whether income and EV purchase costs remain barriers to EV uptake despite residents having physical access to charging infrastructure.

3. While this research sought to provide a high-level depiction of the personal travel constraints and demand factors, as well as physical and contextual factors constraining low-emissions transport use in Greater Wellington, the precision with which these factors could be assessed was limited. It would be useful to conduct further analysis using more detailed data on individual GWR

---

[13] As noted earlier, it is unclear whether the feebate scheme may or may not be implemented.

residential travel patterns. For instance, aside from reported transport modes for daily commute to work and study, detailed data on the transport modes used for all other activities, such as sport, shopping, and leisure, could offer greater insight into the ability of low-emissions transport to facilitating access to wider opportunities.

4. Although survey responses provided demographic data, respondents were not asked to provide their ethnic details. It would be of interest to assess whether ethnicity (and any differences in associated social/behavioural patterns) had any role in influencing decisions to use low-emissions transport to access opportunities.

5. Finally, this thesis conducted research in the GWR context. Holmes et al. (2016) found that Auckland residents exhibit greater private vehicle dependency, but few studies have examined the region's low-emissions transport demand along accessibility lines. A comparative study of Auckland and Wellington, two of the three largest cities in New Zealand, could provide further insight into low-emissions transport motivators and their links to differences in population and topography, as well as regional and local level governance institutions.

6.5 Conclusion

This thesis was premised on the need for a meaningful shift in domestic transport behaviour and petrol-based access dependency. Its primary aim was to understand low-emissions transport demand in the GWR, in order to inform the development of policies to promote a low-emissions transport sector transition. This was predicated on the informed hypothesis that GWR residents diverge in their ability and desire to shift to low-emissions transport. This informed the choice of an accessibility-based framework to evaluate travel patterns and transport demand, and the contextual and physical factors in the regional transport system.

The research also aimed to assess the challenges of a low-emissions transport transition, and attitudes towards accessibility-based planning measures, within current transport policy and planning structures. A convergent mixed-methods research approach was employed to achieve these aims. The following subsections will outline the key findings in relation to the aims of this thesis.

Using an accessibility-based framework, six primary factors were found to motivate transport demand in the GWR, for both petrol-based and low-emissions modes and services. A range of factors were found to influence low-emissions transport use ability, and established the significance of contextual and user-based variables. Several factors were applicable to the full sample size (e.g. route connectivity, speed/travel time), while others were felt more acutely among specific demographic subsets (e.g. participants with young children, women, non-Wellington City residents).

User-based needs and abilities were principal determinants of transport choice. Travel patterns and modal choice were strongly correlated to multiple factors (area of residence, employment, household member size, income, age, and gender), although singular and composite factors were found to differ in their degree of influence. Practicality was the strongest predictor of low-emissions transport use ability. Respondents who reported using low-emissions transport as being of below-average practicality were particularly limited in their ability to use such modes. This confirmed both the need to address user-based factors in transport planning, and the challenges of providing improved services, as interpretations of what was "reasonable" varied according to user-based circumstances.

Contextual elements, including land-use patterns and the characteristics of the external environment, were also found to be influential drivers of transport behaviour. These factors had bearing on several transport demand determinants: route connectivity, proximity to transport modes and destinations, physical ability requirements, trip distances, and travel time.

Land use and urban form was also a primary theme in stakeholder interviews, considered to constrain the overall ability to provide improved GWR low-emissions transport, at all

levels of governance. Such factors also influenced participant perceptions of practicality, convenience, and safety.

Stakeholder interviews also revealed the influence of overarching transport policy and funding structures, as well as governance roles and agendas. A desire to incorporate aspects of accessibility-based planning, such as enhanced integration between transport and land-use policies, was apparent. However, several interviewees stressed that the barriers to policy alignment, complex funding procedures, and pressure to rapidly reduce road emissions constrained their ability to incorporate such measures.

EVs were characterised as the principal solution to transforming the transport sector. Interviewees were more reluctant to call for augmented or increased public and active transport provision, due to their perceived long-term requirements and high capital costs. This suggests that, all other things being equal, mobility-based planning measures will continue to be generally dispositive of policies to promote multi-modal low-emissions transport uptake, and accessibility considerations will remain secondary. The strong conclusion from this research can only be that, normatively, all other things must not remain equal. A paradigmatic shift is vital.

In summary, GWR transport demand is driven by a diverse range of factors. Addressing these will prove arduous, particularly where overarching transport policy and planning structures remain aligned principally with historic mobility planning paradigms. Although high rates of private vehicle use prevail in the GWR, this research shows that this is not always due to any inherent mode superiority. It may rather be explicable in terms of the limited capacity of alternative modes to deliver access along similar lines, under the constraints of current thinking.

Transforming the region's auto-centric transport demand will require the improvement of alternative modes. While accessibility frameworks have recently enjoyed greater attention in transport policy discourse, still greater support for accessibility-based planning approaches, and public and active transport improvements, could better encourage GWR residents to transition to low-emissions transport alternatives.

References

Abley, S., & Halden, D. (2013). *The New Zealand accessibility analysis methodology* (NZ
Transport Agency Research Report No. 512; p. 182). NZ Transport Agency.

AECOM New Zealand Ltd. (2016). *Community Greenhouse Gas Inventory for Wellington
City and the Greater Wellington Region 2000-2015* (No. 60443383; p. 55).
Greater Wellington Regional Council, Wellington City Council.
https://www.gw.govt.nz/assets/Climate-
change/CommuntityGHGInventoryWlgtnCityRegion2016.pdf

Allen, M. (2017). *The SAGE Encyclopaedia of Communication Research Methods*. SAGE
Publications, Inc. https://doi.org/10.4135/9781483381411

Argyrous, G. (Ed.). (2009). *Evidence for Policy and Decision Making*. University of New
South Wales Press Ltd.

Badland, H. M., Garret, N., & Schofield, G. M. (2010). How does Car Parking Availability
and Public Transport Accessibility Influence Work-Related Travel Behaviours?
Sustainability, *2*, 576–590.

Banister, D. (2018). *Inequality in Transport*. Alexandrine Press.

Banister, D. (2007a). Is Paradigm Shift too Difficult in U.K. Transport? *Journal of Urban
Technology*, *14*(2), 71–86.

Banister, D. (2007b). Sustainable Transport: Challenges and Opportunities.
Transportmetrica, *3*(2), 91–106. https://doi.org/10.1080/18128600708685668

Banister, D. (2005). *Unsustainable Transport: City transport in the new century*.
Routledge.

Berry, A., Jouffe, Y., Coulombel, N., & Guivarch, C. (2016). Investigating fuel poverty in the transport sector: Toward a composite indicator of vulnerability. *Energy Research & Social Science*, *18*, 7–20. https://doi.org/10.1016/j.erss.2016.02.001

Bertolini, L., Le Clercq, F., & Kapoen, L. (2005). Sustainable accessibility: A conceptual framework to integrate transport and land use plan-making. Two test-applications in the Netherlands and a reflection on the way forward. *Transport Policy*, *12*, 207–220.

Blick, G., Comendant, C., & Davies, P. (2018). *Analysis of the regional fuel tax and increase to national Fuel Excise Duty* (p. 37). Sapere Research Group Ltd.

Boulange, C., Gunn, L., Giles-Corti, B., Mavoa, S., Pettit, C., & Badland, H. (2017). Examining associations between urban design attributes and transport mode choice for walking, cycling, public transport and private motor vehicle trips. *Journal of Transport & Health*, *6*, 155–166. https://doi.org/10.1016/j.jth.2017.07.007

Bourke, B. (2014). Positionality: Reflecting on the Research Process. *The Qualitative Report*, *19*(33), 1–9.

Brierley, J. A. (2017). The role of a pragmatist paradigm when adopting mixed methods in behavioural accounting research. *International Journal of Behavioural Accounting and Finance*, *6*(2), 140–154. https://doi.org/10.1504/IJBAF.2017.086432

Cervero, R. (1997). Paradigm Shift: From Automobility to Accessibility Planning. *Urban Futures: Issues for Australian Cities*.

Chapman, R. (2018). *Access and land use: A brief exploration* (p. 21) [New Zealand for Sustainable Cities Policy Paper].

Chapman, R. (2008). Transitioning to low-carbon urban form and transport in New Zealand. *Political Science*, *60*(1), 89–98.

Chapman, S., & Weir, D. (2008). *Accessibility planning methods* (NZTA Research Report No. 363; p. 110). New Zealand Transport Agency. http://www.nzta.govt.nz/resources/research/reports/363/docs/363.pdf

Chandra, L. (2005). *Modelling the impact of urban form and transport provision on transport-related greenhouse gas emissions* [Mcoursework, Murdoch University]. https://researchrepository.murdoch.edu.au/id/eprint/40854/

Climate Change Response (Zero Carbon) Amendment Bill, Pub. L. No. 136–2. Retrieved 31 October 2019, from http://www.legislation.govt.nz/bill/government/2019/0136/latest/LMS183736.html

Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. SAGE Publications, Inc.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). SAGE Publications.

Creutzig, F., Baiocchi, G., Bierkandt, R., Pichler, P.-P., & Seto, K. C. (2015). Global typology of urban energy use and potentials for an urbanization mitigation wedge. *Proceedings of the National Academy of Sciences*, 201315545.

David Simmonds Consultancy, MVA, University of Leeds Institute for Transport Studies, & Oxford Brookes University. (1998). *Accessibility as a criterion for project and policy appraisal.* Department for Environment, Transport and Regions.

Deakin, E. (2001). *Sustainable Development and Sustainable Transportation: Strategies for Economic Prosperity, Environmental Quality, and Equity* (Working Paper No.

2001–03). Institute of Urban and Regional Development.
https://escholarship.org/uc/item/0m1047xc

de Bernardo, D. H., & Curtis, A. (2013). Using Online and Paper Surveys: The Effectiveness of Mixed-Mode Methodology for Populations Over 50. *Research on Aging*, *35*(2), 220–240. https://doi.org/10.1177/0164027512441611

de Hoog, J., Thomas, D., Muenzel, V., Jayasuriya, D., Alpcan, T., Brazil, M., & Mareels, I. (2013). Electric Vehicle Charging and Grid Constraints: Comparing Distributed and Centralized Approaches. IEEE Power and Energy Society General Meeting, Vancouver, Canada. https://ieeexplore.ieee.org/document/6672222

Dewey, J. (1925). *Experience and nature*. Kessinger.

DHC Consultancy. (2000). *Guidance on Accessibility Measuring Techniques and their Applications*.

DHC Consultancy, & University of Westminster. (2003). *Developing and Piloting Accessibility Planning* [Final Report].

Ding, C., Wang, D., Liu, C., Zhang, Y., & Yang, J. (2017). Exploring the influence of built environment on travel mode choice considering the mediating effects of car ownership and travel distance. *Transportation Research Part A: Policy and Practice*, *100*, 65–80. https://doi.org/10.1016/j.tra.2017.04.008

Dooney, L. (2018). *Cause of Wellington's bus network failure revealed*. RNZ. https://www.rnz.co.nz/news/national/378678/cause-of-wellington-s-bus-network-failure-revealed

Ewing, R., Nelson, A. C., Bartholomew, K., Emmi, P., & Appleyard, B. (2011). Response to Special Report 298 Driving and the built environment: the effects of compact development on motorized travel, energy use, and CO2 emissions. *Journal of Urbanism, 4*(1), 1-5.

Farrington, J., & Farrington, C. (2005). Rural accessibility, social inclusion and social

        justice: Towards conceptualisation. *Journal of Transport Geography*, *13*(1), 1–12.

        https://doi.org/10.1016/j.jtrangeo.2004.10.002

Feilzer, Y. (2010). Doing Mixed Methods Research Pragmatically: Implications for the

        Rediscovery of Pragmatism as a Research Paradigm. *Journal of Mixed Methods*

        Research, *4*(1), 6–16. https://doi.org/10.1177/1558689809349691

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving Integration in Mixed

        Methods Designs—Principles and Practices. *Health Services Research*, *48*(6 Pt 2),

        2134–2156. https://doi.org/10.1111/1475-6773.12117

Fiztgerald, G. (2012). *The social impacts of poor access to transport in rural New Zealand*

        | NZ Transport Agency (NZ Transport Agency Research Report No. 484; p. 99).

        NZ Transport Agency.

        https://www.nzta.govt.nz/resources/research/reports/484

Fol, S., & Gallez, C. (2014). Social inequalities in urban access. Better ways of assessing

        transport improvements. *Finance and Governance Models for Transport*

        Infrastructure, 46–86.

Frost, J. (2017). *Standard Error of the Regression vs. R-squared*. Statistics By Jim.

        http://statisticsbyjim.com/regression/standard-error-regression-vs-r-squared/

Geurs, K. T., & Van Wee, B. (2004). Accessibility evaluation of land-use and transport

        strategies: Review and research directions. *Journal of Transport Geography*, *12*,

        127–140.

Geurs, K. T., & van Eck, R. (2001). *Accessibility measures: Review and applications.*

        Evaluation of accessibility impacts of land-use transportation scenarios, and

        related social and economic impact (408505 006; p. 265). Urban Research

        Center. https://rivm.openrepository.com/handle/10029/259808

Girod, B., van Vuuren, D. P., & de Vries, B. (2013). Influence of travel behavior on global CO_2 emissions. *Transportation Research Part A: Policy and Practice*, *50*, 183–197. https://doi.org/10.1016/j.tra.2013.01.046

GIZ: Transport Policy Advisory Services. (2007). *Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I)*. Federal Ministry for Economic Cooperation and Development. https://www.sutp.org/files/contents/documents/resources/E_Fact-Sheets-and-Policy-Briefs/SUTP_GIZ_FS_Avoid-Shift-Improve_EN.pdf

Gould, P. (1969). Spatial Diffusion. *Association of American Geographers, Resource Paper Number 17, Washington D.C.*

GWRC. (2019). *2018/19 Annual Monitoring Report on the Regional Land Transport Plan*. Wellington, New Zealand: Greater Wellington Regional Council. https://www.gw.govt.nz/assets/Transport/Regional-transport/RLTP-2015/Annual-Monitoring-2015-onwards/201819-Annual-Monitoring-ReportWellington-RLTP.pdf

GWRC. (2016). *About the region*. https://www.gw.govt.nz/about-the-region/

GWRC. (2013). *Census 2013: Journey to Work Analysis* (p. 13). https://www.gw.govt.nz/assets/Transport/Regional-transport/Regional-Transport-Analysis/2013-Census-JTW-Analysis-Document.pdf

GWRC. (2015). *Wellington Regional Land Transport Plan 2015* (Attachment 2 Report 15.157; p. 215). Wellington, New Zealand: Greater Wellington Regional Council https://www.gw.govt.nz/rltplan/

GWRC & KiwiRail. (2009). *Wellington Regional Rail Plan 2010-2035 'A Better Rail Experience'* (No. 609365; p. 140).

http://www.gw.govt.nz/assets/Transport/Public-
transport/Docs/RegionalRailPlan.pdf

Halden, D. (2003). Accessibility analysis: Concepts and their application to transport
policy, programme and project evaluation. In J. Nellthorp & P. Mackie (Eds.),
Transport Projects, Programmes and Policies: Evaluation Needs and Capabilities
(pp. 227–243). Routledge.

Halden, D., Jones, P., & Wixey, S. (2005). *Accessibility Analysis Literature Review*
(Working Paper No. 3; Measuring Accessibility as Experienced by Different
Socially Disadvantaged Groups). Transport Studies Group- University of
Westminster.

Handy, S. (2002). *Accessibility- vs. Mobility-enhancing strategies for addressing
automobile dependence in the US* [Paper]. European Conference of Ministers of
Transport (ECMT), Paris.

Hansen, H. S. (2009). Analysing the Role of Accessibility in Contemporary Urban
Development. *Part I*. Computational Science and Its Applications: ICCSA 2009,
Seoul, Korea. https://link.springer.com/chapter/10.1007/978-3-642-02454-2_27

Hansen, W. G. (1959). How Accessibility shapes land use. *Journal of the American
Institute of Planners*, *25*, 73–76.

Hickman, R., & Banister, D. (2014). *Transport, Climate Change and the City*. Routledge.

Holmes, F., Chapman, R., & Dodge, N. (2016). *Auckland Council People's Panel Survey –
Auckland Neighbourhood, Housing, and Travel Preferences*. Retrieved from
Auckland http://sustainablecities.org.nz/2016/12/housing-transport-survey/

Horizon Research. (2019). *Transport Perceptions Survey 2019*. Greater Wellington
Regional Council. http://www.gw.govt.nz/assets/Transport/Regional-

transport/Regional-Transport-Analysis/Transport-Perceptions-survey-report-August-2019-FINAL.pdf

HUD. (2019). *Urban Growth Agenda*. Ministry of Housing and Urban Development. https://www.hud.govt.nz/urban-development/urban-growth-agenda/

.id. (2013). *About the profile areas—Wellington City*. .idcommunity Demographic Resources. https://profile.idnz.co.nz/greater-wellington/about?WebID=170

.id. (2018a). *Current population estimate—The Wellington Region*. .idcommunity Demographic Resources. https://profile.idnz.co.nz/greater-wellington/population-estimate

.id. (2018b). *Wellington City Method of travel to work*. .idcommunity Demographic Resources. https://profile.idnz.co.nz/wellington/travel-to-work

.id. (2016). *Population forecasts Wellington City*. .idcommunity Demographic Resources. https://forecast.idnz.co.nz/wellington/home

.id. (2019a). *Telecommunication access | the Wellington Region*. Greater Wellington Regional Council Community Profile. https://profile.idnz.co.nz/greater-wellington/telecommunications

.id. (2019b). *Wellington City Current population estimate*. .idcommunity Demographic Resources. https://profile.idnz.co.nz/wellington/population-estimate

.id, & GWRC. (2018). *Number of cars per household*. https://profile.idnz.co.nz/greater-wellington/car-ownership?WebID=10

IEA. (2018). *Emissions*. Global Energy & CO2 Status Report. International Energy Agency. https://www.iea.org/geco/emissions/

IEA. (2019). *Transport*. International Energy Agency.
https://www.iea.org/topics/transport/

ITF. (2019). *ITF Transport Outlook 2019* (p. 200). International Transport Forum.
https://www.oecd-ilibrary.org/transport/itf-transport-outlook-
2019_transp_outlook-en-2019-en

Jacobsen, P. L., & Rutter, H. (2012). Cycling Safety. In J. Pucher & R. Buehler (Eds.), *City
Cycling* (pp. 141–156). The MIT Press; JSTOR.
https://doi.org/10.2307/j.ctt5hhjxr.11

Jensen, K. B., & Glasmeier, A. K. (2010). Policy, Research Design and the Socially
Situated Researcher. In D. DeLyser, S. Herbert, S. Aitken, M. Crang, & L.
McDowell (Eds.), *The SAGE Handbook of Qualitative Geography* (pp. 82–93).
SAGE Publications Ltd.

Jing, W., An, K., Ramezani, M., & Kim, I. (2017). *Location Design of Electric Vehicle
Charging Facilities: A Path-Distance Constrained Stochastic User Equilibrium
Approach* [Research Article]. Journal of Advanced Transportation.
https://doi.org/10.1155/2017/4252946

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research
Paradigm Whose Time Has Come. *Educational Researcher*, *33*(7), 14–26.

Jones, P. M., Dix, M. C., Clarke, I., & Heggie, I. G. (1983). *Understanding Travel Behaviour
(Oxford studies in transport)*. Gower Publishing Company Limited.

Lah, O. (2015). The barriers to low-carbon land-transport and policies to overcome
them. *European Transport Research Review*, *7*(1), 5.
https://doi.org/10.1007/s12544-014-0151-3

Land Transport Management Act 2003 (as at 22 October 2019), Pub. L. No. 118 (2003).
http://www.legislation.govt.nz/act/public/2003/0118/latest/DLM226230.html

Levinson, D., Krizek, K. J., & Gillen, D. (2005). The Machine for Access. In D. M. Levinson
    & K. J. Krizek (Eds.), *Access to Destinations* (pp. 1–10). Emerald Group Publishing
    Limited. https://doi.org/10.1108/9780080460550-001

Litman, T. (2019). Evaluating Accessibility For Transport Planning. *Victoria Transport
    Policy Institute*, 64.

Litman, T. (2003). Traffic, Mobility and Accessibility. *Institute of Transport Engineers
    Journal*, *73*(10), 28–32.

Local Government Act 2002 No 84 (as at 01 July 2017), Pub. L. No. 84 (2002).
    http://www.legislation.govt.nz/act/public/2002/0084/167.0/DLM170873.html#
    DLM170878

Lovejoy, K., & Handy, S. (2012). Developments in Bicycle Equipment and Its Role in
    Promoting Cycling as a Travel Mode. In Pucher J. & Buehler R. (Eds.), *City
    Cycling* (pp. 75-104). Cambridge, Massachusetts; London, England: The MIT
    Press. doi:10.2307/j.ctt5hhjxr.9

Lucas, K. (2006). Providing transport for social inclusion within a framework for
    environmental justice in the UK. *Transportation Research Part A: Policy and
    Practice*, *40*(10), 801–809. https://doi.org/10.1016/j.tra.2005.12.005

Lyons, G., Davidson, C., Forster, T., Sage, I., McSaveney, J., MacDonald, E., Morgan, A., &
    Kole, A. (2014). *Future Demand: How could or should our transport system
    evolve in order to support mobility in the future?* (p. 66). Ministry of Transport.
    https://www.transport.govt.nz/assets/Uploads/Our-
    Work/Documents/23ed0ae6fc/fd-final-report.pdf

Manaugh, K., & El-Geneidy, A. M. (2013). Does distance matter? Exploring the links
    among values, motivations, home location, and satisfaction in walking trips.

Transportation Research Part A: Policy and Practice, *50*, 198–208.
https://doi.org/10.1016/j.tra.2013.01.044

Mattioli, G. (2016). Transport needs in a climate-constrained world. A novel framework
to reconcile social and environmental sustainability in transport. *Energy
Research & Social Science*, *18*(1), 118–128.

McDonald, N. C. (2012). Children and Cycling. In J. Pucher & R. Buehler (Eds.), *City
Cycling* (pp. 235–256). The MIT Press; JSTOR.
https://doi.org/10.2307/j.ctt5hhjxr.15

MfE. (2018). *Reducing barriers to Electric Vehicle uptake: Behavioural insights analysis
and review*. Wellington: Ministry for the Environment.
https://www.mfe.govt.nz/sites/default/files/media/Final

Miller, H. (2005), "Place-Based Versus People-Based Accessibility", Levinson,
D. and Krizek, K. (Ed.) *Access to Destinations*, Emerald Group Publishing Limited,
pp. 63-89. https://doi.org/10.1108/9780080460550-004

MoT. (2018a). *Annual fleet statistics 2018* (p. 28). Wellington, New Zealand: Ministry of
Transport.
https://www.transport.govt.nz/assets/Import/Uploads/Research/Documents/Th
e-NZ-Vehicle-Fleet-Report-2018-web-v2.pdf

MoT. (2019a). *Climate Change and Energy*. Multi-Modal.
https://www.transport.govt.nz/multi-modal/climatechange/

MoT. (2007). *Comparing travel modes: Household travel survey*.
http://www.transport.govt.nz/research/Documents/Comparing-travel-
modesv1.4.pdf

MoT. (2019b). *Electric vehicles*. Multi-Modal. https://www.transport.govt.nz/multi-
modal/climatechange/electric-vehicles/

MoT. (2019c). *Let's Get Wellington Moving*. Land.
https://www.transport.govt.nz/land/lgwm/

MoT. (2020). *Monthly electric and hybrid light vehicle registrations*. Wellington, New
Zealand: Ministry of Transport. https://www.transport.govt.nz/mot-
resources/vehicle-fleet-statistics/monthly-electric-and-hybrid-light-vehicle-
registrations/

MoT. (2018b). *Results from Household Travel Survey 2015-2017*. Wellington, New
Zealand: Ministry of Transport. https://www.transport.govt.nz/mot-
resources/household-travel-survey/results-from-household-travel-survey-2015-
2017/

MoT. (2018c). *Statement of Intent: 2018-2022* (F.5 SDI). Wellington, New Zealand:
Ministry of Transport.
https://www.transport.govt.nz/about/governance/statementsofintent/stateme
nt-of-intent-2018-2022/

MPI. (2019). *Rural proofing*. Wellington, New Zealand: Ministry for Primary Industries.
https://www.mpi.govt.nz/about-us/our-work/rural-proofing/

Mullen, C., & Marsden, G. (2016). Mobility justice in low carbon energy transitions.
Energy Research & Social Science, *18*, 109–117.
https://doi.org/10.1016/j.erss.2016.03.026

New Zealand Government. (2018). *Government Policy Statement on Land Transport:
2018/19-2027/28*. https://www.transport.govt.nz/assets/Uploads/Our-
Work/Documents/c6b0fea45a/Government-Policy-Statement-on-land-
transport-2018.pdf

NZPC. (2018). *Low-emissions economy: Final report*. Wellington, New Zealand: New
Zealand Productivity Commission

https://www.productivity.govt.nz/assets/Documents/4e01d69a83/Productivity-Commission_Low-emissions-economy_Final-Report.pdf

NZTA. (2019a). *About the NLTP*. Wellington, New Zealand: New Zealand Transport Agency. https://www.nzta.govt.nz/planning-and-investment/national-land-transport-programme/about-the-nltp/

NZTA. (2014). *Accessibility planning* (BCA Strategic Options Toolkit, p. 11). Wellington, New Zealand: New Zealand Transport Agency. https://www.nzta.govt.nz/assets/userfiles/transport-data/Accessibility%20Planning.pdf

NZTA. (2019b). *Funding sources*. https://www.nzta.govt.nz/planning-and-investment/planning-and-investment-knowledge-base/planning-and-investment-principles-and-policies/investment-and-funding-assistance-policy/funding-sources/

NZTA. (2018a). *Investment Assessment Framework for the 2018-21 National Land Transport Programme* (p. 30). Wellington, New Zealand: New Zealand Transport Agency. https://www.nzta.govt.nz/assets/planning-and-investment/nltp/IAF-for-GPS-2018.pdf

NZTA. (2018b). *National Land Transport Programme 2018-21* (p. 106). Wellington, New Zealand: New Zealand Transport Agency. https://www.nzta.govt.nz/planning-and-investment/national-land-transport-programme/

NZTA. (2019c). *Wellington*. Wellington, New Zealand: New Zealand Transport Agency. https://www.nzta.govt.nz/planning-and-investment/national-land-transport-programme/nltp-2015-18/nltp-in-the-regions/wellington/

NZTA. (2019d). *Whakarāpopo: A Aotearoa National Summary* (Engagement F). Wellington, New Zealand: New Zealand Transport Agency.

https://www.nzta.govt.nz/assets/planning-and-investment/docs/arataki/national-summary-december-2019.pdf

Ng, W.-S., & Acker, A. (2018). *Understanding Urban Travel Behaviour by Gender*. Transportation Research Board 97th Annual Meeting Transportation Research Board. https://trid.trb.org/view/1497406

Nichols, D. P. (1995). *Using Categorical Variables in Regression*. SPSS LIBRARY: UNDERSTANDING AND INTERPRETING PARAMETER ESTIMATES IN REGRESSION AND ANOVA. https://stats.idre.ucla.edu/spss/library/spss-libraryunderstanding-and-interpreting-parameter-estimates-in-regression-and-anova/

Nilsson, M., & Küller, R. (2000). Travel behaviour and environmental concern. *Transportation Research Part D: Transport and Environment*, *5*(3), 211–234. https://doi.org/10.1016/S1361-9209(99)00034-6

OECD. (2017). *Environmental Performance Reviews: New Zealand 2017*. Paris, France: Organisation for Economic Co-ordination and Development. https://www.oecd.org/environment/country-reviews/Highlights_OECD_EPR_NewZealand.pdf

Parr, G. (2019). *Social Impact Assessments: The Ministry of Transport's proposed approach*. NZAE Conference, Wellington, New Zealand.

Pawson, E. (2014). *Cars and the motor industry—Cars and urban planning* [Web page]. Te Ara- the Encyclopaedia of New Zealand. https://teara.govt.nz/en/cars-and-the-motor-industry/page-8

Pereira, R. H. M., Schwanen, T., & Banister, D. (2017). Distributive justice and equity in transportation. *Transport Reviews*, *37*(2), 170–191.

Public Transport Management Act 2008 (as at 13 June 2013), Pub. L. No. 87 (2008). http://www.legislation.govt.nz/act/public/2008/0087/latest/DLM1179939.html#DLM1180040

Pyrialakou, V. D., Gkritza, K., & Fricker, J. D. (2016). Accessibility, mobility, and realized travel behavior: Assessing transport disadvantage from a policy perspective. *Journal of Transport Geography*, *51*, 252–269. https://doi.org/10.1016/j.jtrangeo.2016.02.001

Rorty, R. (1999). *Philosophy and social hope*. Penguin Books.

Rose, E., Witten, K., & McCreanor, T. (2009). Transport related social exclusion in New Zealand: Evidence and challenges. *Kōtuitui: New Zealand Journal of Social Sciences Online*, *4*(3), 191–203. https://doi.org/10.1080/1177083X.2009.9522454

Ryan, N. (2018). *Towards a More Comprehensive Picture of Park-and-Ride: A Mixed Methods Study of Stakeholder Perspectives and Transport Behaviour in Greater Wellington*. Victoria University of Wellington.

Santos, G., Behrendt, H., & Teytelboym, A. (2010). Part II: Policy instruments for sustainable road transport. *Research in Transportation Economics*, *28*(1), 46–91. https://doi.org/10.1016/j.retrec.2010.03.002

Sims R., R. Schaeffer, F. Creutzig, X. Cruz-Núñez, M. D'Agosto, D. Dimitriu, M.J. Figueroa Meza, L. Fulton, S. Kobayashi, O. Lah, A. McKinnon, P. Newman, M. Ouyang, J.J. Schauer, D. Sperling, and G. Tiwari. (2014): *Transport*. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press.

SEU. (2003). *Making the Connections: Final Report on Transport and Social Exclusion* (p. 145). Social Exclusion Unit. https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_policy/---invest/documents/publication/wcms_asist_8210.pdf

Stats NZ. (2012). *Household Use of Information and Communication Technology: 2012*. http://archive.stats.govt.nz/browse_for_stats/industry_sectors/information_technology_and_communications/HouseholdUseofICT_HOTP2012.aspx

Stats NZ. (2019). *New Zealand's greenhouse gas emissions*. https://www.stats.govt.nz/indicators/new-zealands-greenhouse-gas-emissions

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. Sage Publications, Inc.

The Treasury. (2018). *Our living standards framework*. https://treasury.govt.nz/information-and-services/nz-economy/living-standards/our-living-standards-framework

The Treasury. (2019). *The Wellbeing Budget 2019* (p. 147). Government of New Zealand. https://treasury.govt.nz/publications/wellbeing-budget/wellbeing-budget-2019-html

URS New Zealand Ltd. (2014). *Greenhouse Gas Inventory for the Wellington Region* (Final Report 42790730/01/02; p. 162). Wellington City Council.

US EPA. (2015). *Fast Facts on Transportation Greenhouse Gas Emissions* [Overviews and Factsheets]. United States Environmental Protection Agency. https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

Vigar, G. (2002). *The Politics of Mobility: Transport, the environment and public policy*. Spoon Press.

Weaver, K. (2018). Pragmatic Paradigm. In B. B. Frey (Ed.), *The SAGE Encyclopedia of Educational Research, Measurement, and Evaluation* (pp. 1287–1288). SAGE Publications, Inc. https://doi.org/10.4135/9781506326139.n534

WCC. (2012). *Accessible Wellington Action Plan 2012/15*. Wellington, New Zealand: Wellington City Council. http://wellington.govt.nz/your-council/plans-policies-and-bylaws/policies/accessible-wellington-action-plan

WCC. (2019). *Wellington City Council's Annual Plan 2019/20* (p. 128). Wellington City Council. http://ap2019.publications.wellington.govt.nz/uploads/WCC-2019-20-Annual-Plan.pdf

WCC. (2015). *Wellington Urban Growth Plan 2014-2043*. Wellington, New Zealand: Wellington City Council. https://wellington.govt.nz/~/media/your-council/plans-policies-and-bylaws/plans-and-policies/a-to-z/wgtn-urban-growth/wgtn-urban-growth-plan2015-1intro.pdf?la=en

WCC & The Property Group. (2014). *Wellington City Housing and Residential Growth Study: Final Planning Assessment and Recommendations* (p. 81). https://wellington.govt.nz/~/media/your-council/projects/files/housing-choice-supply/wcc-residential-study-final-report.pdf

WEF. (2017). *Global Risks Report 2017*. World Economic Forum. http://wef.ch/1PYitI7

Wright, K. B. (2005). Researching Internet-Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages, and Web Survey Services. *Journal of Computer-Mediated Communication*, *10*(3). https://doi.org/10.1111/j.1083-6101.2005.tb00259.x

Appendices

Appendix A. Human Ethics Committee Approval Letter

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

VICTORIA
UNIVERSITY OF WELLINGTON

Phone   0-4-463 6028
Email   judith.loveridge@vuw.ac.nz

MEMORANDUM

G. A. Loveridge

Appendix B. Information Sheet for Survey Participants

Masters Thesis:

Transitioning to a Low-Emissions Transport Sector in the Greater Wellington Region

INFORMATION SHEET FOR SURVEY PARTICIPANTS

You are invited to take part in this research. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to participate, thank you for considering this request.

Who am I?

My name is HanLing Petredean and I am a Masters student in Environmental Studies at Victoria University of Wellington. This research project is for my thesis.

What is the aim of the project?

This project rests within the context of Aotearoa New Zealand's climate change mitigation commitments aiming to achieve net zero carbon emissions by 2050. My research seeks to understand motivators of low-emissions transport use in the Greater Wellington Region. This research has been approved by the Victoria University of Wellington Human Ethics Committee, ResearchMaster application reference # 0000027534.

How can you help?

You have been invited to participate because as a Greater Wellington resident, your perspective will help to understand your ability to use low-emissions transport in the present and how efforts to reduce transport emissions could impact the way you and others use transport and access areas in your day to day life. If you agree to take part, you will complete a survey. The survey will ask you questions about transport use and access, fuel prices, and climate change. The survey will take you approximately 5-10 minutes to complete.

What will happen to the information you give?

This research is anonymous. This means that nobody, including the researchers, will be aware of your identity. By answering it, you are giving consent for us to use your responses in this research. Your answers will remain completely anonymous and unidentifiable. Once you submit the survey, it will be impossible to retract your answer. Please do not include any personal identifiable information in your responses.

Personal details will be collected only for those who wish to enter the prize draw. All personal details

will be received separately from the survey data and will be held in confidence. This ensures that your answers to the survey questions will not be linked to your identity.

What will the project produce?

The information from my research will be used in Masters thesis, associated conference presentations, academic journal articles, and any potential press releases.

If you have any questions or problems, who can you contact?

Student: HanLing Petredean, **Email Address:** petredha@staff.vuw.ac.nz
Supervisor: Associate Professor Ralph Chapman **Contact Info:** 04 463 6153,
ralph.chapman@vuw.ac.nz

Human Ethics Committee information

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Dr Judith Loveridge. Email hec@vuw.ac.nz or telephone +64-4-463 6028.

Many thanks,

HanLing Petredean

○ Okay, I wish to participate (1)

Appendix C. Survey Questionnaire

Transitioning to a Low-Emissions Transport Sector in the Greater Wellington Region

Start of Block: Demographic Details

NOTE: Questions marked with an asterix (*) are coded as mandatory.

Q1* How many members are in your household? (Please do not include flatmates unless you share transport costs)

○ 1 (yourself) (1)

○ 2 (2)

○ 3 (3)

○ 4 (4)

○ 5+ (5)

Q2 What gender do you identify as?

○ Female (1)

○ Male (2)

○ Non-Binary (3)

○ Prefer not to answer (4)

Q3* What is your current age group?

○ 18-23 (1)

○ 24-30 (2)

○ 31-50 (3)

○ 51-70 (4)

○ Over 70 (5)

Q4 What approximately is your current **household weekly** income before taxes and other deductions?

○ 0-$750 (1)

○ $751-$1200 (2)

○ $1,201-$2,500 (3)

○ $2,501-$5000 (4)

○ $5,001 or more (5)

Q5* What approximately is your current **household annual** income before taxes and other deductions?

○ 0-$39,000 (1)

○ $39,001-$62,400 (2)

○ $62,401-$130,000 (3)

○ $130,001-$260,000 (4)

○ $260,001 or more (5)

Q6* On average, how much does your **household** spend on transport needs **per week**?
(e.g. petrol/diesel fuel, public transport fares, etc.)

○ $0-30 (1)

○ $31-60 (2)

○ $61-90 (3)

○ $91-120 (4)

○ $121-150 (5)

○ $151-180 (6)

○ $181-210 (7)

○ $211 or more (8)

Q7* Do you currently reside in the Greater Wellington region?

○ Yes (1)

○ No (2)

- -

Q8* Which Greater Wellington district do you currently reside in?

○ Carterton (1)

○ Masterton (2)

○ South Wairarapa (3)

○ Tararua (4)

○ Kāpiti Coast (5)

○ Upper Hutt (6)

○ Lower Hutt (7)

○ Porirua (8)

○ Wellington (9)

Q9 How long have you lived in your current area of residence?

○ 0-2 years (1)

○ 3-5 years (2)

○ 6-10 years (3)

○ Over 10 years (4)

End of Block: Demographic Details

Q10* In an average week, how many days do you use the following modes of transport?

	None (1)	1 Day (2)	2-3 Days (3)	4-5 Days (4)	Daily (5)
Walk/Jog (1)	○	○	○	○	○
Bicycle/Non-Motorised Scooter (2)	○	○	○	○	○
Motorbike/Motorised Scooter (3)	○	○	○	○	○
Public Bus/Ferry (4)	○	○	○	○	○
Train/Rail (5)	○	○	○	○	○
Drive a car/truck/van (6)	○	○	○	○	○
Passenger in a car/truck/van (7)	○	○	○	○	○
Taxi or similar service (e.g. Uber or Lyft) (8)	○	○	○	○	○

Q11* On average, what is your main travel mode you use to get to work or your place of study?

○ Walk/Jog (1)

○ Bicycle/Non-Motorised Scooter (2)

○ Motorbike/Motorised Scooter (3)

○ Public Bus/Ferry (4)

○ Train/Rail (5)

○ Drive a car/truck/van (6)

○ Passenger in a car/truck/van (7)

○ Taxi or similar service (e.g. Uber or Lyft) (8)

○ I do not work or attend school (9)

○ Other (10) _____

Q12* Typically, how far is your average daily commute to work or your place of study?

○ 0-10 kilometres (1)

○ 11-20 kilometres (2)

○ Over 20 kilometres (3)

Q13* On average, how much time does it take you to get to work or your place of study by way of your main mode of transport?

○ 1-10 minutes (1)

○ 11-20 minutes (2)

○ 21-30 minutes (3)

○ 31-45 minutes (4)

○ 46 minutes-60 minutes (1 hour) (5)

○ Over an hour (please specify) (6)

_____

Q14 How would you rate the reliability of your main mode of transport to work or your place of study?

	Low reliability	Low-Average reliability	Average reliability	Average-High reliability	High reliability	Not Applicable
	1	2	3	4	5	
Please use a scale of 1-5 ()						

Q15* Typically, what is your main mode of transport used for activities other than commuting to work or your place of study? (i.e. leisure, sport, socializing, etc.)

○ Walk/jog (1)

○ Bicycle/non-motorised scooter (2)

○ Motorbike/motorised scooter (3)

○ Public bus (4)

○ Train/Rail (5)

○ Drive a car/truck/van (6)

○ Passenger in a car/truck/van (7)

○ Taxi or similar service (eg, Uber/Lyft) (8)

○ Other (please specify) (9)
_____

Q16 On average, how much do you consider you spend on your individual transport needs? (e.g. petrol/diesel, public transport fares)

○ A great deal (1)

○ A lot (2)

○ A moderate amount (3)

○ A little (4)

○ None at all (5)

Q17 Do you own or have regular access to a private car?

○ Yes (1)

○ No (2)

- -

Q18 On average, how much **per week** do you individually spend on petrol or diesel?

○ 0-$20 (1)

○ $21-50 (2)

○ $51-100 (3)

○ $101-150 (4)

○ $151 or more (5)

Q19 At what level would you consider an **increase** in your weekly transport costs to be a financial hardship?

Measured in dollars

	0	10	20	30	40	50	60	70	80	90	100
Please give your answer on the scale using increments of $10											

Q20 How would you rate your current access to public transport options (bus, ferry, or train)?

	No access	Low access	Low-Average access	Average access	Average-High access	High access
	0	1	2	3	4	5
Please rank your answer on a scale of 0 to 5 (0 meaning no access)						

Q21 How would you rate the practicality of using public transport? (Practicality broadly means if it gets you to where you need to go at a reasonable cost, in reasonable time, and with reasonable ease)

	Low practicality	Low-Average practicality	Average practicality	Average-High practicality	High practicality
	1	2	3	4	5
Please rank your answer on a scale of 1 to 5					

Q22 How would you rate your current access to active transport options for your daily travel to work or study (for example, pedestrian walkways or bicycle lanes)?

	No access	Very limited access	Low access	Low-Average access	Average-High access	High access
	0	1	2	3	4	5
Please rank your answer on a scale of 0 to 5 (0 meaning no access)						

Q23 How would you rate the practicality of using active transport (for example, walking or bicycling)? (Practicality broadly means if it gets you to where you need to go at a reasonable cost, in reasonable time, and with reasonable ease)

	Low practicality	Low-Average practicality	Average practicality	Average-High practicality	High practicality
	1	2	3	4	5
Please rank your answer on a scale of 1 to 5					

Q24 Thinking about other destinations than your daily commute to work or study, how would you rate your current ability to get to these desired locations on a day to day level?

	Low ability	Low-Average ability	Average ability	Average-High ability	High ability
	1	2	3	4	5
Please rank your answer on a scale of 1 to 5					

Q25 Overall, considering both your commute and other day-to-day destinations, how would you rate your current ability to use low-emissions or sustainable transport options (e.g. electric vehicles, electric buses, electric railways, walking, cycling)?

	No ability	Low ability	Low-Average ability	Average ability	Average-High ability	High ability
	0	1	2	3	4	5
Please rank your answer on a scale of 0 to 5 (0 meaning no ability)						

Q26 Why do you consider your ability to be limited? (you may select more than one answer)

☐ Limited or no access to low-emissions transport options (1)

☐ Low-emissions transport options don't take me to most of my desired destinations (2)

☐ The cost of low-emissions transport is too high (3)

☐ Low-emissions transport options are too slow (4)

☐ Other (please explain) (5) _____

Q27* How important is it to you that your transport options be low-emissions or sustainable? (e.g. use less fossil fuel and emit less carbon emissions)

○ Extremely important (1)

○ Very important (2)

○ Moderately important (3)

○ Slightly important (4)

○ Not at all important (5)

Q28* What are your three preferred modes of transport?

Please drag and drop your first choice across to the box on the right. Then do the same with your second and third choices: (1= first choice, 2= second choice, 3= third choice)

Top-Three Choices

⊗_____ Walk/Jog (1)

⊗_____ Bicycle/Non-Motorised Scooter (2)

⊗_____ Motorbike/Motorised Scooter (3)

⊗_____ Public Bus/Ferry (4)

⊗_____ Rail/Train (5)

⊗_____ Private car/truck/van (6)

⊗_____ Passenger in private car/truck/van (7)

⊗_____ Taxi or similar service (eg, Uber/Lyft) (8)

⊗_____ Other (please specify) (9)

- -

Q29* What are the three most important factors in determining your choice of transport?

Please drag and drop your first choice across to the box on the right. Then do the same with your second and third choices: (1= first choice, 2= second choice, 3= third choice)

Top-Three Factors

⊗_____ Sustainability/Environmental Impact (1)

⊗_____ Your proximity to the transport option (2)

⊗_____ Reliability/Safety (3)

⊗_____ Speed/Travel Time (4)

⊗_____ Ability to take you to desired end location (5)

⊗_____ Health benefits (6)

⊗_____ Cost (7)

⊗_____ Physical ability required (9)

⊗_____ Other (please specify) (10)

Q30* Would you pay more for a mode of transport if it produced less carbon emissions?

○ Yes (1)

○ Yes, if it's practical and convenient (2)

○ Yes, if other people are also being asked to pay more (3)

○ Yes, if it's practical and convenient and other people are also being asked to pay more (4)

○ No (5)

- -

Q31 If you have any further comments or questions in relation to the survey, please write them below:

_____

Q32 **Done! Thank you for your response!**

If you know any family, friends, or coworkers that would be interested in completing this survey, please direct them to this link **(https://tinyurl.com/carbonpricingGWRC)** or copy and paste it to share this survey to social media.

If you would like to participate in the drawing to win a **$75 voucher to Moore Wilson's**, please click YES below to access a link to input your preferred contact email information. Your email will NOT be recorded in relation to your survey responses, all answers will be kept confidential and anonymous.
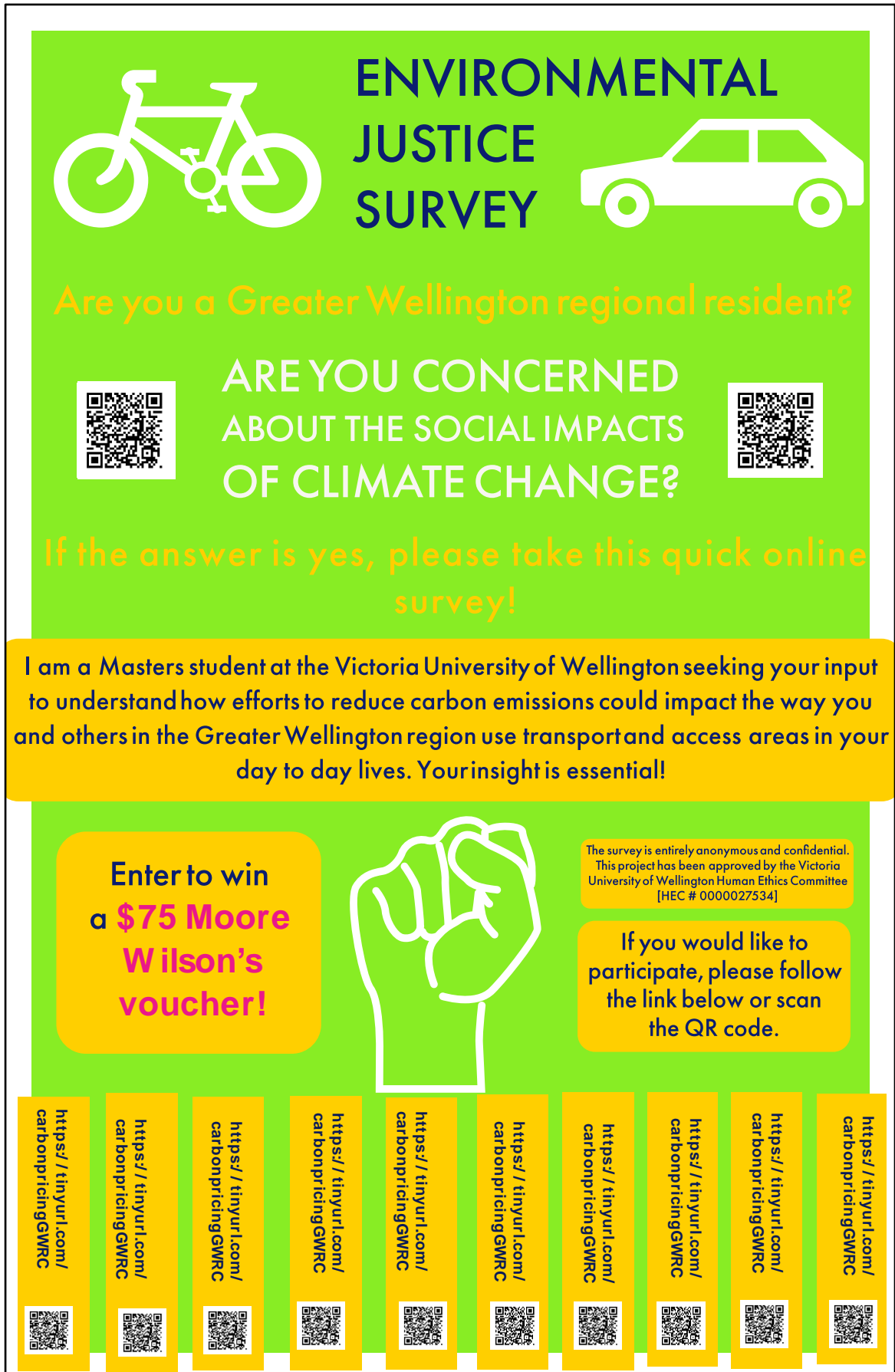
If you have any questions regarding this survey, please feel free to contact me at petredha@staff.vuw.ac.nz.

Alternatively, please contact my thesis supervisors:
Associate Professor Ralph Chapman: ralph.chapman@vuw.ac.nz or;

○ Yes, I would like to be entered in the prize draw survey! (1)

○ No thank you, I'm all done. (2)

End of Block: Conclusion/Prize Link

Appendix E. Information Sheet for Interview Participants

Masters Thesis:
Transitioning to a Low-Emissions Transport Sector
in The Greater Wellington Region

INFORMATION SHEET FOR INTERVIEW PARTICIPANTS

You are invited to take part in this research. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to participate, thank you for considering this request.

Who am I?

My name is HanLing Petredean and I am a Masters student in Environmental Studies at Victoria University of Wellington. This research project is work towards my thesis.

What is the aim of the project?

This project rests within the context of Aotearoa New Zealand's climate change mitigation commitments aiming to achieve net zero carbon emissions by 2050. My research seeks to understand motivators of low-emissions transport use in the Greater Wellington Region. This research has been approved by the Victoria University of Wellington Human Ethics Committee, ResearchMaster application reference # 0000027534.

How can you help?

You have been invited to participate due to your significant background in relation to my thesis research subject area. In particular, your perspective will carry a high degree contextual understanding and insight regarding a low-emissions transport sector transition in the Greater Wellington Region. If you agree to take part, I will interview you at the Victoria University of Wellington or at another preferred location. I will ask you questions about low-emissions transport, residential travel patterns and behaviour, and your insight into policy integration, the role of governance in implementing transition policies. The interview will take approximately 45 - 60 minutes. I will audio record the interview with your permission and write it up later. You can choose to not answer any question or stop the interview at any time, without giving a reason. You can withdraw from the study by contacting me at any time before 1 September 2019. If you withdraw, the information you provided will be destroyed or returned to you.

What will happen to the information you give?

This research is confidential. This means that the researchers named below will be aware of your identity but the research data will be combined and your identity will not

be revealed in any reports, presentations, or public documentation. Findings may be published and disseminated at future academic or professional conferences.

Only my supervisors and I will read the notes or transcript of the interview. The interview transcripts, summaries and any recordings will be kept securely and destroyed on 13 March 2020.

What will the project produce?

The information from my research will be used in my Masters thesis.

If you accept this invitation, what are your rights as a research participant?

You do not have to accept this invitation if you don't want to. If you do decide to participate, you have the right to:

- choose not to answer any question;
- ask for the recorder to be turned off at any time during the interview;
- withdraw from the study before 1 September 2019;
- ask any questions about the study at any time;
- receive a copy of your interview recording;
- read over and comment on a written summary of your interview;
- be able to read any reports of this research by emailing the researcher to request a copy.

If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact either me or my supervisor:

Student:	Supervisor:
Name: HanLing Petredean	Name: Associate Professor Ralph Chapman
University email address: petredha@staff.vuw.ac.nz	Role: Supervisor
	School: Geography, Environment and Earth Sciences
	Phone: 04 463 6153
	ralph.chapman@vuw.ac.nz

Human Ethics Committee information

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Dr Judith Loveridge. Email hec@vuw.ac.nz or telephone +64-4-463 6028.

Appendix F. Informed Consent Form for Interview Participants

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

VICTORIA
UNIVERSITY OF WELLINGTON

Masters Thesis:
Transitioning to a Low-Emissions Transport Sector
in the Greater Wellington Region

CONSENT TO INTERVIEW

This consent form will be held for a minimum of five years.

Researcher: HanLing Petredean, School of Geography, Environment and Earth Sciences, Victoria University of Wellington.

- I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time.

- I agree to take part in an audio recorded interview.

I understand that:

- I may withdraw from this study at any point before 1 December 2019 and any information that I have provided will be returned to me or destroyed.

- The identifiable information I have provided will be destroyed on 13 March 2020.

- Any information I provide will be kept confidential to the researcher and the supervisor.

- I understand that the findings may be used for a Masters thesis.

- I understand that the findings may be published and disseminated at future academic or professional conferences.

- I understand that the recordings will be kept confidential to the researcher and the supervisor.

- My name will not be used in reports and utmost care will be taken not to disclose any personal information that would identify me.

- I would like a copy of the recording of my interview: Yes ☐   No ☐

- I would like a summary of my interview: Yes ☐   No ☐

- I would like to receive a copy of the final report and have added my email   Yes ☐   No ☐
address below.

Signature of participant: 	_____

Name of participant: 	_____

Date: 	_____

Contact details: 	_____

Appendix G. Interview Guide

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

Masters Thesis:
Transitioning to a Low-Emissions Transport Sector
in the Greater Wellington Region

Interview Question Guide

1. **Introduction:**

   a. Discuss and sign the information sheet for participants and interview consent form.

   b. In terms of data confidentiality, I want to emphasise that your name will remain entirely anonymous. However, what level of description would you feel comfortable with? What do you do in terms of profession?

2. **Low-Emissions Transition**

   a. What are your thoughts regarding New Zealand's commitments towards achieving net zero emissions by 2050?

   b. How do you think this transition will impact the domestic transport sector?

   c. How would you characterise low-emissions transport demand in the Greater Wellington Region?

   d. What are the most effective mechanisms to reduce transport sector emissions in your opinion?

   e. What are the most effective *planning* strategies to promote greater uptake of low-emissions transport?

   f. What are the challenges of encouraging this transition?

   g. Do you think the Government should have a role in encouraging this transition? If so, which levels of government and why?
   h.

3. **Accessibility**

a. As a pivot of sorts, do you have any thoughts on the idea of accessibility? What do consider this concept to mean? What does it mean relation to transport?

b. How do you think a low-emissions transport sector specifically links to accessibility?

c. How is accessibility perceived in the current transport policy and planning process? If so, which levels of government and why?

d. What are the challenges of incorporating accessibility-based planning in the GWR?

4. **Conclusion**

   a. Do you have anything else you might want to add before we wrap up?