Global Evidence Base for the VKT Reduction Pathway

This report consolidates a diverse array of both local and international research sources, including research papers, academic studies, and modelling outputs. The coverage extends across various themes such as active modes, public transport, travel demand management and land use interventions, offering a database of findings and insights that support VKT Reduction Programme. The report includes a wide range of studies that provided a number of varying perspectives on how VKT reduction programme can become an effective pathway to enhance Auckland's transport system.

1.0 Active Modes Evidence Base

1.1 Package 1: Cycle Connectivity

1.1.1 Intervention: Upgrade and expand cycling network

Overview

This intervention proposes to upgrade existing cycle infrastructure (where currently unprotected) and provide new facilities to expand the cycle network to that of the Future Connect Network (regional, major and connector), as well as elements of the supporting FC network layer, where it overlaps with recommendations contained within the transit study. This translates to an expansive network connecting all communities across Auckland, with ~900km of cycle network being achieved.

Evidence Base

Increasing the cycling mode share is a key component of emissions reduction for many cities, considered one of the most effective and affordable means of reducing private vehicle use. Evidence from Auckland, wider New Zealand and international cities shows that this intervention shows great potential for Auckland to achieve this.

In an Auckland context, a study was completed to understand the effects after the implementation of contra-flow cycling on Federal Street, Auckland CBD. The study measured the safety, usability and comfort through cycle counts, crash data and the attitudes of road users. The results found that overall, contra-flow cycling has increased the volume of cyclists as there was an **82% increase of cyclists** on Federal Street between Kingston Street and Victoria Street West. In addition, **average vehicles speeds have decreased** (from 27.7 to 22.2 km/h) within the area which has improved the environment for vulnerable road users such as pedestrians and cyclists.

In a wider New Zealand context, Cambridge has demonstrated great success in delivering an extensive cycle network. Road space reallocation played an integral role in the roll out of this intervention in a timely and const effective way. The city is still in the process of addressing several notable gaps in its network, although a key facet of its success has been the focus on creating a cohesive and connected network of safe cycling routes, making cycling a viable mode of transport for a wide range of journeys and potential users. To show measurable results from the provision of cycle infrastructure in Christchurch, the Streets for People project trialled low-cost changes to streets and intersections (including a protected cycleway, kerb build outs and enhanced crossings). The study area included four schools, from primary to secondary, and the designs were developed based on surveys and workshops with children, parents and teachers. Results showed a **141 percent rise in active modes at school peak** times around Cambridge Primary School, including a **58 percent increase in cycling**, Mean speed reductions of 7-20 percent across all sites (schools and around the township), and **lower traffic volumes (from 2-68 percent) on three key roads** near schools.

Another New Zealand based study has also found a positive impact of new infrastructure on mode shift (Chapman et al., 2020). The before–after study investigated whether an initiative promoting active travel managed to change travel patterns of residents in New Plymouth and Hastings, known as the *Activating Communities to Improve Vitality and Equality (ACTIVE)* programme. The initiative aimed to provide safe urban environments that would encourage active travel, particularly among students and workers via fully integrated walking and cycling transport networks. In Hastings, to link the city to surrounding centres, the funding allocated by the ACTIVE programme was invested in developing four arterial paths (29.5 km) and connecting them with more than 50 km of marked on- and off-road walking and cycling 'collector' facilities. Meanwhile, as New Plymouth already had an extensive network of tracks, the allocated funding was used to connect and upgrade existing paths and to create an additional 12 km of off-road facilities and more than 20 km of on-road marked cycle lanes. Other interventions in New Plymouth included installing cycle parking, widening path entries, creating a number of shared spaces with reduced speed limits for vehicles (30 km/h), substantial media campaigns and events, and cycle-skills training at local schools (Chapman et al., 2020). The study found **that the odds of trips being made by active modes (walking or cycling) increased by 37%** in the intervention cities between baseline and post-intervention. **The net proportion of trips made by active modes increased by about 30%** relative to a background decline in active travel occurring in the control cities. **The net 30% increase in active trips implies a 5.3% decrease in the relative number of motorised trips** (Chapman et al., 2020).

In an international context, Seville is a prime example of a city which has heavily invested in cycling, with the roll out of an extensive cycleway network since 2005, which since the investment, has resulted in a t**enfold increase in cycling mode share**. The first 80km of its new network, which relied heavily on the transformation of existing traffic lanes and parking spaces, was built between 2005 and 2007, led to a **450% increase in cycling trips between 2006 and 2011**.

One study evaluated the impact of the Connect2 programme on promoting active travel, a five-year programme started in 2006 and consisted of developing new walking and cycling infrastructure in 79 communities around the UK (Song et al., 2017). The study looked at changes in travel behaviour before and after the construction of the new infrastructure in three selected sites – Cardiff, Kenilworth and Southampton – noting that the physical improvements differed among the selected sites. In Cardiff, the new infrastructure consisted of a traffic-free pedestrian and cyclist bridge connecting to the city centre. Similarly, in Kenilworth, a walking and cycling bridge crossing a busy dual carriageway was implemented. Meanwhile, the new infrastructure in Southampton involved a raised boardwalk linking the city centre and nearby residential areas along the shore of the River Itchen. **The study found that the experience of using the infrastructure was positively associated with a shift from private car use to walking and cycling**. However, some differences were found between the three selected sites in terms of total travel time, and total distance travelled. For instance, Southampton registered the largest changes towards active travel mode. In Kenilworth, a similar pattern of mode shift was found, but not to the extent of Southampton. On the contrary, in Cardiff, active travel decreased and driving mode share increased.

In Canada, Frank et al. (2021) looked at the impact that an infrastructure intervention had on cycling in downtown Vancouver. Specifically, the study looked at whether cycling trips will increase after the opening of a greenway for residents living within 300m of the facility compared to those living further away. The 2-km route is located in Vancouver's West End neighbourhood, a dense and mixed-use residential and commercial area. The infrastructure incorporated a range of cycling facilities and other streetscape changes to improve the walking and cycling experiences of the neighbourhood's residents. The changes were intended to reduce the amount of motor vehicle traffic, improve the level of comfort for vulnerable road users, and reduce traffic stress for pedestrians and cyclists using the facilities. The main finding of the experiment was that the **new greenway facility resulted in a 251% increase in cycling trips for the experimental group compared to the control group**, who lived further away.

Between 2005 and 2013, four cycle and pedestrian infrastructure programmes in pilot communities across the United States were funded to investigate the mode shift potential to active modes (Lyons et al., 2014). Investments included bicycle parking, 523 km of on-street bicycle facilities (300.9km bicycle lanes, 167.4km shared lane markings, and 54.7km bicycle boulevards), off-street infrastructure (footpath improvements), and outreach, education, and marketing to promote walking and bicycling. As a result, **walking mode share increased 15.8% from 2007 to 2013**. This represents an **increase from an estimated 12.8% of mode share to 14.8%. Bicycling mode share increased 44% from 2007 to 2013**. While this is a positive result, it should be noted that this is from a low base with mode share increasing from 1.0% to 1.5% in pilot communities. Cycling trips increased every year in each of the four communities. Project reporting estimated that **85.1 million VMT were averted by non-motorised trips between 2009 and 2013 relative to the 2007 baseline**.

1.2 Package 2: Bike Hubs and Bike Parking

1.2.1 Intervention: Expansion of bike hubs and bike libraries

Overview

This intervention proposes to ensure facilities to aid and encourage cycling, such as bike hubs and bike libraries) are provided across the city. It is proposed that 60 bike hubs will be provided across Auckland (including incorporated bike library), as well as all bike shops and Marae being equipped with bike library facilities. The 'Bikes at Schools' programme will also be extended to 150 schools, providing 50 mechanical bikes on site for students. Auckland Transport currently partners with a range of community organisations to operate a network of bike hubs across the city, which includes basic bike repairs, bike education, affordable bike sales, bike and gear safety checks, local information / advice, and events – all free of charge.

Evidence Base

In an Auckland context, EcoMatters have provided bike hubs in five locations across the city (Pakuranga, New Lynn, Henderson, Glen Innes and Queens Wharf). These bike hubs have been highly successful with over **50,000 visitors and 17,000 since their inception in 2017, as well as having 990 bikes donated** in the year 2021-2022 alone.

An evaluation of the impact of the New Lynn EcoMatters bike hub was completed by Lissy Fehnker in 2018, which aimed to better understand the extent of progress made within one year of operation.

This study found that on average, 25% of users attended the bike hub to get their bike repaired, 18% to learn a new skill, 14% a donate a bike, 9% to buy a bike and 9% to socialise.

The hub saw a notable increase in visitors, volunteers, bike repairs and bike donations between 2017 and 2018, as shown below.

1.2.2 Intervention: Expansion of bike parking

This intervention proposes to ensure that bike parking and e-bike park and charge facilities to aid and encourage cycling are provided across the city. It is proposed that ~120k bike parks and ~9k e-bike park and charge ports will be provided across Auckland.

Evidence Base

Cervero et al. (2013) conducted a study if the Bay Area Rapid Transit (BART) system, to understand if the provision of high quality bike parking facilities at transit stations resulted in an increase in bicycle mode share of trips, dubbed "built it and they will come." This research stressed the importance of separate, protected facilities in encouraging cycling more broadly, finding that among the system's 42 stations, **the presence of bike stations and increases in bike rack and electronic locker spaces were statistically associated with increased bicycle access trips to BART.** Such improvements are not "amenities" but rather basic "provisions," not unlike the provisions for safe and convenient facilities provided to park-and-riders. Dutch and Danish cities show that directing significant shares of municipal budgets into bicycle and pedestrian improvements translates into significant shares of trips being made by non-motorized modes.

Another study based in the United States, conducted by Hamre and Buehler (2014) investigated the impact on automobile trips when providing differing facilities such as free car parking, PT benefits, showers/lockers and bike parking. This research found that **the provision of bike / walk benefits (showers, lockers, bike parking) were significant for the choice between cycling and driving.** Although some commuters who walk to work may also benefit from showers/lockers, this analysis did not find a significant effect for these facilities for the choice between walking and driving in the full model. It is likely that most regular pedestrians would not need a shower after walking to work.

The impact of infrastructure-based improvements (either free or paid-for) in the workplace setting has also been studied in the context of Cambridge in the UK (see Patterson et al., 2020). Specifically, the study looked at the associations between changes in the physical and social workplace environment and changes in commute mode over one year. Changes in the social workplace environment were measured as the modes of transportation used by colleagues and senior management to travel to and from work (i.e., walking, cycling, and driving). The study found some gender-related differences. For example, an increase in active commuting was associated with improvements in the physical workplace environment among men, while a supportive social workplace environment was associated with improvements in women. In this

sense, regarding males, **changes in the workplace environment supporting active travel (i.e., new or additional bicycle parking and/or shower facilities) were found to be associated with a 3.3% reduction in the proportion of commutes by private motor vehicle, and active travel among men increased by 4.4%**. It should be noted that these associations were not seen in women.

1.3 Package 3: Walking Connectivity

1.3.1 Intervention: New footway connections and wider footpaths

Overview

This intervention seeks to improve and expand the existing walking network to provide a more equitable walking network that enables safe participation for people of all ages, abilities and backgrounds. 73.6km of new walking infrastructure is proposed, as well as 1,163km of footpaths being widened to 1.8m.

Evidence Base

In a New Zealand context, similarly to Package 1, the Streets for People project trialled low-cost changes to streets and intersections (including a protected cycleway, kerb build outs and enhanced crossings in Cambridge, Hamilton. he study area included four schools, from primary to secondary, and the designs were developed based on surveys and workshops with children, parents and teachers. Results showed a **141 percent rise in active modes at school peak times** around Cambridge Primary School.

On an international basis, new walking infrastructure was shown to increase pedestrian volume and perceived walking experience in Portugal (Cambra & Moura, 2020). This project aimed to improve walking conditions in three sites, with each site having distinct improvements that included green spaces, sidewalks, outdoor seating, and redesign of allocated space for private cars, public transportation, parking and bicycles. New cycling infrastructure was also built, and no changes in local transport services were made. The project was implemented from June 2016 to February 2017. The before–after study assessed whether the new infrastructure enhanced walkability in pedestrian volumes and walking experience. The **pedestrian volume increased**, at different levels, across the intervention sites. **People reported a more satisfying walking experience following the intervention, with a positive relationship found between the magnitude of change in walkability and the changes in pedestrian volume and walking experience.**

Additionally, Knell et al (2019) conducted a study to examine changes in self-reported and accelerometer-derived physical activity associated with living near recently improved sidewalks within Houston, Texas. This research found that individuals living within proximity to two or more sidewalk improvements reported a **60% increase in time spent walking each week**.

A study conducted by Manoj and Verma (2016) investigated the effect of built environment measures on trip distance and mode choice decisions in India. One of the measures investigated is whether neighbourhoods have footpaths of adequate width available. The analysis of mode choice behaviour found that **those who live in neighbourhoods having footpaths of adequate width available made walking a more attractive mode, with increased walking trips for household / business trips, and amongst families with school-going children.**

A study conducted by Song et al. (2017) analysed to track changes in travel behaviour following provision of new walking infrastructure so that modal shift from private car use to walking can be investigated. This study found that infrastructure provision alone was not a sufficient condition for modal shift, however, the findings of this study support the construction of walking and cycling routes, but also suggest that **such infrastructure alone may not be enough to promote active travel**.

1.4 Package 4: Increased Crossings

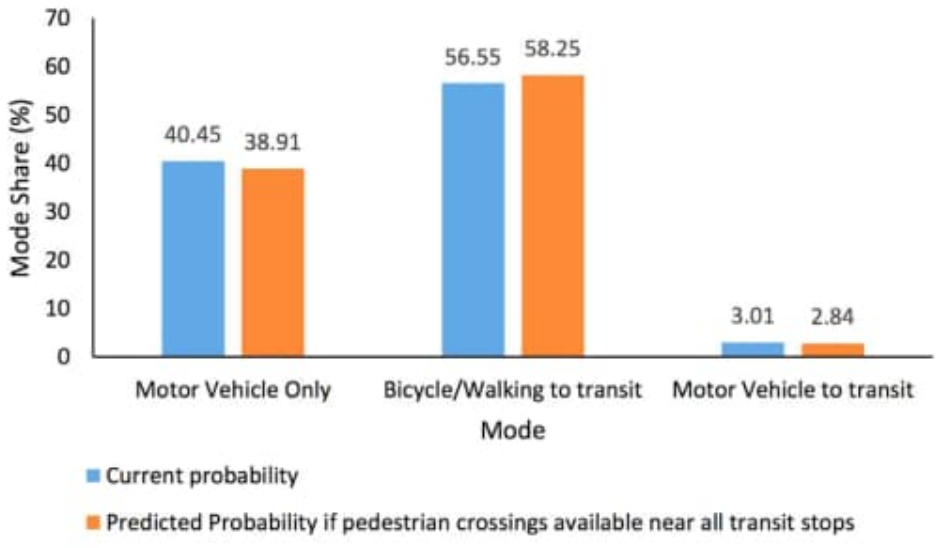
1.4.1 Intervention: Provide crossings around transit stations (where absent)

Overview

This intervention proposes the provide adequate active mode crossings in the vicinity of all RTN stations across Auckland, as identified within the transit study. A total of 1,287 crossings are proposed around 81 stations.

Evidence Base

A study conducted by Mohanty et al (2017) investigated the effect of integration of cyclists and pedestrians with transit in New Delhi. This research highlighted how traditionally, transportation mode shares in cities have been calculated separately for walking, bicycling and public transport. However, it is well known that all PT trips have a component which is mostly executed through walking or cycling. Hence, the choice of whether to choose transit for a particular trip depends as much on the walking or bicycling component of the trip as the transit component itself. This research aimed to study behavioural effects of integrating bicycling and walking infrastructure with transit and provide predictions for outcomes of policy implementations modifying bicycle-to-transit or walk-to-transit environment in New Delhi. Various variables were selected that affect active mode access to transit, including crossings. This research found that the **presence of pedestrian crossings in proximity to a transit station positively influences approximately 96% of the population to walk to transit**, identified as the most effective means of positively impacting walking trips. This study modelled the impact of the presence of pedestrian crossings near all transit stations to understand its impact on mode share. In this scenario, enough pedestrian crossings were marked to allow easy access from any transit station. The results found that under this scenario, **mode share for bicycle / walking (both alone or to transit) increases by 1.7%**, while the mode share for **motor vehicles (alone) decreases by 1.54%** and **motor vehicles (to transit) decreases by 0.17%**.



1.5 Package 5: Improved Access

1.5.1 Intervention: Improve and increase provision of wayfinding facilities

Overview

This intervention proposed to expand and enhance the provision of wayfinding facilities around 50 RTN stations, busway stations, train stations and ferry terminals, as well as fixing wayfinding at the top 1,000 bus stops with shelters. Additionally, provide multi-modal uniform wayfinding design across all urban centres.

Evidence Base

Among the clearest indicators that wayfinding plays a key role in the promotion of walking comes from Legible London (UK), one of the most extensive and prominent urban wayfinding initiative to date. The Legible London programme aims to provide a user-focused world-class integrated system of wayfinding information to support pedestrian movement in the capital to tackle the key barrier to walking: a lack of clear and consistent on-street information. Transport for London (TfL) conducted an evaluation of the pilot study for the Legible London programme is 2010. This report compared a range of indicators between the baseline and post-implementation conditions, including mode shift. Survey respondents indicated that they expected that Legible London would increase their walking. Quantitative results found that between 2009 (pre-implementation) and 2010 (post-implementation), there was a **5% increase in pedestrian counts on weekdays, and a 7% increase at the weekend.**

1.5.2 Intervention: Increase the provision of inclusive infrastructure

Overview

This intervention proposed to expand and enhance the provision of inclusive infrastructure (dropped kerbs, tactile paving and audio aids), streetlighting and additional animal control officers to ensure walking is accessible for all members of society.

Evidence Base

'Walking for Everyone' is a guide created by Living Streets, Sustrans and Arup (2022) with the goal of making walking and wheeling more inclusive. This document explains how disabled people take far fewer trips every year than non-disabled people, with the National Travel Survey for England finding that people with a mobility-related disability take 38% fewer journeys each year by any mode of transport than non-disabled people. This is partially a result of barriers, including walking and wheeling, that can lead to isolation, reduced physical activity, not being able to access services and amenities, and poor mental wellbeing.

Traffic Choices (UK) highlights the advantages associated with inclusive infrastructure. They have detailed how dropped kerbs not only allow wheelchair and mobility scooter users to easily cross the road but can also be used as guiding pedestrians to cross at the safest point in the road. Tactile paving not only helps visually impaired and blind people to identify a suitable crossing point, but the colour and presence of such paving also helps alert vehicle drivers to the existence of the crossing point. While there is limited research on the specific impact of the presence of such infrastructure, the likely outcomes identified from Traffic Choices are that these facilities make it **easier for pedestrians to use local roads, especially those with a disability. Helping disabled people move around the local area with dropped kerbs allows them to stay active and maintains their access to local facilities. For other pedestrians, dropped kerbs make**

it easier to walk around the local area – keeping walking as a healthier, cheaper and environmentally friendly alternative to using a car.

1.6 Package 6: Low Traffic Neighbourhoods

1.6.1 Intervention: Provide low traffic neighbourhoods across Auckland

Overview

This intervention proposes the roll out LTNs across Auckland to encourage residents to engage in active modes when completing short-medium distance journeys. There is a total of 87 LTNs proposed across Auckland.

Evidence Base

London is the primary evidence source for the impact of low traffic neighbourhoods, with 101 LTNs being introduced in 2020 and 2021. A host of monitoring and evaluation has been completed across these LTNs to understand their impact on trip frequency, trip length and mode shift. Various results from these studies are detailed below.

A study was undertaken by Bosetti et al (2022) to understand how LTNs across London were impacting mode shift, vehicle trips and car ownership on an individual basis. The findings of this research are detailed in the tables below.

Changes in walking and / or cycling inside and outside selected London LTNs

Study Area	Change in active mode use inside LTN	Change in active mode use outside LTN
Lambeth – Railton	58% increase in cycling	31% increase in cycling
Lambeth – Tulse Hill	69% increase in cycling	43% increase in cycling
Lambeth – Oval to Stockwell	87% increase in cycling	Not available
Waltham Forest – Maryland	125% increase in cycling	Not available
Waltham Forest – Odessa	172% increase in cycling	Not available
Waltham Forest – Langthorne	37% increase in cycling	Not available
Waltham Forest – Montague and Woodhouse	56% increase in cycling	Not available

Changes in car traffic

Study Area	Change in car traffic within the LTN (average)	Change in car traffic on peripheral roads (average)
Lambeth – Railton	58% decrease	11% decrease
Lambeth – Tulse Hill	35% decrease	7% increase
Lambeth – Oval to Stockwell	25% decrease	8% decrease, but some nearby roads up to 28% more traffic.

Hackney – London Fields	44% decrease	21% decrease
Hackney – Homerton	35% decrease	5% decrease
Waltham Forest and Newham – Maryland	76% decrease	19% increase
Waltham Forest and Newham – Odessa	61% decrease	3% decrease
Waltham Forest and Newham – Langthorne	31% decrease	9% increase
Waltham Forest and Newham – Montague and Woodhouse	22% decrease	2% increase

Changes in car use or ownership inside and outside selected London LTNs

Study Area	Change in car use or ownership	Assessment method
Kingston, Enfield and Waltham Forest Mini Hollands	People living in LTN areas have become less likely to own a car, and to have used a car in the past week, and spent less time using a car, than people living in other outer London boroughs where Mini Hollands weren't introduced.	Longitudinal resident survey (the same residents were surveyed over three years)
Kingston, Enfield and Waltham Forest Mini Hollands	• In the Waltham Forest LTN there was a 7% decrease in car and van ownership per adult compared to outer London areas without Mini Hollands. • In other Mini Holland areas that didn't include an LTN but had other active travel infrastructure (such as protected bike lanes) there was a 4% decrease in car and van ownership per adult.	Driver and Vehicle Licensing Agency (DVLA) data on car and van ownership

Another London based study found living in an LTN was associated with decreased car ownership and use (Aldred & Goodman, 2020). It surveyed residents in three areas in outer London that received funding from the Transport for London Mini-Hollands programme. It separated survey respondents into those living in areas that received funding and those who did not. It further specified whether the area received a 'high-dose' intervention (with substantial infrastructure improvement) or 'low-dose,' and whether it implemented an LTN (by removing private vehicle through-access). It measured results in 2017, 2018, and 2019 compared to a 2016 baseline**. People in LTNs became less likely to own a car each year studied; by 2019, the survey found residents of high-dose LTNs were 20% less likely to own a car**, while no change was found in the other intervention groups (Aldred & Goodman, 2020). In 2018, residents in **high-dose LTNs reported 43 fewer minutes of car use per week than people living in neighbourhoods that did not** receive funding from the Mini-Hollands programme. In 2019, they reported an average of **17 fewer minutes driving per week compared to 2016. Residents of LTNs were also more likely to report**

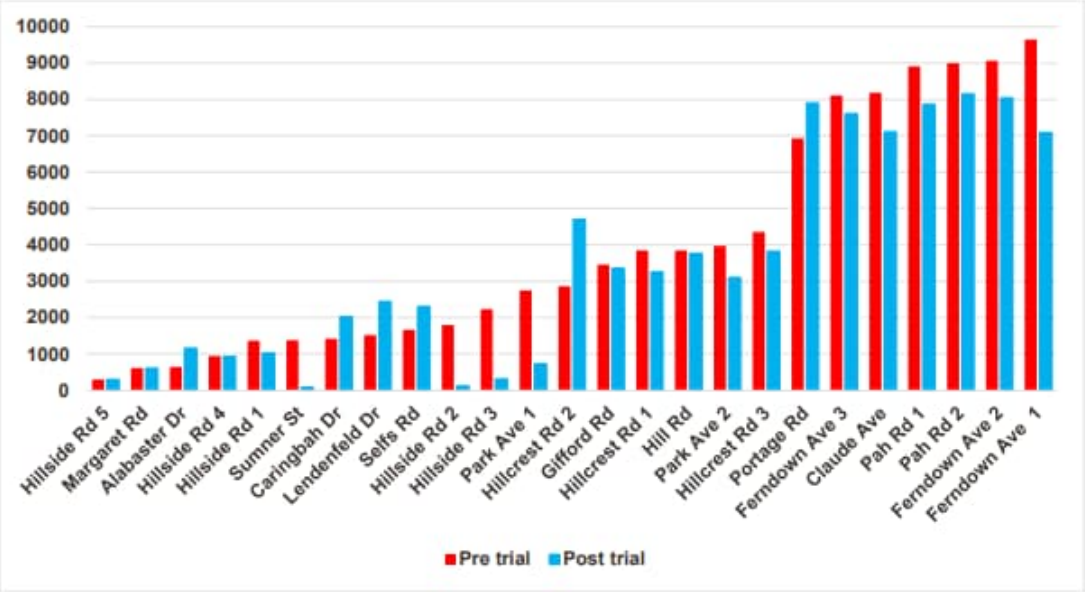
spending more time walking and cycling than residents from other areas. The study contained wide confidence intervals, suggesting it is too early to draw firm conclusions from this initial study. However, these results suggest LTN interventions may have contributed to reduced VKT among residents in LTNs. Other early research also suggests that reduced traffic within an LTN is not offset by increased traffic elsewhere. Early research from trial LTN interventions suggested that the decreases in vehicle volumes within the neighbourhood were more significant than increases on streets surrounding the neighbourhood (London Borough of Waltham Forest, n.d.), though further research is needed to draw more precise conclusions as to the relationship on area-wide traffic volumes.

Another study undertaken by Possible (a UK based climate change charity) evaluates how LTNs affect the usage motor vehicles in London, specifically the 46 LTN schemes were introduced between May 2020 and May 2021. The results of the study show that with the implementation of LTNs there was a **reduction in motor traffic usage on 74% of internal roads**. LTNs have contributed to approximately a **50% reduction in the median and mean traffic volumes on internal roads** (1,226 to 666 vehicles and 1,816 to 964 vehicles respectively). However, LTNs were not as impactful on boundary roads as 47% of boundary roads saw a reduction in motor vehicles and 53% experienced an increase.

On a more localised level, a study completed by Goodman et al (2023) examined how residents' driving changed after the implementation of five low traffic neighbourhoods (LTNs) in Lambeth, London. This research found that the pre/post change in mean past-year driving was **-0.7km/day among residents living inside the LTNs (from 20.3km/day to 19.6km/day)**, and +0.6km/day among residents in the control area (20.4km/day to 21.0km/day) This corresponds to a difference-in-differences effect of -1.3km/day (95%CI -2.4 to -0.3) in the LTN versus control areas, or a **6.4% decrease** in relative terms.

While there is limited data in an Auckland context, the Otara-Papatoetoe local board prepared a monitoring and evaluation report for the Papatoetoe West LTN in 2021, which investigated the impact of the LTN on local travel patterns. Traffic volume and speed data was monitored for 7 days pre-installation and 14 days post-installation, which found that overall, **speeds reduced on 18 of the 25 monitored streets, with an average 85th percentile speed reduction of 50km/h to 46km/h**, with operating speeds reduced to 44km/h for school frontages in the local area. The monitoring also found that **motor traffic reduced by 9% for the monitored area**, with 19 of the 25 roads showing motor traffic volume reduction, with the detail breakdown shown below.

Figure 10: Changes in traffic volumes (Average Annual Daily Traffic) pre– and post–trial



2.0 TDM Evidence Base

2.1 Package 1: Parking Management

2.1.1 Intervention: Increase parking cost

Overview

Review parking pricing structures and enforcement with view to double or triple parking fees - develop a parking charging strategy throughout the city.

Evidence Base

MRCagney (2014) reviewed 32 previous research papers on parking elasticities. This research concluded that the elasticity of car travel demand with respect to parking prices, principally related to commuters, is likely to fall in the range of -0.10 to -0.60. They recommend a 'best guess' elasticity of commuter car travel with respect to CBD parking changes of -0.30, meaning **a 10% increase in price will lead to a 3% reduction in demand.**

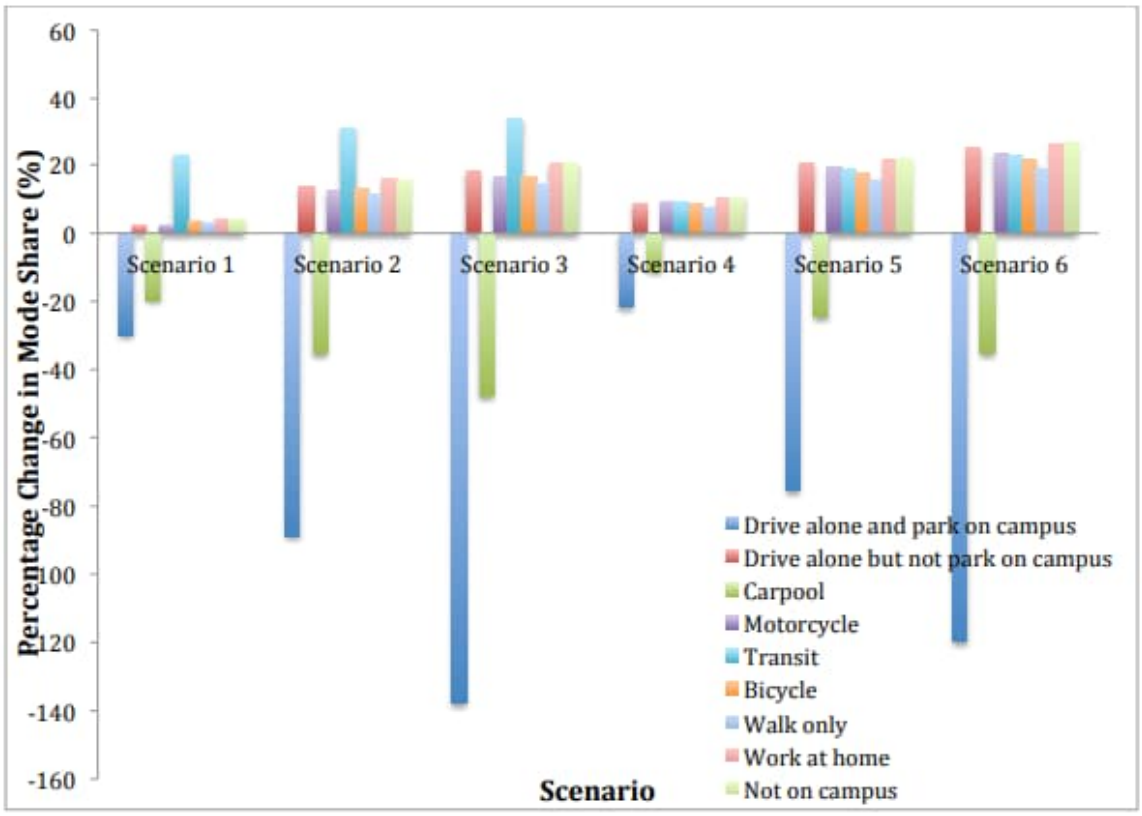
Marsden (2006) undertook a similar literature review and drew similar conclusions with respect to commuter parking, finding a range of parking demand elasticities relating to pricing from -0.1 to -0.6. The study found significant variations to an average of -0.3, depending on circumstance, such as the availability of other parking options.

Marsden (2006) also reviewed the more limited evidence on elasticities for non-commuter parking, principally retail parking, finding that some studies, but not all, suggest that demand for retail parking is more sensitive to price than demand for commuter parking. Ostermeijer et al (2019) found that **Amsterdam residents own about 30% more vehicles if parking is bundled (included at no additional cost) with housing** compared with what they would own if they were forced to pay directly for parking at home.

Additionally on a Dutch context, 1995 was a turning point for mode shift in the city, of Amsterdam after city-controlled parking tariffs were introduced. In 2001, the city government estimated that **without parking tariffs, car use within the city ring would have increased by 13% instead of the observed reduction**. Another report estimates **the effect of paid parking has been a 20% decrease in car traffic in the inner city, as well as a 20% reduction in traffic searching for a space to park** (Hermann and Kodransky 2011). Amsterdam has continued to increase parking prices to manage demand and now has some of the highest hourly on-street parking rates in Europe. The revenue generated supports parking management and the Amsterdam Mobility Fund, which is spent on public transport and active modes.

Wei-Shiuen Ng (2014) completed a study to assess the impact of parking pricing on transportation mode choice and behaviour at the UC, Berkeley campus. The main objective of this study was to analyse whether and to what extent changes in parking policies can alter commuters' mode choice and parking preferences given different travel constraints, options and needs. The impact on mode choice was modelled for six different scenarios, as shown in the figure below. The baseline for the scenarios reflects actual travel and parking prices used in the analysis. On-campus parking prices can range from $2.25 to $16 per day depending on the type of campus parking permit purchased, while off-campus parking prices depends on parking location and were assumed to range from zero to $13.36 per day. Carpool parking prices also depends on the University affiliation of the employee, which determine the type of carpool parking permit purchased. Transit fare has a wide rage starting from $1.85 to as high as $36 per trip depending on the residential location of the employee and the transit services chosen to travel to campus. In Scenarios 1, 2 and 3, transit fare would be fully subsidized by the University, while in Scenarios 4, 5 and 6, transit fare is the same as in the baseline. This research found that **raising daily on-campus parking prices will certainly decrease driving and lead to an increase in other mode shares. When transit fare is fully**

subsidized, there will be further decreases in drive alone share (up to approximately 18 percent) compared to when transit is not subsidized.



A similar trend occurred in Portland, Oregon when on-street parking was priced (having been previously free) and when transit discounts were given to commuters (Bianco, 2000). Using a multinomial logit model, Hess (2001) **found that with free parking, 62 percent of commuters will drive, and 22 percent will use public transport, while when there is $6 daily parking fee, the percentage dropped to 46 percent for driving and increased by 50 percent for public transport** in Oregon and Southwestern Washington.

A study by ICF (1997) indicates that a $1.37 to $2.73 increase in **parking fees reduces auto commuting 12-39%, and if matched with transit and rideshare subsidies, reduces total auto trips by 19-31%**. A survey of automobile commuters found that **nearly 35% would consider shifting to another mode if they were required to pay for parking, with fees** of $1-3 per day in suburban locations and $3-8 per day in urban locations (Kuppam, Pendyala and Gollakoti, 1998). The table below shows the typical reduction in automobile commute trips that result from Parking Pricing.

Worksite Setting	$1	$2	$3	$4
Low density suburb	6.5%	15.1%	25.3%	36.1%
Activity center	12.3%	25.1%	37.0%	46.8%
Regional CBD/Corridor	17.5%	31.8%	42.6%	50.0%

One study estimates that **pricing commuter parking can reduce total regional VMT up to 4.0%,** and that **parking pricing for non-work trips could reduce regional VMT by another 4.2%** (Apogee, 1994). Deakin and Harvey (1997) model the effect of minimum employee parking charges in four major urban regions in California. The table below summarises their results. It indicates, for example, that in the South

Coast (Los Angeles) region, **a $3 per day parking fee would reduce total vehicle trips by about 2.8%, and congestion delay would decline by a much larger amount (8.5%)**.

Region	Price	VMT	Trips	Delay
Bay Area	$1.00	-0.8%	-0.9%	-2.7%
	$3.00	-2.1%	-2.4%	-7.0%
Sacramento	$1.00	-1.0%	-1.1%	-2.5%
	$3.00	-2.6%	-2.8%	-6.5%
San Diego	$1.00	-0.9%	-1.0%	-2.5%
	$3.00	-2.4%	-2.6%	-7.0%
South Coast	$1.00	-0.9%	-1.1%	-2.9%
	$3.00	-2.5%	-2.8%	-8.5%

2.1.2 Intervention: Workplace Parking Levy

Overview

Workplace parking management: in Tier 3 parking zones - mandating workplace car park charges

Evidence Base

Employer-paid parking is an implicit incentive for commuting by car. Russo, van Ommeren and Dimitropoulos (2019) provide insights into the effects of employer-paid parking on car use and the environment. In a typical European and North American city, the cost incurred by firms to provide a parking space has been estimated at EUR 5 per day per parking spot. Taking into account the average length and duration of commuting trips, the value of in-vehicle time, average fuel economy and the retail price of gasoline, the authors calculate that the average cost of a commuting trip by car (excluding parking) is about EUR 12 a day. This means that the supply of free parking to employees implies a subsidy equal to around 30% of the private costs of the trip. Considering a demand elasticity of car use with respect to private costs equal to -0.5 (Litman, 2017), **the demand for car commuting is inflated by about 15% due to the provision of free parking at the workplace**.

In a UK-based study, Knott et al. (2019) investigated whether changes in workplace car parking policies were associated with changes in commute mode. The study was conducted with adults aged 16 and over who worked in Cambridge and lived within 30 km of the city. Some aspects to consider for the study were that employees in Cambridge tend to commute to work by car less that the average in the UK, and that the city has a distinctive cycling culture (Knott et al., 2019). The main finding of the study was that **relaxations of parking policies (less restrictive of motor vehicle use) were associated with higher proportions of commute trips made exclusively by motor vehicle. In this respect, the proportion of trips undertaken solely by motor vehicle was 11.4% higher. Meanwhile, rates for trips involving walking and/or cycling (−13.3%) or public transport (−5.8%) were lower.**

An evaluation of Nottingham's Workplace Parking Levy (WPL) found a positive impact of the workplace parking level (WPL) scheme in terms of decreased vehicle trips and change to sustainable travel modes (see Dale et al., 2019). In April 2012, Nottingham became the first UK City to implement the WPL. The scheme was set up to charge employers who had over 10 liable workplace parking spaces within the city. The objective of the scheme was to reduce congestion in the city by increasing the effective cost of commuting by car while also funding transport improvements that would incentivise mode shift. The evaluation conducted by Dale et al. (2019) included data from a survey collected in 2016 from 2,500 commuters in Nottingham. The survey was supplemented with data provided by the city council showing

the changes to mode share for mechanised modes (car, bus, tram and motorbike), public transport patronage, and the number of cycle trips over time between 2007 and 2017. The study found that **8.6% of car-based commuters switched to sustainable modes between 2010 and 2016 at least in part due to the implementation of the WPL** and/or the associated transport improvements. When looking at the data regarding travel mode among those who switched from driving a car, **13.1% of cyclists indicated that their decision was due at least in part to the introduction of the WPL scheme, while 4.2% said they did so because of the WPL as a standalone scheme. Percentages among bus users in this respect were 7.3% and 5.4%, respectively, while for train users 7.1% and 3.5%.** Dale et al. (2019) points out that the data suggests an increase in the mode share of public transport from 2010 to 2017; however, they clarify that the increase was also registered prior to the introduction of the WPL scheme. In addition, the study found evidence of commuters switching to the car away from other modes, suggesting a significant suppressed demand for travel by car, which may counterbalance some of the beneficial impacts of the WPL scheme.

Most current parking pricing studies have focused on its impact on parking space demand (Kulash, 1974; Kelly and Clinch, 2009) and fewer empirical studies of parking pricing changes have considered mode choice impacts. Surveys tracking parking pricing changes in Los Angeles city centre and suburbs have shown that **when employers stopped paying for parking, the number of solo drivers decreased substantially, between 19 and 81 percent depending on the location**. Likewise, the **use of private vehicle as a commuting mode had decreased by 15 – 38 percent after the removal of parking subsidies** (Willson and Shoup, 1990; Surber et al., 1984).

Another Los Angeles modelling study estimated that there would be **23 to 24 percent fewer automobile commute trips overall if employees are expected to pay market rates for parking**, as opposed to receiving free parking**. Free parking led to a 70 percent chance of solo commuting, but this percentage dropped to only 39 percent when drivers were asked to pay a daily parking fee** (Willson, 1992).

2.2 Package 2: Road User Charging

2.2.1 Intervention: Increase fuel duty and extend regional fuel tax

Overview

Low increase fuel duty for private vehicle use (inflation + 5%) and extend regional fuel tax.

Evidence Base

Fuel prices, and the external costs of energy consumption (such as the economic costs to petroleum importing countries, and environmental costs of carbon emissions) are predicted to increase and fluctuate significantly in the future due to growing demand and rising production costs (Magoon 2000), so higher fuel taxes are justified now to increased transport system efficiency, so the future economy is less burdened by excessive fuel costs. Fuel is the largest and most visible motor Vehicle Operating Expense. Increasing vehicle operating costs tends to reduce vehicle travel. For this reason, fuel tax increases are sometimes proposed as a way to reduce driving and increase transport system efficiency. **Higher fuel prices cause a combination of reduced driving and increased vehicle fuel efficiency** (Institute for Transport Studies 2004; CBO 2008). **Short-term fuel savings consist of reduced driving and a shift toward more fuel-efficient vehicles owned in multi-vehicle households**. Over the long-term, higher fuel prices encourage consumers to purchase more fuel-efficient vehicles. About two-thirds of long-term fuel savings typically come from increased fuel efficiency and one third from reduced vehicle travel.

The price Elasticity of gasoline is typically about -0.3 in the short run and -0.7 in the long run, meaning that a **10% price increase reduces fuel consumption 3% in a year or two, and 7% in five to ten years** (Litman 2013). DeCicco and Gordon (2003).

Deakin and Harvey (1997) model the effect of a fuel tax increase on transportation impacts in four major urban regions in California. The table below summarises their results for the year 2010. It indicates, for example, that in the South Coast (Los Angeles) region, **an additional 50¢ per gallon tax would reduce total vehicle trips by only about 3.5%, but congestion delay would decline by 9.5%, and fuel consumption would decline by 9.3%.** Another study finds that a **$0.40 increase in fuel prices would reduce regional vehicle trips by 1.2% and vehicle mileage by 1.4%, while a $2.00 increase would reduce trips by 6.7%, and mileage by 7.2%** (PSRC 1994).

Region	Tax Increase	VMT	Trips
Bay Area	$0.50	-3.6%	-3.4%
	$2.00	-11.7%	-11.3%
Sacramento	$0.50	-4.1%	-3.9%
	$2.00	-13.2%	-12.7%
San Diego	$0.50	-3.9%	-3.5%
	$2.00	-12.5%	-12.0%
South Coast	$0.50	-4.2%	-3.5%
	$2.00	-13.0%	-12.5%

Singapore has implemented several measures to reduce the inequalities borne from car restriction policies. For example, cars with an OMV higher than NZ$22,200 pay a higher additional registration fee. A number of measures have resulted in a high cost of car ownership across Singapore, which according to several researchers, these **taxes, fees and duties were effective in substantially reducing the growth in vehicle ownership**, which was further restrained by the Vehicle Quota System (VQS) after its introduction in 1989. **From 1973 to 1982, vehicle growth increased 35%, significantly below the 100% to 150% projected by the OECD** (Olszewski 2007).

2.2.2 Intervention: Road User Charing

Overview

Implement road user charges (RUC) for all vehicles ($0.1 distance charge).

Evidence Base

In an experiment, the effect of economic disincentives on private car use was investigated in the context of the Swedish city of Gothenburg (Jakobsson et al., 2002). A total of 80 two-adult households were recruited for the study and assigned randomly to one control and three experimental groups. Participants in the experimental and control groups logged their car trips during one week before, one week during, and one week after treatment. Data was collected between January 1999 and April 2000; however, during major holidays no data gathering was conducted as daily travel was expected to differ significantly. The households in the experimental groups were charged per kilometre of driving their car(s) during a designated period (2 and 4 weeks). Households agreed to pay back SEK 10 (approximately NZ$1.53) per 10 km of driving their car(s). This corresponded roughly to a 100% increase of the cost for driving. The study found that car use decreased but only during the time of the intervention. In this regard, more

households in the experimental groups than in the control group reduced both weekly frequency of car use and driving distance. **For instance, households who were charged per km of driving reduced their weekly frequency of trips as well as driving distance from 55% to 45% in both cases. Households who were charged and asked to plan car use registered a reduction of 10% in both weekly trip frequency and weekly driving distance.**

Distance-based vehicle fees (also called pay-as-you-drive, usage-based and per-kilometre pricing) mean a vehicle's insurance premiums and registration fees are based directly on how much it is driven (Bordoff and Noels 2008; Ferreira and Minike 2010). The more you drive the more you pay and the less you drive the more you save. Existing pricing factors are incorporated so higher-risk motorists pay more per unit than lower-risk drivers. For example, a $500 annual insurance premium becomes $0.04 per kilometre, and a $2,000 annual premium becomes $0.10 per kilometre, giving higher-risk drivers the greatest incentive to reduce their vehicle travel. If fully implemented this is expected to **reduce affected vehicle travel by 10% to 15%,** but is not a new fee, just a different way to pay existing fees. Because higher-risk drivers have a greater incentive to drive less it can provide proportionately large crash reductions, so a 12% reduction in vehicle travel is likely to reduce crashes by 15% to 20% (Greenberg and Evans 2017; Litman 2012).

Some older research conducted by Deakin and Harvey in 1997 calculated the predicted vehicle travel reductions predicted from mileage-based fees. The estimates for 2001 rates are shown below.

Mileage Fee	Travel Reduction
1¢	-1.8%
2¢	-3.5%
3¢	-5.1%
4¢	-6.7%
5¢	-8.2%
6¢	-9.7%
7¢	-11.2%
8¢	-12.5%
9¢	-13.8%
10¢	-15.2%

This research also modelled the impact of a 2c per mile distance charge for four Californian regions, with estimates based on the year 2010. The table below details this.

Region	VMT	Trips	Delay
Bay Area	-3.9%	-3.7%	-9.0%
Sacramento	-4.4%	-4.1%	-7.5%
San Diego	-4.2%	-4.0%	-8.5%
South Coast	-4.3%	-4.1%	-10.5%

2.2.3 Intervention: Congestion Charging & Motorway Tolling

Overview

Implement the congestion charge around city centre and a motorway toll in three locations ($4.06 for AM/PM, $1.74 for IP).

Evidence Base

Congestion charging or road pricing is defined as 'charging vehicles for use of specific roads during specific times and days, in order to reduce the severity and duration of congestion on the network' (Ministry of Transport, 2020, p. 3). Numerous studies have found positive impacts of congestion charging in congestion reduction in Gothenburg, Stockholm, London and Singapore. However, the extent of the reduction varied across these cities due to different conditions and need for additional actions. These included the level of maturity of the public transport system, provision of additional public transport, further infrastructure to support alternative modes of transportation, the topographical characteristics of sites of intervention, and/or the existence and impact of policies restricting car ownership. Another aspect outlined in the papers reviewed was that because charging drivers for road use can be contentious, there is a need for consultation with key stakeholders as well as political leadership during design and implementation of this sort of intervention.

In January 2006, Stockholm introduced a cordon-based congestion charging system with the purpose of improving air quality and reducing traffic congestion in Sweden's capital city. Vehicles travelling into and out of the cordon were charged for every passage during different hours of weekdays. The congestion charge system also consisted of extended public transport (16 new bus lines) and more Park and Ride (PnR) sites in the city and the county. The total public transport service was extended by 7% and the PnR capacity was extended by 29%. An evaluation of the initiative was conducted by Johansson et al. (2009) via modelling of road traffic. To assess the impact of the initiative, traffic flow (e.g., number of vehicles and road use) was calculated. Congestion was quantified based on floating car measurements or from traffic cameras. The study estimated a **15% reduction in total road use within the charged cordon while the reduction in total number of vehicle passages over 24 hours was 22%.** The calculation also indicated that the reduction was lower during the morning peak period (16%) and higher during the afternoon/evening peak (24%). Regarding impact on emissions, the total traffic emissions in the cordon area of **NOx and PM10 fell by 8.5% and 13%, respectively**.

Based on the Stockholm's experience, Sweden's second-largest city, Gothenburg, introduced an adapted version of the congestion charge system in early 2013. The system used the same technology as in Stockholm, with automatic number plate recognition cameras taking pictures of vehicles' number plates. Using a traffic modelling approach, Börjesson and Kristoffersson (2015) estimated the impact of the initiative on traffic congestion and the environment in Gothenburg. A key finding of the study was that **car traffic across the cordon was reduced by 12% during charged hours**. Also, **survey data regarding adaptation strategies show that commuters priced off the road apparently switched to public transport (24% increase)**.

One of London's most significant TDM strategies has been the city's congestion charge, introduced in 2003. Drivers who enter the 21 km2 congestion zone in the centre of the city must pay a daily charge of £11.50. The congestion zone is in force between 7 am and 6 pm every weekday. The charge does not apply to people with disabilities, and residents inside the zone only pay 10% of the charge (£1.15). The charge was originally considered a success, **with the number of vehicles coming into central London 25% lower than in the previous decade**. In particular**, private cars entering the zone decreased by 39% between 2002 and 2014.** As a result of decreased traffic volumes in the zone, more space has been available for allocation to cyclists and pedestrians (Transport for London, 2012).

2.3 Package 3: Mobility Management

2.3.1 Intervention: Travel Planning

Overview

Rollout and accelerate Travelwise (i.e., travel plan) program (voluntary + mandatory) to offer tailored engagement for:

- Workplaces;
- Schools;
- Events; and
- Communities

Evidence Base

Workplaces

Outreach measures are commonly referred to as 'voluntary behaviour change programmes', and often considered to be 'soft' approaches to TDM. They aim to reduce car trips without committing to physical infrastructure, service improvement, new regulation or price changes (Brog et al 2009). Common measures include personal travel planning, travel awareness campaigns, workplace travel plans, school travel plans and car sharing schemes (Chatterjee and Bonsall 2009). While some researchers have concluded that voluntary behaviour programmes are insufficient to significantly influence behaviour alone, and should be conducted as part of a mixture of measures to tackle travel mode and behaviour (Kent and Ampt 2012), others warn not to dismiss behaviour change programmes too quickly, noting that difficult-to-change behaviours are more changeable at the time of major life events, such as moving house or taking on a new job (Klöckner and Ellen 2004; Stanbridge and Lyons 2006; Waerden et al 2003). Ralph and Brown (2017) suggest there is a 'right time and right place' to change travel behaviour, and that campaigns are likely to be most effective when combined with other measures, such as public transport infrastructure/service that exceeds expectations. Cairns et al (2004) reviewed the impact of workplace travel plans in the United Kingdom (UK), finding that:

- **10% of plans achieve no change;**
- **20% reduce car use by >0-10%;**
- **35% reduce car use by >10-25%;**
- **25% reduce car use by >25-35%; and**
- **10% reduce car use by over 35%.**

Schools

Another study assessing the impact of travel planning on reducing car use was reported by Fujii and Taniguchi (2005) in Japan. The authors assessed the impact of a travel planning and feedback programme and compared it with a traditional travel information approach. The intervention took place in one elementary school in the city of Sapporo and included 292 students aged 10–11 as well as their families. During a week, a group of students received individualised information and advice about reducing family car use. At the same time, another group was asked to develop behavioural plans to modify car trips. **The most significant finding regards those participants who made behavioural plans. Reductions of 27.7% in terms of total trip duration and 11.6% in terms of car-use days were reported for this group** (Fujii & Taniguchi, 2005). While the findings are promising, no further details about the context of the study were provided such as characteristics of the participating school and the households or the city's public transport system and its services/infrastructure supporting other modes of transportation.

Communities

In Sweden a field experiment looked for changing perceptions to reduce car travel via travel planning based intervention (see Eriksson et al., 2008). Participants were randomly assigned to a control and an

intervention group. The intervention included a home-visit by one of the researchers, where during the visit, the participants filled in a prospective car diary containing all the car trips they planned to perform the following week. Then, a list of different car reduction strategies (e.g., changing travel mode, changing destination, cancelling trips, trip chaining, car-pooling) was presented to them. For each car trip, the participants had to decide whether they were willing to reduce car use on that particular trip or not. If they chose to modify their car trip, they were asked to indicate the strategy they planned to use and make a note of the changes in the prospective car diary. **The study concluded that the intervention made the choice of travel mode more deliberate. The study also found that there were other reasons to reduce car use such as willingness to save money or to strive for a healthier lifestyle via active travel** (Eriksson et al., 2008).

2.3.2 Intervention: Transport Management Associations

Overview

Roll out of Transport Management Association (TMA) in five (5) locations across Auckland.

Evidence Base

TMAs provide an institutional structure to deliver various TDM strategies. One study estimates that **TMAs can reduce 6-7% of total commute trips if implemented** alone, and significantly more if implemented with other TDM strategies (TDM Resource Centre 1997). Transportation Management Associations can increase Transportation Options, provide financial savings to businesses and employees, **reduce traffic congestion and parking problems, and reduce pollution emissions**. Parking and road facility savings often repay TMA operating costs.

The Lloyd District, located across the Willamette River from downtown Portland, currently consists of approximately 650 businesses and 20,000 employees, including a major convention centre, a mall, medical clinics, hotels, and office building. Since 1995 the Lloyd District Transportation Management Association (LDTMA) has worked to promote the area's economic vitality by providing transportation programs and services to improve access. The LDTMA has 69 member businesses representing approximately 9,000 employees. It manages several programs to improve and promote walking, cycling, ridesharing and transit, including Commuter Connection, a retail transportation store that brings a new level of convenience for access to transportation information and services. The LDTMA works to improve walking and bicycling facilities, improve public transit services, and in various ways promotes use of alternative modes, including the Passport Transit Pass Program, an annual all-zone transit pass employers can purchase at a reduced rate per employee for all qualified employees. It manages Commuter Connection, a retail transportation store that brings a new level of convenience for access to transportation information and services. Transportation Coordinators (TC's) act as liaisons between the LDTMA and employees. In 1997, 76% of all employee commute trips to the Lloyd District were made in an automobile, 60% were drive alone trips and 16% were carpool. Despite the rise and fall in the number of participating employees from one year to the next, the percentage of drive alone trips have decreased during 6 out of the last 7 years, and transit ridership has increased, particularly among Passport Transit Pass member, among whom the percentage of transit trips nearly equals the percentage of drive alone trips. **This has reduced about 1,000 daily peak period vehicle trips and about 3.9 million annual vehicle-miles with associated mode shift detailed below.**

	1997	2005	Percentage Change
Drive alone	60%	42.7%	-28%
Rideshare	16%	11.0%	-24%
Bus/MAX	21%	39.1%	91%
Bicycle	3%	3.3%	8.8%
Walk	2%	2.3%	13%
Telecommute	0%	0.8%	NA
Compressed Work Week	0.5%	0.9%	88%

The Cambie Corridor Consortium (CCC) was the first transportation management association (TMA) established in Canada. Cambie's aim is to reduce the number of single occupancy vehicles commuting to the Cambie/Broadway area of Vancouver and improve air quality by providing alternative transportation solutions and information. Approximately 25,000 employees are represented through CCC's 21 members. The program provides a variety of TDM activities and services. Transit kiosks were erected at each member's work site where employees could easily obtain information on transit fares, shuttle bus schedules, and other information. A shuttle bus service was implemented to transport hospital staff between sites. The bus makes approximately 2,100 trips per month carrying 9,000 passengers. The CCC also uses the shuttle bus to transport equipment, supplies, and documents between sites, saving member hospitals approximately $200,000 each year in courier costs. Van pooling services were arranged and are used by approximately 200 employees. Another 500+ staff members carpool. A payroll deduction program that allows employees to purchase bus passes at a 15% discount. To respond to the needs of employees, and address some of the barriers expressed in the initial surveys, an emergency ride home has been implemented. CCC has a contract with a local taxi company and employees are given vouchers if they need to leave work in case of illness or emergency. Also in response to employee requests, additional shower and change facilities, and secure bike cages were installed at some of the members' work sites. Since 1994, **single occupancy vehicle drivers had dropped by 1.6%, transit use had increased by about 25%, and cycling had increased to 5.5% from 4.5%. The number of walkers had increased tremendously since 1994. Previously, employees who lived a short distance away would drive to work so that they would have a car available during the day to make trips between sites. Almost 10% of all survey respondents said that they regularly walked to work. In addition, of the people responding to the 1998 survey, 85% said they no longer brought their car to work because the shuttle bus allowed them to travel between sites.**

Breikers is a transport management association established by the business community in the metropolitan region of Amsterdam as part of Beter Benutten. When the Beter Benutten programme ended, Breikers continued as a foundation in the Zuidas area of Amsterdam. Services offered include mobility scans and advising on the implementation of mobility budgets for employees to replace lease cars. Breikers are also talking with the government about making employee mobility flexible for tax purposes. Breikers partner, the Enexis group, organised their first car-free day in 2018. **More than 24 organisations participated with 35,000 employees. This resulted in an estimated CO2 reduction of 35,000 kilograms** (Breikers 2019).

2.4 Package 4: Improved Access

2.4.1 Intervention: Car Sharing

Overview

Expand network for car sharing to all communities and incentivise/subsidise on-demand shared mobility programs for car sharing.

Evidence Base

Cervero et al., 2007 evaluated the impact of the first four years of City CarShare, a carsharing private enterprise, on travel behaviour and car ownership in the San Francisco Bay Area in California. The private initiative was launched in March 2001 on the premise of renting cars by the hour. City CarShare gained steady popularity during its first 4 years. In this respect, the monthly number of reservations or formal leases (of unlimited duration by a City CarShare member) increased from less than 1,000 during the first year to over 5,000 by mid-2005. The study adopted a quasi-experimental approach and collected data from five surveys conducted every year (starting February 2001) with people who signed up to join the private initiative (members) and those who said they may join someday (non-members). Participants who were members of the programme were approached on point-of-departure car pick-up locations, which increased as the programme grew. Members also filled in a travel diary. **The findings show that 29% of carshare members had gotten rid of one or more cars, and 4.8% of members' trips and 5.4% of their vehicle miles travelled were in car-share vehicles.**

Carshare culture also plays a significant role in Vancouver, with the city having more carshare vehicles per capita (4.22 per 1,000 people) than any other North American city. A 2018 report by Vancouver City Savings Credit Union looked at carshare uptake in the city, including details about the financial advantages of taking part (Vancity 2018). There is a carshare fleet of about 3,000 cars in Vancouver, and the growth of the fleet has been aided by encouragement from the City of Vancouver. This has included allowing carshare vehicles to use permit-only car parking spaces, and relaxing car parking requirements in new developments if carshare is provided instead. A survey of 4,000 carshare members found more than half of users belonged to more than one carshare scheme and the prevalent reason for taking part was convenience. **More than a quarter of participants in the survey had got rid of at least one private vehicle, replacing it with carshare. Forty percent of respondents had avoided buying a vehicle because they were a member of a carshare scheme** (Vancity 2018). Reasons cited for Vancouver's high uptake of carshare include: the high urban population density; a limited supply of taxis and an absence of ride-hailing services (see section 10.6.3); good public transport networks in the city; and support from the City of Vancouver by providing parking for the carshare services.

2.4.2 Intervention: Bike Sharing

Overview

Accelerate and incentivise/subsidise on-demand shared mobility programs for bike sharing across Auckland.

Evidence Base

London launched a public bicycle hire scheme in 2010, allowing tourists and people who do not own a bike to utilise the city's expanded cycling network. It has been highly successful, **with more than 10 million trips taken in 2019**, and the number of bicycles included in the scheme has progressively increased from 5,000 to 11,500 since its launch.

Seattle introduced a city bike share programme 'Pronto' in 2014 with 54 stations and 500 bikes, but the programme was discontinued in 2017 due to low levels of ridership and revenue. They are currently piloting a dockless bike scheme with permits being reviewed for three main operators: Jump, Lime and Lyft. **The pilot included 10,000 bikes but results showed there was excess demand and they plan to extend the fleet to 20,000. Evaluation of the pilot showed that bike parking was the biggest challenge** and there are plans to increase supply and educate the public on how to park (Clark 2018).

2.4.3 Intervention: Shared Mobility Services

Overview

Accelerate and incentivise/subsidise on-demand shared mobility services (AT Local) across Auckland.

Evidence Base

The Seattle region has a long history of rideshare programmes and these continue to expand. Central Puget Sound boasts the largest vanpool programme in the nation with more than 2,200 public vans in operation every weekday (Puget Sound Regional Council 2017). King County offers a variety of vanpool options from fixed monthly pass commute services to first-mile last-mile connections to public transport. King County Metro is currently trialling TripPool, a flexible van pool service that connects people to local park and ride facilities. The service incentivises users by providing partial subsidies above $2.75 (one-zone peak) public transport charges, and full subsidies for ORCA monthly pass holders. The region's ride-matching system, which helps people form and maintain carpools and vanpools, has been expanded to serve the entire state (Puget Sound Regional Council 2009). 'RideshareOnline' is a state-wide database of people seeking to carpool or vanpool. It also offers matching services for people seeking to bike to work together and matching services for special events. A longitudinal study of travel behaviour in the Puget Sound Region showed that the availability of HOV lanes is one of the factors contributing to people's willingness to carpool or vanpool (Wang and Chen 2012). In the Seattle region, the HOV system consists of a network of special-use highway lanes which connect major population and employment centres. Three of the region's public transport agencies are working on programmes to leverage ride-hailing services Uber and Lyft to provide enhanced mobility options to their customers. These partnerships are focused on solutions for first-mile last-mile connections, managing demand at park and ride lots, and providing guaranteed ride home services when fixed-route services are unavailable at certain times.

2.4.4 Intervention: Circulation Plans

Overview

Roll out the circulation plans for city centre.

Evidence Base

Several cities worldwide have implemented changes to their traffic circulation systems to limit private vehicles' ability to travel across an urban centre or neighbourhood while maintaining or improving access for public transport, walking, and cycling across the same area. Such circulation concepts divide an urban area into distinct zones that cars can enter or exit from designated routes.

In 1977, Groningen implemented a traffic circulation plan aimed at 'keeping out the through traffic from the inner city' (Tsubohara, 2007). It divided the city centre into four zones and created a one-way system so that cars could not pass between zones. Several studies measured traffic patterns before and after the scheme was adopted, in 1977 and 1978 (Tsubohara, 2007). The city measured traffic volumes at 29 locations in the inner city and found a **47% drop in hourly traffic intensity in the city centre**. A separate study found that the **share of cars travelling to the city centre decreased from 36% to 34% of all trips**. This discrepancy may show that the scheme was effective at reducing through-traffic across the city centre, while traffic to the centre was less significantly impacted. **A substantial increase in bus passengers and cyclists was also observed after introduction of the traffic circulation plan** (Tsubohara, 2007, p. 1). Under the plan, buses can travel deep into the city centre and cyclists can pass between city centre zones.

The plan also included additional cycle paths, bike parking, and bus lanes in the city centre. **The share of bus and train passengers increased from 17% to 21% of all trips to the city centre** from 1977 to 1978. Surveys also found a substantial decrease in perceived odour from traffic in the city centre, and noise measurements in 29 inner city locations registered a nearly 50% decrease in average noise.

In 2017, the city of Ghent introduced a circulation plan that divided the city into six zones that cars cannot pass between. The city monitored the number of cyclists using bicycle counters and periodic counts across the city (Engels, 2018). In his analysis of Ghent's circulation plan, Engels compared cycle counts between March 2017 (before the circulation plan) and October 2017 (after the circulation plan), and between March 2017 and October 2018. His 2018 report **found increases in the number of cyclists in the city centre of up to 50% compared to before the circulation plan in 2017**. He found a **35% increase in cyclists entering and exiting the city centre in 2017 and a 60% increase between March 2017 and October 2018. Meanwhile, the mode share of public transport increased from 9% in 2015 to 14% in 2018.**

2.4.5 Intervention: Mobility Hubs

Overview

Implement mobility hubs at key origins/destinations to encourage a shift to active and shared modes.

Evidence Base

MobilZentral was the first Mobility Centre in Austria when opened in 1997 in a central location of Graz city centre. It currently offers information on public transport, including personalised timetables, all fares on all local public transport, on Austrian and European rail services and on mobility services in general. It sells all tickets and takes in reservations, and there is a rental service for bikes and bike trailers. Besides these basic services, MobilZentral offers various mobility consulting services. It also takes part and initiates campaigns and general awareness activities. MobilZentral is financed by the Styrian Public Transport Association, the City of Graz, the county of Styria. It is operated by Austrian Mobility Research (AMOR). The services are provided via phone and personally at the Mobility Centre. The objective of MobilZentral is to offer one-stop information on all mobility related questions and beyond, e.g. information on leisure destinations and city information. When regarding the long-term development of customer contacts MobilZentral has been a success. The number of contacts has increased from 300 in the beginning to 4,000 per month today. The annual citizen survey by the Styrian public transport association, which monitors the awareness and use of services and customer satisfaction from a sample of 1000 respondents, offers some long-term data:

- The knowledge of MobilZentral is constant for the last five years at a level of 26-29% of the population.
- The use of the services has increased from 10% of those who know MobilZentral in 1998 to 23% in 2001. This results in 6% of the population having used their services.
- User satisfaction is on a high level of about 80-90%. In 2001 it dropped slightly to 73%.

2.5 Package 5: Policies

2.5.1 Intervention: Road Space Reallocation

Overview

Fast track legislation/policy to accelerate road space allocation and VKT interventions.

Evidence Base

London extended its cycleway network by more than 100km during the first year of the Covid-19 pandemic, primarily by reallocating road space. The proportion of Londoners living within 400m of a safe cycling route grew from 12% in 2019 to 18% by October 2020, showing the massive change that was made possible by adopting a quicker and more resourceful approach to rolling out cycling infrastructure.

There is a growing body of evidence to suggest that well-planned measures that reduce road space for private cars do not add to congestion. On the contrary, reductions in road capacity can lead to "disappearing traffic". The most comprehensive study of the phenomenon was carried out by Sally Cairns, Carmen Hass-Klau and Phil Goodwin in 1998 (Cairns et al., 1998). The study brought together more than 70 case studies of road space reallocation from 11 countries (and the collation of opinions from over 200 transport professionals worldwide). The results suggest that predictions of traffic problems resulting from reallocating space away from private vehicles are often unnecessarily pessimistic. The study found that in the right circumstances**, significant reductions in overall traffic levels can occur, with people exhibiting a far wider range of behavioural responses than traditionally assumed**. In the 70 cases examined**, a mean traffic reduction of 21.9% was recorded**, median 10.6%. In other words**, in half of the case studies, there was a more than 10% reduction in the number of vehicles across the whole area where road space for traffic was reduced**, including the main roads. The surrounding areas saw no additional traffic. The study confirms that reallocation of road space does not simply shift traffic from one place to another but leads to an overall reduction in the number of motor vehicles on roads.

Oslo has shown similar results in the last four years. A reduction in capacity on three main roadways did not result in severe consequences in terms of delays or congestion. **Car use on commutes fell from 21% to 16%**, but the quality of the commuter experience (for all modes) remained high (Tennøy and Hagen, 2020). The city of Copenhagen reported that the total number of people travelling across a main thoroughfare bridge increased following the reduction of space for private motor vehicles and increasing space designated for walking, cycling, and public transport on the bridge (City of Copenhagen, 2017). The capacity of individual car users to change their travel behaviour in a range of creative ways presents real opportunities for urban planners seeking to optimise the use of space and quality of life in the city.

Paris has undergone a radical expansion of protected cycle lanes around the city and further closure of riverbank expressways to car traffic. Many streets were considerably restructured as the bike path network grew 43% from 2014 to 2020, from 700 km to a total of 1 000 km (Hidalgo, 2014). Major intersections are also being redesigned to favour pedestrians and cyclists. In the last seven years, the city eliminated approximately 15 000 parking spaces (Chauveau, 2019). According to Apur (2019), the city could further reduce its parking supply by 150,000 spaces, which represents a potential 96ha that could be put to other uses. The city also established 2,500 parking spots dedicated to e-scooters, as a way to avoid cluttering narrow footpaths. Although there has been some fierce criticism from taxi drivers and private car owners, the city has been progressively scaling up interventions to reduce the space allocated to private vehicles. As a result, **since 1990 the modal share of the automobile has fallen by 45%, public transport has increased by 30% and the share of cyclists has increased tenfold**.

2.6 Package 6: Subsidies and Grants

2.6.1 Intervention: E-bike Subsidy

Overview

Provide discounted E-bike fares to both the general public and CSC holders to encourage uptake.

Evidence Base

Ben-Elia and Ettema (2011) assessed the effect of two types of incentives to reduce car use during rush hours (between 7:30 and 9:30 am) in The Hague. The intervention consisted in providing either money or a mobile phone to a group of 341 participants if they avoided travelling by car on a busy motorway during the morning rush-hour. These participants were previously identified via licence plate observations as regular car commuters with three trips per week or more. The study found that, overall, **about 50% of participant who received any of the two incentives changed their driving times while 15% changed to the use of public transport.** The study also found that changes were more significant among those who received the financial reward compared to those who chose the mobile device (the latter were more likely to choose to drive later).

In another study conducted in the Netherlands (de Kruijf et al., 2018), financial incentives were also applied to encourage mode shift from car use to e-bikes. A total of 547 participants from the province of North Brabant took part in the study. To stimulate the use of e-bikes instead of cars, these participants received a monetary reward depending on their e-bike use while commuting. The incentive consisted of €0.15 per kilometre during the peak hours and €0.08 per kilometre in the off-peak hours. Participants could earn a maximum of €1,000 per person overall based on the number of kilometres cycled multiplied by the incentive. Data was collected via three surveys administered before and after the intervention. Additionally, data about e-bike use was gathered through a smartphone app that tracked e-cycling behaviour. The study found that vehicle trips decreased while cycling trips jumped. In this respect, **after one month, e-bike commute trips increased from 0% to 68%, with an increase up to 73% after six months**. However, the study also found that distance is an important factor – e-bike use decreased as commuting distance increased. Other factors that influenced e-cycling were age, gender, physical condition, car ownership and household composition (de Kruijf et al., 2018).

2.7 Package 7: Education and Awareness

2.7.1 Intervention: Marketing, messaging and education

Overview

Implement above and below the line marketing campaigns at local, site-specific and area-wide level to support with behavioural objectives of other VKT interventions. Improve travel messaging and information materials through comms and engagement channels (direct and indirect) to ensure people have the right information at the right time. Raise awareness of travellers on impact of VKT and how active modes / public transport can improve their travel.

Evidence Base

Marketing

The Victoria Transport Policy Institute's TDM encyclopedia (2019) states that "*marketing involves determining consumer needs and preferences, creating appropriate products, providing useful information about products to consumers, and promoting their use. Public knowledge and attitudes have a major effect on travel behaviour, so marketing is an important component of TDM implementation*."

Examples provided of specific TDM marketing activities include:

- Survey users and potential users of alternative modes to determine preferences, knowledge, barriers and opportunities for changing travel behaviour and providing TDM services.
- Targeted, personalized marketing campaigns, which identify consumers who are most able and willing to change their travel patterns and providing them with suitable incentives to try alternatives.
- Educate public officials, businesses about TDM strategies they can implement.

- Promote benefits and changing public attitudes about alternative modes. For example, promote alternatives modes as enjoyable, Healthy and Prestigious.
- Produce a Multi-Modal Access Guide that provides concise information on how to access a particular destination by alternative modes.
- Provide information that encourages people to compete to achieve travel change objectives, such as contests between individuals, businesses and communities (Cialdini 2001).

This document that's that given adequate resources, **marketing programs can significantly increase use of alternative modes and reduce automobile travel**, although there are limits to what marketing can accomplish by itself. Marketing cannot change every person or every trip, and can be counterproductive if alternative modes are inadequate. For example, advertising that encourages motorists to try transit will fail if transit service is inconvenient and unpleasant to use; travellers who try it will have a bad experience, give up, and tell their friends. Similarly, a commuter who tries cycling for the first time, but has no support, will be discouraged if they find it difficult and frightening, or have an accident or mechanical problems.

Spears, Boarnet and Handy (2013) conclude that **well-managed voluntary travel behaviour change programs typically reduce participant's vehicle travel by 5% to 8%.** Dill and Mohr (2010) found that **the City of Portland's SmartTrips program, which used individualized marketing to encourage residents to drive less and rely more on other modes, caused 8-12% reductions in automobile trips**, with impacts that lasted at least two years (Dill and Mohr 2010). Vehicle travel reductions tend to be larger in more walkable neighbourhoods (Ma, Mulley and Liu 2017). Taniguchi (2006) found even larger travel reductions from **"travel feedback programs" in Japan, with 50% increases in transit travel and 18% reductions in automobile travel** among affected populations.

TravelSmart is a community-based program that encourages people to use alternatives to travelling in their private car. It provides information, motivation and skills to help people choose alternatives to driving for personal travel. This is done through a programme called 'Individualised Marketing' that reaches households through schools, businesses, local government and major destinations that run their own TravelSmart programs. TravelSmart also forms partnerships with environmental, health, cycling organizations and other organizations that have an interest in supporting travel alternatives. The Perth Metropolitan Transport Strategy targets a 35% reduction in single-occupant-vehicle trips over the next 30 years. TravelSmart is a significant part of that strategy. TravelSmart research indicates that travellers have alternatives to driving for about 45% of all personal trips. Increasing the portion of these trips made by environmentally-friendly modes (walking, cycling, transit and tele-access) from 10% to 25% would achieve the Transport Strategy targets (Zhang, Stopher and Halling 2013). The Western Australian Department of Transport plans to expand the program to the entire city of Perth. **If the objectives are realised, a 7% reduction in car travel across the whole region** will be achieved.

A Brisbane marketing pilot was applied in the Grange District, a group of suburbs in the north of the city with a population of around 26,000 (10,000 households). The suburbs are relatively well serviced by public transport with four rail stops on one line and 17 bus services spread over three main routes. The motivation phase involved detailed discussions with those who requested further information to identify problems they had, and their travel needs. A service sheet allowed householders to select the exact information they wanted to receive. The convincing phase involved home visits to discuss in detail the possible mode changes with those who had indicated the need for this level of support. In addition, a small number of households who were interested in swapping to a sustainable mode and did not already use public transport were given a one-month system experience ticket for bus or rail. The final phase, evaluation, involved another travel survey, again including the control group. **The results indicated there had been a 10**

percent reduction in vehicle trips, which roughly equates to one return trip per week per person by either public transport, walking or cycling (Victoria Transport Policy Institute, 2019).

The US Federal Transit Administration commissioned individualized marketing pilot projects in four US cities (Bellingham, Washington State; Sacramento city, California; Durham, North Carolina and Cleveland, Ohio) to test the effectiveness of individualised marketing in increasing public transport use. These cities were chosen because each exhibited different socio-demographic and cultural profiles, urban densities, population sizes, and public transport patronage trends. **Public transport use within targeted communities increased between 14% to 43%**. The number of **walking and cycling trips also rose across each of the four target communities**. When averaged across the four pilots, **participants drove 4.5% less leading to an average 6.75% reduction in vehicle miles travelled** (Victoria Transport Policy Institute, 2019).

Messaging

The current Travel Choices programme was established in 2015 by the Sydney Coordination Office to support the construction of the CBD and Southeast Light Rail and maintain a high level of awareness of the need to change travel behaviour to minimise the effects of disruptions. It has contributed to **a 9% reduction in cars during morning peak in the CBD to date** and its key aims are to enable commuters to make informed choices about their daily commute and shape long-term, sustainable travel behaviour aligned to future workplaces. Travel Choices utilises the following principles to engage with customers and influence travel behaviour change, notably these are the same areas the London Olympics TDM policy was shaped around:

- Remode – customer message: Use public transport, as driving may no longer be your best option;
- Retime – customer message: Avoid travel during the peak, especially between 8 am and 9 am and 5 pm and 6 pm;
- Reroute – customer message: Use the city's preferred driving routes where possible; and
- Reduce – customer message: Minimise the number of times you have to travel, especially by car.

Education

An earlier rendition of London's TDM Programme was called Smarter Travel. A showcase example of this was in the borough of Sutton. £5 million was spent on the programme from 2006 to 2009, encouraging the 184,500 residents of the borough of Sutton to reduce car use. The programme involved travel planning for schools and larger employers, direct travel advice and information to households and medical patients, reward programmes, advertising, car club, cycle training and facilities, and a touring roadshow. Results were:

- **75% increase in average cycle traffic;**
- **an increase in cycling's mode share, from 0.6% to 2.1%;**
- **an increase of more than 16% in bus patronage;**
- **an increase in walking's mode share from 19.4% to 22%; and**
- **a reduction of 6% in car mode share • traffic levels reduced by 3.2%.**

2.7.2 Intervention: Riding Safety Courses

Overview

Roll out riding safety courses for schools, workplaces and communities (bikes, ebikes scooters)

Evidence Base

Psychol (2010) undertook a study which aimed to evaluate the "Bike Smart" program (Bike Smart, 2005), an eHealth software program aimed at training children in grades kindergarten to three key bicycle safety behaviours. This program was designed utilizing instructional design principals in order to improve upon traditional classroom instruction and deliver bike safety training in an efficient and instructionally effective manner. Specifically, the study hypothesized that participants who viewed the program would demonstrate increased ability to: discriminate safe and unsafe riding behaviours; identify hazards in the riding environment; judge the appropriate placement of a bicycle helmet; and demonstrate correct helmet placement on their own heads, when compared to participants in the control condition. The results of the evaluation demonstrated a significantly greater increase in the pre-test to post-test scores for the treatment condition compared to the control condition representing a large overall effect size. Overall, the **results demonstrated that students could learn and apply bike safety information from the relatively brief yet targeted information contained in the Bike Smart program**. This revealed an advantage of the program over more traditional, lecture-based educational approaches which are time and staff intensive and may not achieve measurable student outcomes (McLaughlin and Glang, 2010).

2.7.3 Intervention: Journey Planning and Engagement Initiatives

Overview

Roll out journey planning services incl. guided rides, car sharing, walks for schools, workplaces and communities (walk/bike buses, walk to school Wednesday, bike week)

Evidence Base

In Australia, the impact of a two-year programme was evaluated by Sahlqvist (2019). The cluster randomised controlled trial targeted children aged 10–12 from 24 primary public schools in inner West Sydney. The study included students' families. The primary intervention was the provision of tailored information and advice to the participants, which comprised classroom activities, development of school travel access guides, teachers' professional development, and parent newsletters. The programme also involved working with local councils to improve safety and walkability of participating schools and their surroundings; however, the extent of these developments was not detailed by the authors. Furthermore, there were some differences among the participating schools, including their size, access to public transport, level of nearby traffic congestion and the socio-economic status and cultural mix of students. The findings based on the parent survey data show an increase in walking activity. In this respect, **28.8% of students in the intervention group increased their walking**, compared with 19% in the control group.

'Ride to Work Day' is an annual event held in Victoria, Australia, that promotes cycling to and from work. Rose and Marfurt (2007) found that in this event, approximately **one in five participants were riding to work for the first time**. Follow up analyses found that of those who rode to work for the first time, **27% were still sometimes riding to work five months after the event. Furthermore, 80% of those riding to work for the first time indicated that the event positively impacted their readiness to cycle to work**. The event was found to have greater impact on creating behaviour change for females than males. This research provides some evidence that events can be an effective strategy in creating travel behaviour change.

3.0 Public Transport Evidence Base

3.1 Provision of Infrastructure and Improved Services

3.1.1 PT Service Improvements

At the onset of this project our data analysis has identified that a large proportion of vehicle kilometres in Auckland are generated outside of the peak hours (around 70% of all daily VKT - see Main Report). This is the period of the day when roads are less congested, and the public transport frequency is significantly lower than service levels during the morning and afternoon peak periods.

The analysis in **Figure 1** shows the origin-destination pairs where it takes PT twice longer to travel than a same journey by car. The lines are mapped based on this criterion and are shown only for origin – destinations that generate more than 200 vehicle kilometres travelled per day. As can be seen from the figure, in the AM and PM peak periods in the Isthmus the PT is better than in other locations such as South, East or Northwest Auckland and therefore the Isthmus is not covered by lines. However, a much more substantial difference is seen when analysing the interpeak period (figure in the centre in **Figure 1**) as it is much more convenient to travel between most of the origin-destinations in Auckland by car.

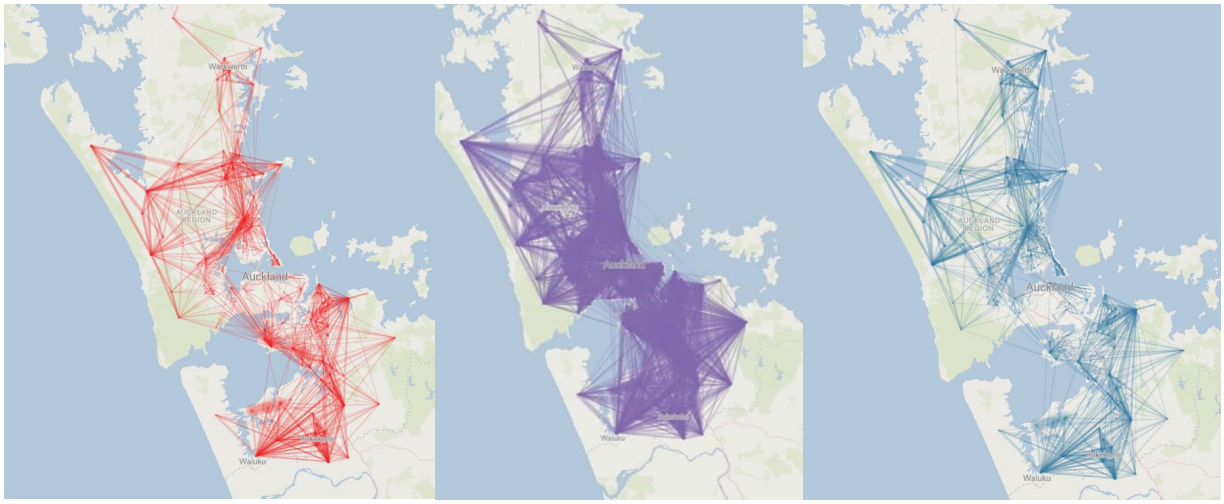


Figure 1:Baseline Scenario - Lines Showing Lack of PT Competitiveness with Cars between Origin - Destination Pairs - AM Peak (left), Interpeak (centre) and PM Peak (right)

When completing the same analysis for the preferred programme and comparing car and public transport competitiveness. The analysis shows significant improvement in the interpeak scenario and notable improvement in the AM and PM peaks (**Figure 2**).

Figure 2: Preferred Scenario - Lines Showing Lack of PT Competitiveness with Cars between Origin - Destination Pairs - AM Peak (left), Interpeak (centre) and PM Peak (right)

There is extensive research documenting the effect of public transport improvements and related patronage elasticities to increasing service frequencies. These are covered in the local research and guidelines such as Monetised benefits and costs manual, Section 4.4[1], in Research Report 487[2] (Experience with the development of off-peak bus services) and 434[3] (Appraisal of factors influencing public transport patronage) all by Waka Kotahi and international research by Institute of Transport Economics[4], European Transport Research Review Journal[5] and Victoria Transport Policy Institute[6]. The research shows that provision of public transport that is frequent and connected with service periods covering off-peak will yield increase in patronage in a range of 0.25 to 0.9 patrons per additional service kilometres with higher elasticities for off-peak service/low frequency service improvements and lower elasticities for peak service improvements.

Specific examples of public transport service improvements are presented below covering a number of cities worldwide.

3.1.2 Sydney, Australia

Sydney is one of the examples of a city that is making significant strides in expanding its rapid transit network. The city's comprehensive heavy rail system serves as the foundation of its transportation system, while recent initiatives have also incorporated light rail, automated metro, and busways. Investment in rapid transit is gaining momentum, with plans to allocate up to NZ$60 billion to several major rapid transit projects over the next decade. This will result in the addition of nearly 80 kilometres of new metro lines across the urban area and a new light rail system in the city's western suburbs. Sydney already boasts the highest public transport mode share of any major city in Oceania, and these projects are part of a larger strategy to further increase public transport usage throughout the city.

Expansion of Sydney's light rail network shows continue passenger growth as shown in Figure 3. L2 Randwick Line and L3 Kingsford Line opened in of 2019 and mid-2020 respectively.

[1] Monetised benefits and costs manual v1.6 April 2023 (nzta.govt.nz)
[2] RR 487 - Experience with the development of off-peak bus services FINAL TAR 08/12 23Jun13 (nzta.govt.nz)
[3] Research report 434 Appraisal of factors influencing public transport patronage (nzta.govt.nz)
[4] Effect of Price Reduction and Increased Service Frequency on Public Transport Travel (usf.edu)
[5] Patronage effects of off-peak service improvements in regional public transport | European Transport Research Review | Full Text (springeropen.com)
[6] Transportation Elasticities (vtpi.org)

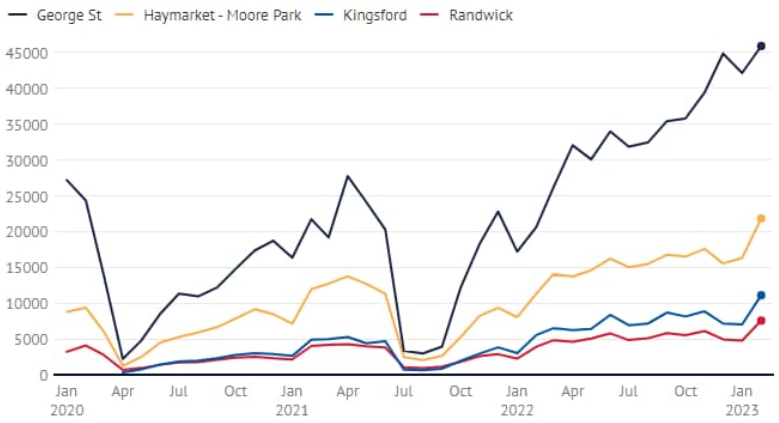


Figure 3: Sydney Light Rail Daily Patronage Counts[7]

3.1.3 Seattle, United States

Public transport investment Seattle has invested heavily in its bus network and increasingly in light rail, through voter-backed tax increases to fund frequency and reliability improvements. As of 2016, the fund administrators claim to have added 270,000 annual service hours, saved five routes from removal, and increased frequency on at least 38 routes, among other service improvements. **Bus patronage increased from 87.5 million trips in 2010 to 102.3 million trips in 2015. In 2015, an estimated 25% of residents lived within a 10-minute walk of a frequent service and this jumped to 64% in 2017.** Sound Transit 3 recently approved $154 billion to expand the light rail system by adding 37 stations to the 41 already built or planned. To gauge expected impact on ridership, when three additional light rail stations were opened in 2016, ridership increased by 75%.

3.1.4 Bogotá, Columbia

The Bogotá BRT system, called TransMilenio, is the highest-capacity BRT system in the world and generally considered a standout international example. The first construction for the TransMilenio started in 1998, and the first parts of the system opened in 2000. Construction has been split into phases, with phase four ongoing. The system currently has 114km of service. Buses in the TransMilenio system use dedicated lanes, which are served by stations more similar to a metro or light rail system than a bus system. Passengers pay fares at stations using an electronic ticket system prior to boarding. The system carries approximately 2.2 million journeys per day (Tsivanidis, 2019). **Based on the CDM methodology, phases two to four of the programme are expected to generate reductions of 578,918 tCO2e per year (UNFCCC, n.d.-a). This is, however, significantly higher than the actual amounts measured between 2006 to 2012, which averaged 72,917 tCO2e per year**. The discrepancy between CO2 emissions reduction projection and the calculation based on measured outcomes results from various problems with the implementation of the programme. Namely, in the years since 2006, the system has struggled to implement local and feeder routes sufficiently. Planned upgrades were also delayed, significantly affecting the emissions reduction results due to the system having fewer passengers than predicted. Despite being unable to meet expectations, these measurements show that BRT infrastructure provides a significant reduction in GHG emissions compared to a baseline situation without such infrastructure.

[7] UTS transport researcher Mathew Hounsell; Transport for NSW open data

3.1.5 Singapore

Singapore has extensive mass rapid transit (MRT) lines across the island, with more than 140 stations across 6 rail lines, as well as three light rapid transit (LRT) systems which act as feeders from residential areas into the MRT (Land Transport Authority, n.d.)[8]. The extent of the network is shown below in Figure 4. Significant investment has been made into the MRT metro lines and LRT making it an incredibly popular transit serviced, with between 2009 and 2019 there was an 88% increase in daily patronage resulting in 3.4 million daily trips on the MRT, as well as increase in LRT patronage by 131% and bus patronage by 35% (Auckland Council, 2022)[9]. To date the MRT and LRT networks span 228km, with additional routes being planned to provide even further coverage, with a target of 360km by 2036. This extended network will result in 8 out of 10 households across the city having access to a train station within 10 minutes of their front door (Land Transport Authority, n.d.)[10].

[8] LTA | Rail Network
[9] Transport Emissions Reduction Pathway (TERP) (aucklandcouncil.govt.nz)
[10] LTA | Upcoming Projects

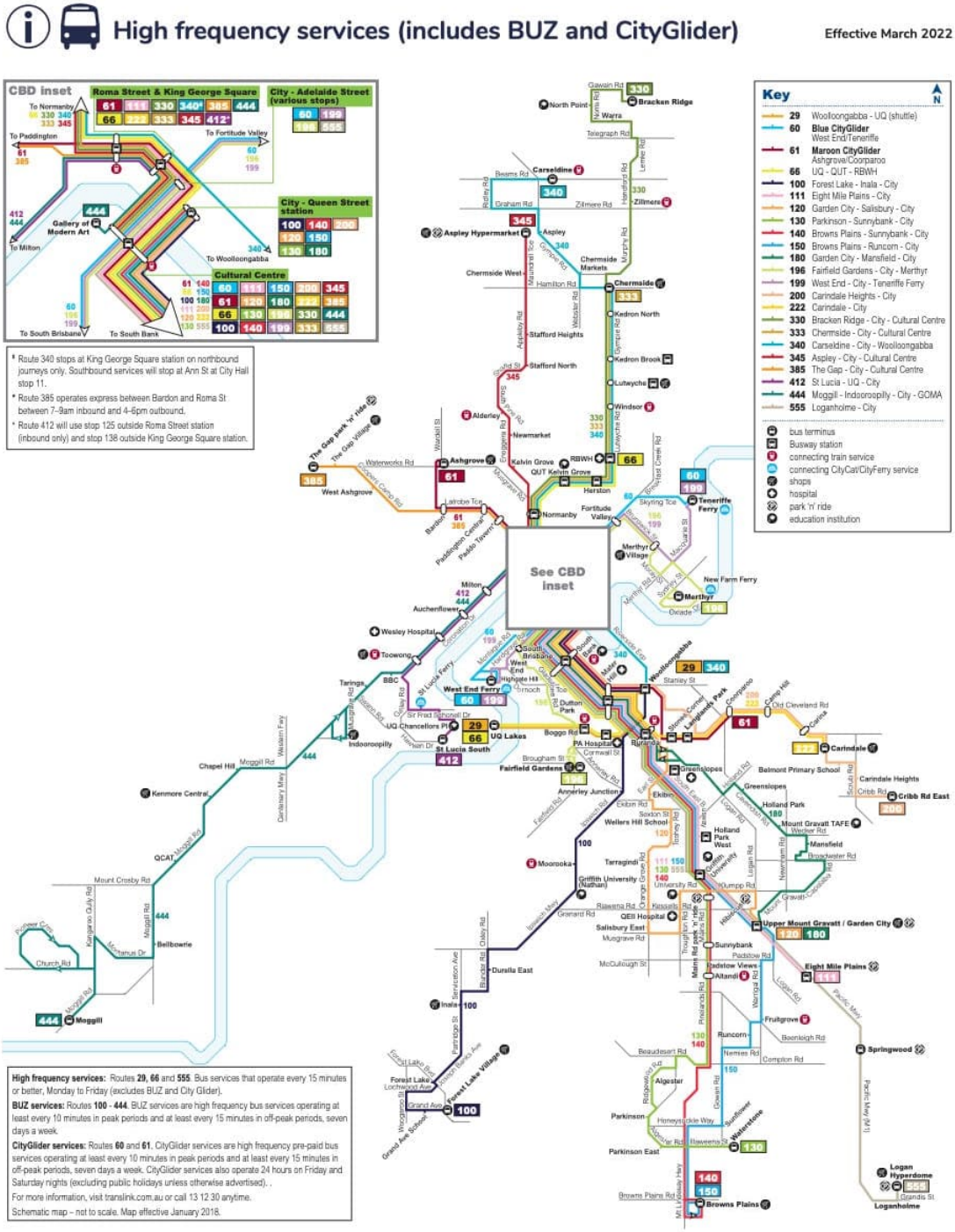
Figure 4: Singapore's MRT and LRT Line Map

3.1.6 Brisbane

Brisbane provides a great example of how frequent bus services can bring convenience and accessibility to a growing population. With continued investment in the high frequency services of BUZ and City Glider, the bus network moves 80 million commuters each year, more than two-thirds of the city's public transport users (Brisbane City Council, 2023)[11]. This network of high frequency services is very extensive as seen in Figure 5 below. BUZ or Bus Upgrade Zones are express services that are based on the concept of "turn-up-and-go" services. With BUZ services commuters have exceptional convenience as these services are available approximately every 10 minutes during peak hours or every 15 minutes during inter-peak hours (Brisbane City Council, 2023)[12]. Furthermore, recent additions to the BUZ have increased express services to outer suburbs from the city, resulting in high patronage on the weekends.

[11] Brisbane's New Bus Network | Brisbane City Council
[12] BUZ services | Brisbane City Council

The City Glider services are the second high frequency service that has been operating for 10 years. It boasts 10 minutes to 15 minutes services and 18 hours/day service from Sunday to Thursday (Brisbane City Council, 2023)[13]. From Friday to Saturday, 24 hours/day services are provided resulting in widespread



[13] CityGlider bus services | Brisbane City Council

convenience and equitable opportunities for all commuters. The services predominantly run in the inner suburbs, as part of Brisbane City Council's plan to reduce congestion and improve public transport in the inner city. The last two introduced City Glider Services generated 4.3 million trips per year pre-covid and the proposed Gold City Glider would build strong public transport habits into the high-growth area of Hamilton (Schrinner, 2021)[14].

Figure 5: Map of High Frequency Services in Brisbane

3.1.7 London - Red Routes

More than 96 per cent of Londoners live within 400 metres of a bus stop, and 90 per cent are within the same distance of a high-frequency service, defined as five buses per hour

London's Red Routes are a network of major roads within the city that are managed by Transport for London (TfL). These routes are designated with distinctive red lines along the edges of the carriageway and are crucial for maintaining efficient traffic flow and ensuring the safety of road users. While the primary focus of Red Routes is on vehicular traffic, they have several implications for public transportation as well:

Bus Priority:

Red Routes often serve as key corridors for bus services. The prioritization of buses on these routes is part of the broader effort to enhance public transportation and reduce reliance on private vehicles. Bus lanes and dedicated spaces for bus stops contribute to smoother and more reliable bus services.

Traffic Management:

The efficient flow of traffic on Red Routes is essential for the punctuality and reliability of public transportation services. Traffic management measures, such as traffic signal coordination and restrictions on stopping or parking, help ensure that buses and other public transport vehicles can operate effectively.

Pedestrian Facilities:

Red Routes often include improved pedestrian facilities, such as well-designed crossings and sidewalks. This enhances accessibility to public transportation hubs, making it easier for pedestrians to access bus stops or train stations along these major routes.

Cycling Infrastructure:

In line with broader sustainability initiatives, Red Routes may incorporate cycling infrastructure, such as cycle lanes or dedicated cycling paths. This contributes to the integration of cycling with public transportation, providing commuters with alternative and environmentally friendly modes of transport.

Integration with Tube and Rail Services:

Red Routes often intersect with London's extensive Underground (Tube) and rail network. The coordination between road and rail-based public transportation is critical for creating a seamless and interconnected transport system.

Accessibility and Inclusivity:

Red Routes are designed to be accessible and inclusive, with features such as tactile paving and ramps at public transportation stops. This ensures that the public transportation system is user-friendly for people with diverse mobility needs.

London's Red Routes play a pivotal role in shaping the public transportation landscape of the city. They contribute to the efficiency and reliability of bus services, facilitate better traffic management, and support the integration of various modes of public transportation for the benefit of commuters across London. The

[14] New 'Gold' CityGlider proposed to service high-growth areas (adrianschrinner.com.au)

Red Routes make up a very small percentage of the overall network, accounting for only 5% of the corridors within the city limits, but they are very busy, carrying more than 30% of London's traffic (Transport for London, n.d.). The map of red routes is shown Figure 6.

Along these corridors, civil enforcement officers and CCTV cameras are used to manage parking. The fines on these routes are £160 ($330).

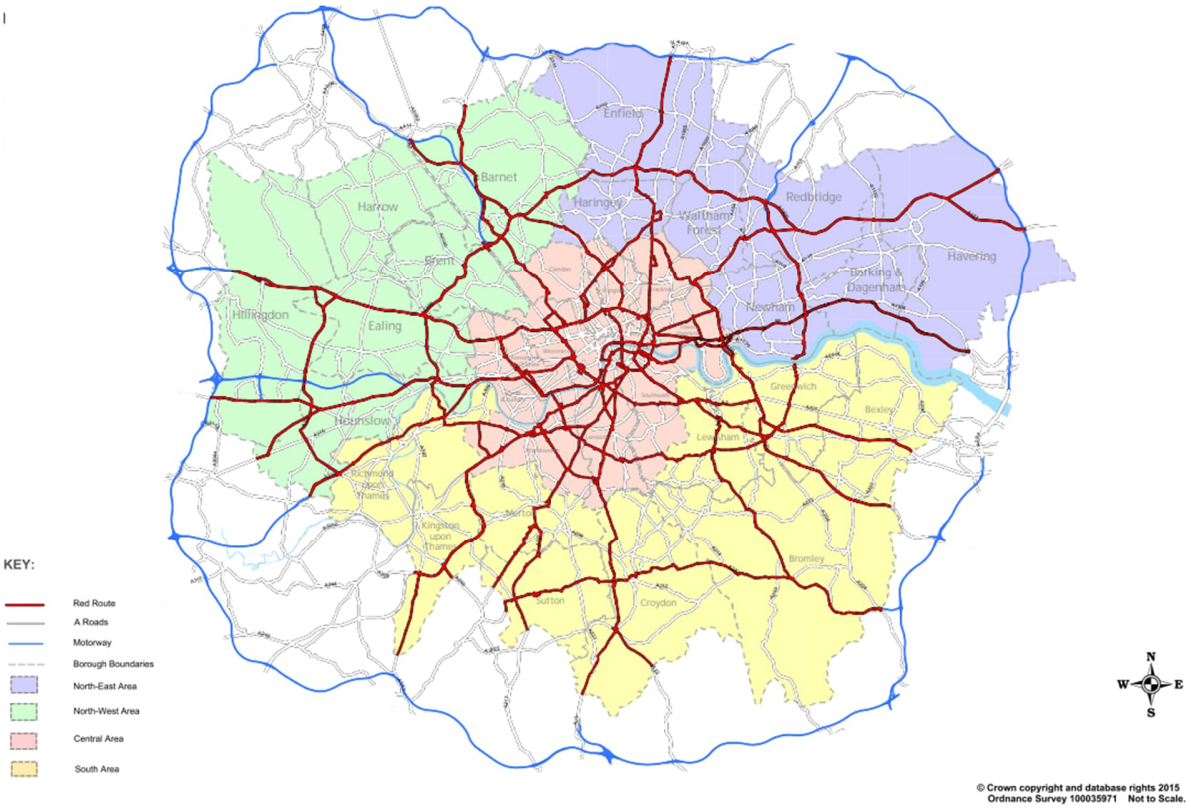


Figure 6: London Red Routes Map

3.1.8 Jakarta, Indonesia

Jakarta's Bus Rapid Transit (BRT) system, known as TransJakarta, is one of the most extensive BRT systems in the world. Here are some key features and aspects of Jakarta's BRT system. It was launched in 2004 as a response to the city's growing traffic congestion and the need for an efficient and reliable public transportation system. Since its inception, the BRT system has undergone expansions, with additional corridors and improvements. Spanning more than 251 kilometres, it carries around 1 million passengers daily, in a city with a population of 11 million[15]. A feeder system of hundreds of microbuses and cars helps the BRT reach 88% of Jakarta's sprawling neighbourhoods and satellite cities. There are now 240 routes across the city, compared with 22 routes a decade ago. In the same period, TransJakarta's fleet has quadrupled to 4,642 buses. As the bus system expands, so do its passenger numbers, from about 100 million in 2013 to more than 264 million in 2019.

TransJakarta buses operate on dedicated lanes, separate from general traffic, allowing them to bypass congestion and maintain a more consistent schedule. These dedicated lanes contribute to the efficiency

[15] 'A bus is open to everyone regardless of class': riding the world's biggest network | Indonesia | The Guardian

and speed of the BRT system. BRT stations are strategically located along each corridor, featuring modern facilities such as ticketing systems, shelters, and real-time information displays. The infrastructure is designed to enhance the overall passenger experience.

TransJakarta employs an integrated fare system, allowing passengers to use a single payment method for transfers between BRT corridors and other modes of public transportation, including feeder buses and commuter trains. TransJakarta buses are designed to accommodate a large number of passengers, and they often have high-frequency services during peak hours to meet the demand.

The BRT system aligns with Jakarta's broader efforts to reduce traffic congestion and promote sustainable urban transportation. It serves as a key component of the city's overall transportation strategy.

Big emphasis on further unlocking BRT potential is increasing PT accessibility. Accessibility to public transport consists of having both entrances and connections to the surrounding area and the stop itself. In order to make TransJakarta useful and usable by everyone, particularly vulnerable groups like the elderly, pregnant women, children, and people with disabilities, the stations must be accessible. Features that create or guarantee accessibility include at level crossing, pedestrian bridges, elevator facilities, and most important, sidewalks. Ultimately, pedestrians have to be at the top of the road user hierarchy, so that their needs are prioritised and always met.[16]

3.2 Incentives

3.2.1 Utrecht, The Netherlands

In 2008 the Municipality of Utrecht, along with other key agencies and organisations, coordinated and implemented a mobility plan that aimed at raising private companies' awareness on urban mobility, reducing the number of cars on the roads in Utrecht during peak hours, and increasing the use of alternative transport modes by implementing the 'UB pass', a free public transport pass. UB-pass holders were able to use the buses, trams and rental bikes in the region. The initiative was implemented to reduce traffic disruption during the major road works planned in and around Utrecht. A marketing communication plan was implemented in parallel and lasted from late 2008 to February 2010. In July 2009 a baseline survey was completed by 1,392 UB-pass owners (partly by email and partly by letter). A second online survey was conducted in February 2010 among UB-pass owners. The total sample for the second survey was 1,890. Furthermore, all new pass owners during 2010 were asked to fill in an online questionnaire; 2,551 participants filled in the questionnaire completely. **The study found a decrease in car use and calculated a total reduction of 2,880 car trips in the morning rush hours** from 6 am to 10 am per working day. A **large majority of the UB-pass owners (95%) used the pass to travel to work, with 61% of respondents who travel to work three days a week used the UB-pass everyday. Meanwhile, 51% of those who travel to work four days a week, used the pass every day, and 52% of participants who travel to work five days a week, used the pass those five days. Furthermore, 40% of UB-pass owners used to drive a car or motorcycle to travel to work before having the UB pass. Of this percentage, 37% said they will keep using public transport rather than returning to driving their cars** once the major road works are completed (Stumpel-Vos et al., 2013)

3.2.2 Stuttgart, Germany

In Germany, a randomised controlled trial assessed the impact of a material incentive (a free one-day bus ticket) as a primary intervention to increase the use of public transport among a group of people moving to Stuttgart. The intervention included the participants receiving tailored information and sources about the city's transport services and how to reach its shopping, leisure, and cultural facilities (Bamberg, 2006). Participants were randomly assigned to a control and an experimental group. Of the 241 participants who

[16] Transjakarta: A Study in Success - Institute for Transportation and Development Policy (itdp.org)

took part in the first stage of the study, 191 had actually moved to Stuttgart. The experiment found a **statistically significant increase, from 18% to 47%, in the use of public transport among movers from the intervention group**. Conversely, in the control group the change was small and statistically insignificant (from 18% to 25%). While the study did not include an assessment of the impact of the city's public transport network, the author pointed out that the services were regarded as 'high quality' (Bamberg, 2006).

3.2.3 Vienna, Austria

In Vienna, Wiener Linien operates the city's public transport network, and on average 2 million passengers use the network every day. One way this city has increased uptake in its public transport network is through a discount incentive on annual passes. In 2012 the cost of annual passes was reduced by 20%, from €449 to €365, equating to €1 per day for unlimited trips within the city's boundaries (Buelher, Putcher & Altshuler, 2017)[17]. There were also discounts introduced for monthly passes and for patrons who are over the age of 60. Following the implementation of this, the use of public transport increased from 36% to 39%, which was five times more than the increases in the previous decade. At its peak in 2019, 852,000 people held annual passes, which is more than the number of registered vehicles in Vienna (Wiener Linien, n.d.[18]). Currently approximately 16% of passengers-kilometres travelled is accounted for by public transport, with the 2040 goal of 23% (Federal Ministry Republic of Austria, 2021)[19].

3.2.4 Kyoto, Japan

In contrast to the above-mentioned study, the impact of free bus tickets was tested for a longer period in an experiment conducted in Japan. The authors, Fujii and Kitamura (2003), focused on university students from Kyoto who were all car users. The intervention consisted of providing a one-month free ticket to the intervention group. It was hypothesised that the material incentive would induce a lasting increase in participants' public transport use. Data was collected through surveys and the measures included travel mode frequency, travel habit, and perceptions and attitudes about car and bus use. The study found an increase in bus use, from **4.13% in Phase 1 to 9.34% in Phase 2**. However, a decrease to 4.95% was registered later in Phase 3 when the free ticket expired. **The habit of car use was significantly weakened in Phase 3 of the study**, which, according to the authors, might suggest that the intervention could be utilised in order to unfreeze habits of car use (Fujii & Kitamura, 2003).

3.3 Subsidies

Public transport is often subsidised to provide affordable mobility for low-income households and to those without access to a car. Subsidising public transport is also sometimes viewed as a second-best approach to promoting efficiency in the transport system as a whole in the absence of charges for the use of roads and the external costs imposed by car use (De Borger and Swysen, 1999). The underlying argument is that reducing fares for public transport with subsidies will attract car users to public transport thus reducing congestion, air pollution and crash risks. Following this argument, some cities have introduced fare-free public transport as a way to encourage the use of shared modes.

This was the case for Tallinn, where after the introduction of fare-free public transport the use of public transport indeed intensified, however, the average length of car journeys increased by 31%, which meant there was more – rather than less – car traffic (Cats et al., 2016). Subsidies and low fares often prove to be

[17] Vienna's Path.pdf (vt.edu)

[18] About Wiener Linien - Wiener Linien

[19] BMK_Mobilitaetsmasterplan2030_EN_UA.pdf

unsustainable and generate deficits making it difficult to increase much-needed capacity or to expand public transport networks to meet the demand stimulated. Many academics argue that service improvements, rather than fare reductions, are more effective at increasing public transport ridership. UITP (International Association of Public Transport) analysis of demand elasticity for metro networks worldwide shows that an average **10% reduction in fare levels results in only a 3% increase in patronage, while a 10% increase in capacity on a fixed network, through frequency enhancements or larger trains, can increase demand by over 5%** (UITP, 2014).

Quality and convenience of public transport are considered the strongest attraction for public transport use (Proost, 2017; Holmgren and Ivehammar, 2015). When private transport is optimally priced, public transport pricing can and should be based on the same principles as pricing for road use; and should take into account the marginal external cost of an additional user, with higher prices at crowded times (Mayeres and Proost, 2004; Proost, 2017). There are several reasons why it may be efficient to charge higher public transport fares during weekday peak periods. First, the marginal cost of providing services is higher in peak periods, as capacity-related costs are incurred to serve the times of highest demand. Second, road congestion is higher during peak hours, so there may be a higher external benefit of public transport use. Third, peak hour overcrowding in public transport (which increases user discomfort and reduces user welfare) could be an important issue for some cities. Expanding capacity is a natural way to alleviate crowding in public transport, but it could require significant investment. Fares contribute to investment as well as managing demand. Proost (2017) analysed the data on the effects of congestion pricing introduced in Stockholm in 2016 on car and public transport demand. Based on this, the author modelled how the optimal pricing, frequency, bus size and a number of bus lanes for a corridor depends on the presence of congestion pricing for cars. Proost argues that the best reform consists of peak and off-peak tolls for cars combined with higher bus fares and frequency in the peak and lower off-peak bus services at lower frequencies. Higher peak fares may also spread demand more evenly across the day, which could reduce capacity-related costs and make services less crowded. Fares in off-peak times may improve cost recovery, provided the additional passengers do not impose additional costs on the system over and above what they pay in fares.

3.4 Fares

A literature review by MRCagney (2014) suggests that the average short-run elasticity of public transport demand, with respect to fare levels, is -0.35, implying that a 10% fare reduction typically increases ridership by approximately 3.5%. The review also suggests that:

- long-run effects are likely to be up to 50% higher
- fare change influence is likely to be lower during peak periods than off-peak or weekends
- higher-income passengers or passengers with cars are likely to be more price-sensitive than lower income passengers or passengers who do not own cars, potentially because they have an immediate alternative choice of travel
- price sensitivity is likely to be higher for short trips and trips to non-city centre locations. Several papers review the literature on the travel demand effects of public transport fare changes (Nijkamp and Pepping 1998; Holmgren 2007; Hensher 2008)

They highlight variation in fare price influence depending on context (such as between different countries, or different types of transport) and methodological differences. Generally, they find that public transport patronage is inelastic with respect to fare price, especially in car-dependent cities in Australia, New Zealand and the US compared with European cities. Fare increases, while providing a short-term increase in revenue, are generally found to have significantly negative impacts on ridership in the long run, negating short-term revenue increases (Paulley et al 2006).

Holmgren (2007) finds **the relationship between fare price, patronage and service provision increases the effect of price on demand. This reflects the fact that fare reductions may increase demand, leading transport agencies to add additional bus services, which in turn improves quality of service and attracts additional users**. The same can also happen in reverse. This highlights the importance of considering policy interventions holistically and asking whether there is likely to be feedback between policies that leads to larger (or smaller) effects than anticipated.

3.5 Vancouver's One Fare Zones

A TransLink public transport fare review was completed in 2018 as part of Transportation 2040. This review suggests a new way of pricing public transport in Metro Vancouver. The aim of the review, which was started in 2016, was to change the fare structure of Metro Vancouver's public transport to grow ridership but also to reduce overcrowding, particularly in peak times. As a result of the review, the fare structure is set to change this year. The previous TransLink zoning systems for fares were adopted in 1984 and involved three zones. The system had been a source of complaint for many customers, as it left some riders paying high fares for substantially shorter journeys compared to other passengers. The most substantial recommendation from the fare review is to change the funding structure to one based on distance, rather than zones. This sought to address the disparity in fare costs across zones for customers and can be considered a TDM strategy in the sense of making the public transport service more appealing and financially viable to users. Bus fares were already changed in 2015, and zone-based fares replaced with a flat rate, regardless of journey distance. The other significant TDM-related finding from the review was the recommendation to explore the potential of charging different fare rates at different times of day. The aim of this recommendation was to address the problem of (peak period) overcrowding on public transport, which is already a significant issue in Vancouver. This recommendation is now being used as the basis for further investigation as to how to implement such a plan. The report suggests options like rewards or discounts only at very particular times of day, to ensure the desired outcome is met and that the discounts do not detract from TransLink's fare revenue (Carran-Fletcher et al., 2020).

3.6 Testing Interventions in MSM Transport Model for Auckland

A number of scenarios with ranging interventions across all intervention themes were run in MSM to test the impact of PT service improvement, PT incentives, improved accessibility to public transport stops and stations, bus priority and road pricing. The list of scenarios that had an impact on PT patronage is listed below in Table 1.

Table 1: List of Scenarios to Test PT Patronage

Scenarios	Theme	Description
Baseline	Baseline	2036 Baseline Scenario
S1	TDM Policy	5% Traffic Reduction Intervention
S2	TDM Policy	10% Traffic Reduction Intervention
S3	TDM Policy	15% Traffic Reduction Intervention
S4	TDM Policy	20% Traffic Reduction Intervention
S5	Land Use Test	Baseline + High Land Use Shift to City Centre
S6	TDM Policy	Double Parking Costs
S7	TDM Policy	Road space Reduction (no PT or Active modes)
S8	TDM Pricing	SH Tolling
S9	TDM Policy	School and workplace travel plans
S10	TDM Pricing	Distance Charging $0.25/km
S11	TDM Pricing	Distance Charging $0.5/km

S12	TDM Pricing	Distance Charging $1/km
S13	TDM Pricing	CBD Cordon (AM,IP & PM)
S14	TDM Pricing	CBD Cordon (AM, IP & PM) + 3 Motorway Tolls
S15	PT Network Improvements	PT A Network (no bus priority)
S16	PT Network Improvements	PT B Network (PT A Network with bus priority)
S17	PT Network Improvements	Remove 15% bus speed penalty as a proxy for more bus priority lanes and priority at intersections
S18	PT Network Improvements	PT B Network (with bus priority + weekly fare cap)
S19	PT Network Improvements	S18 + first and final leg improvements
S20	PT Network Improvements	S19 + transfer improvements
S21	PT Network Improvements	S20 + PT Network refinements - fixing shoulder running BRT
S22	PT Network Improvements	S21 + Rail PBC
S23	PT Combined + TDM Combined	S21 + Double parking + CBD_Motorway_Toll
S24	PT Combined + TDM Combined	S23 + Double_CBD_Motorway_Toll
S25	PT Combined + TDM Combined	S24 + $0.1_Dist_toll
S26	PT Combined + TDM Combined	S25 but lower CBD charging
S27	PT Combined + TDM Combined	S26 + $0.25_Dist_toll
S28	PT Combined + TDM Combined	S26 + $0.5_Dist_toll
S29	PT Combined + TDM Combined	Scenario 1 - TDM heavy scenario replicating delayed action - $0.3 distance charge
S30	PT Combined + TDM Combined	Scenario 2 - Balanced scenario between TDM and Transport interventions - $0.2 distance charge
S31	PT Combined + TDM Combined + Land Use	Scenario 3 - Compact scenario that includes lower TDM pricing, same transport interventions as Sc2 and less growth in the greenfields - $0.1 distance charge
S32	PT Combined + TDM Combined + Land Use	Preferred Scenario = Scenario 3 + Further PT refinements
S33 - Final Preferred	PT Combined + TDM Combined + Land Use	S32 + further Land Use refinements

The Figure 7 below shows the PT patronage change for the above described modelled scenarios.

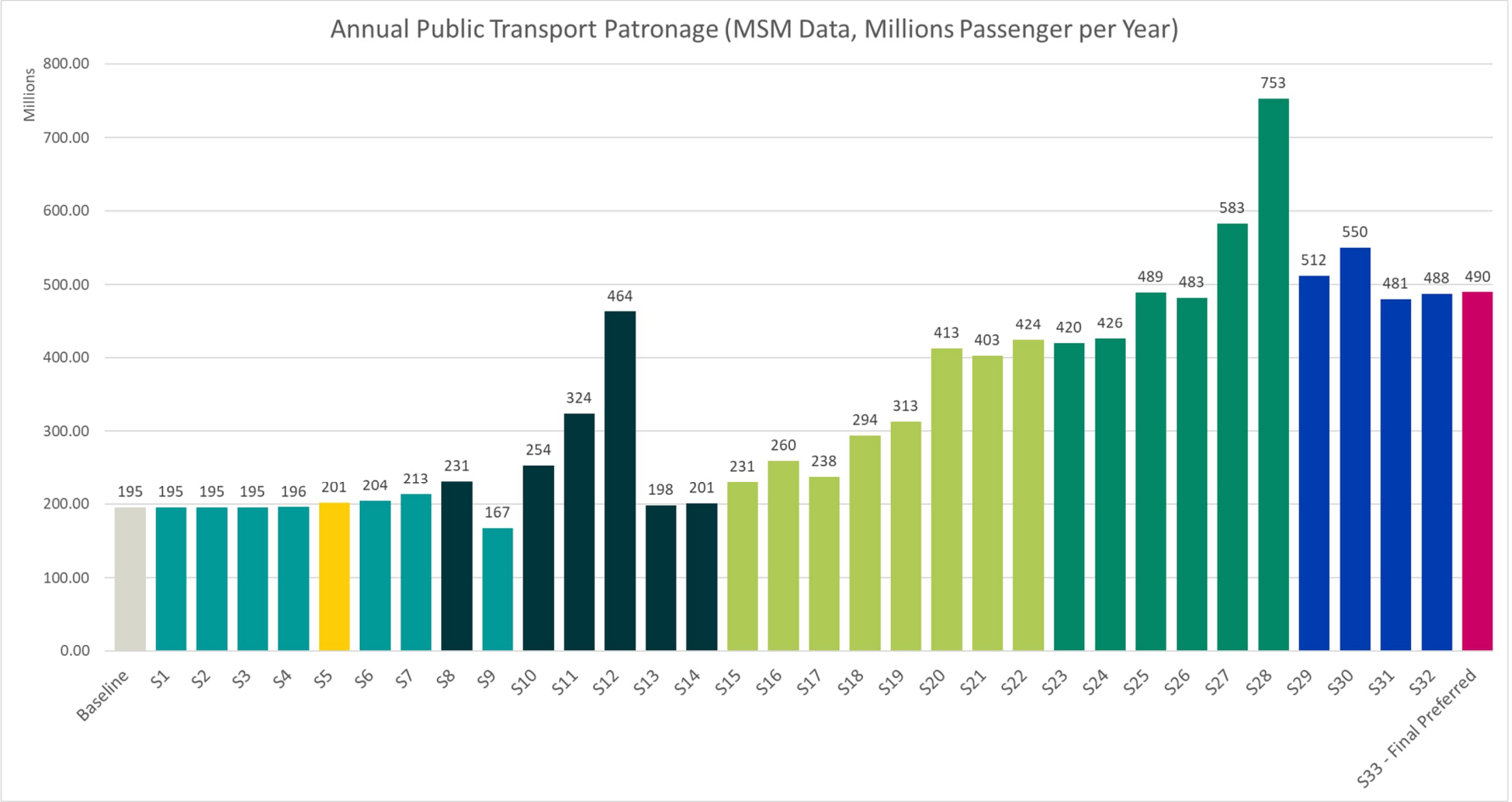


Figure 7: Modelled Annual Public Transport Patronage

The modelling results show a number of interventions which resulted in public transport patronage change. A few observations to discuss:

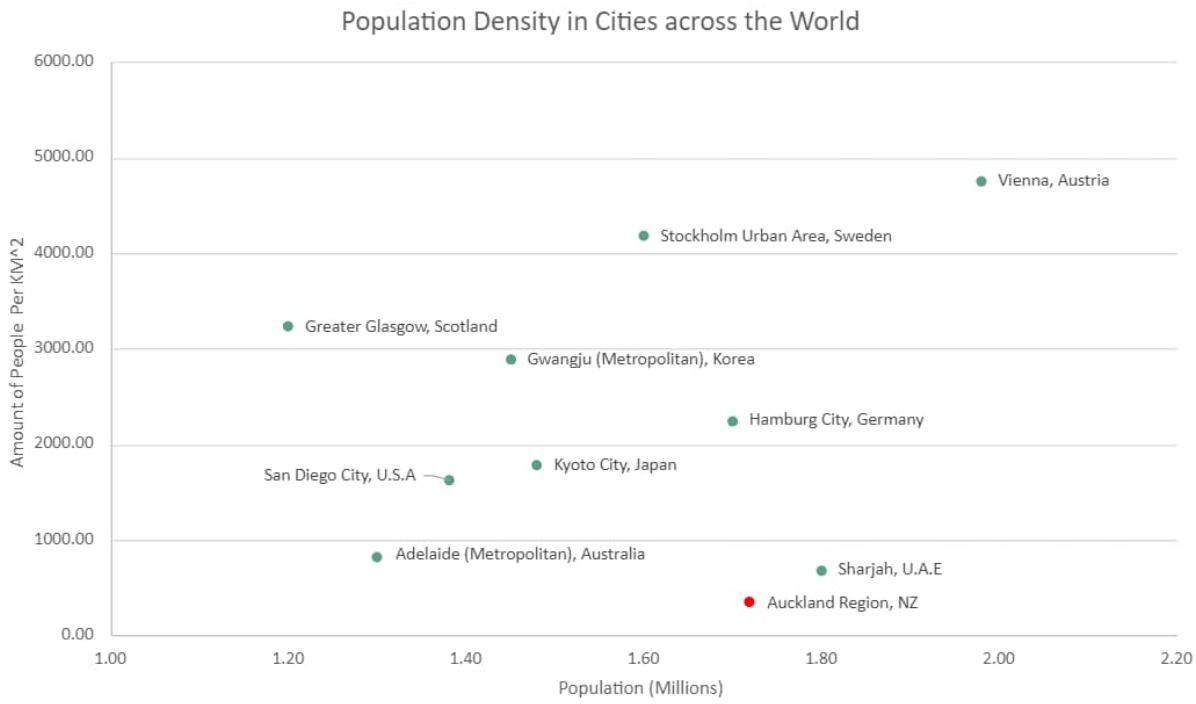
- S11 and S28 both have $0.5 /km distance charging. S11 has only this intervention and results in 324 million passenger trips per year. S28 also has the same distance charging but it is combined with significant improvements to PT network, bus priority and other travel demand measures. This results in patronage increase by more than two-fold to 753 million passenger trips per year. This shows how much more efficient is the combination and variety of interventions when put together.
- S18, S19 and S20 show that other measures improving PT such as weekly cap, first and final leg connections and improvements to transfers (e.g. neighbourhood interchanges) have a big impact on patronage. Combined with strong network and high levels of bus priority these interventions can attract around addition 100m passenger trips per year.
- S29, S30 and S31 show the modelling of shortlisted scenarios.
- S32 and S33 show the PT refinements of the Preferred Scenario (S31) and minor changes in patronage.

The modelling tests have its limitations (as discussed in the VKT Modelling Report) but results of the tests correlate well with the research review completed for this work. E.g. Vienna's example shows that implementing capped public transport tickets and pricing them right can lead to notable patronage increase. Research from London, Brisbane and local research in NZ also showed that service frequency and bus priority are one of the major factors for people when deciding which mode of transport to use.

4.0 Land Use Evidence Base

Land use changes are an initiative that have the ability to affect vehicle kilometres travelled (VKT) by **changing where people live, work, and commute**. Incentivisation of development in brownfields, restricting the growth in greenfields, allows for dense accessible neighbourhoods, especially when land use is integrated with transport planning focussing on accessibility rather than mobility. As summarised by MRCagney's "*Enabling Density"* report, there is **substantial evidence that accessible neighbourhoods, that are not only dense but have equitable access to amenity and opportunities, are more sustainable** as there is less driving undertaken as people are able to access alternative modes more readily. The relationship between physical characteristics of the urban environment and peoples travelled behaviour has been studied in 1990s (Cevero & Kockelman, 1997) and discussed well into the 2020s (Currans et al., 2022 and Tomer & George, 2023).

Auckland has a population of 1.72m, within an area covering 4,941km^2, resulting in an average population density of 348 people per km^2. When compared to other cities, the severity of Auckland's sprawl and subsequent low density is evident. Auckland has a notably lower population density than a range of cities (with smaller, similar and larger populations), as illustrated below.



This low density hinders the ability to provide high quality public transport and active mode amenities, inducing car dependency and creating less sustainable communities. By increasing Auckland's density through land use changes such as zoning, intensification, integration of land use and transport planning and transit-oriented development, opportunities to address VKT efficiently and effectively will arise.

In order to implement land use changes, a number of incentives and regulations would need to be set out. Proposed land use changes as part of the VKT interventions are discussed below.

4.1 Land Use Rezoning

Land use, especially mixed land use, plays a key role in reducing VKT. **Combining households with education, employment, and leisure, in proximity allows for people to have shorter journeys and to utilise alternative modes to more efficiently make these shorter trips. In the USA, households within 1 mile of an activity centre drive on average 40% less than households 10 miles from an activity centre** (MRCagney, 2023). This difference is even more pronounced when households are close to multiple activity centres. Rezoning is a method that can encourage density to develop near transit hubs, and updating to mixed use zones allows for employment and households to be in a proximity that encourages mode shift.

4.1.1 Zoning Systems

New Zealand currently utilises **Euclidean zoning rules, which spatially separates residential and commercial activities into defined areas**, making the development of mixed use zones difficult (Planitzen, 2023). An alternative zoning system is a permissive zoning system, as utilised by Germany and Japan, **permissive zoning systems more readily allow for mixed uses within the same zone**.

In Germany zones allow for a wide range of uses, even at the **lowest level which allows for small apartments, shops restaurants and non-polluting industrial developments** (MRCagney, 2023). Permissive zoning has been utilised for the development of a new district, Dietenbach, while this

development is in the greenfields, it has undergone holistic mixed use planning and is designed around a future tram line. It includes mixed housing, of differing typologies, sizes, social, market affordable and multi-family housing, it has green spaces, shops, business spaces, schools, and cultural and places of worship. **As a result of the mixed use development, and the district being designed around the tram line, the development can reduce the car ownership and VKT.**

Whereas Japan establishes what uses can go together based on level of nuisance. Even the **zones that have low levels of permissiveness, which are primarily for housing, allow for mixed use development, which is controlled by floor areas and different uses** (MRCagney, 2023). Housing is allowed within almost every zone, and the residential types are not differentiated, requiring only adherence to certain formal design requirements. Developments within Japan tend to be dense due to the smaller land packages within the cities. **With restrictions on car ownership and parking, alongside walkable and cyclable neighbourhoods, a strategic widespread rail system provides access for cities like Tokyo**.

4.1.2 Addressing Sprawl

Los Angeles is a city that has struggled with widespread sprawl and high private vehicle usage, which is primarily the result of zoning designed for single family dwellings. **Sprawl has been found to be a key influence on transport emissions**. **A study based in Melbourne and Sydney found that distance from the city centre accounted for 71% of the variance in emissions between different neighbourhoods, even when accounting for density and public transport** (Trubka, Newman & Bilsborough, 2010). Greenfields are an area commonly used to accommodate future growth for a city, progressively extending further and further from city centres, and as a result increasingly producing more emissions as travel distances increase to access amenities. Where it is possible to limit, delay, or rezone future greenfield growth areas, VKT can be reduced. **Several cities have developed legislation to limit future growth in Greenfields including Canberra and Glasgow.**

Freiburg is another example that has strong sprawl regulation. It is known for its sustainable urban planning and commitment to public transportation, including its extensive tram network. The city has been a pioneer in sustainable urban development and transportation policies[20].

Freiburg places a strong emphasis on public transportation, and the tram system plays a central role in the city's mobility strategy. The city encourages the use of public transport to reduce reliance on private cars, promote sustainability, and address traffic congestion. The city has a history of integrating transportation planning with land use planning. This integration aims to create more walkable and transit-oriented developments, where public transportation, cycling, and walking are viable options for residents. As a result the city boasts high percentage of travel completed by shared or active modes.

The city has been a leader in sustainable development practices, including energy-efficient buildings, green spaces, and pedestrian-friendly zones. Development projects are often designed with a focus on environmental sustainability and reduced carbon emissions.

Freiburg has implemented urban growth boundaries to manage and control the expansion of the city. This approach aims to curb urban sprawl, protect green spaces, and promote denser, more sustainable urban development.

Freiburg often involves the community in the planning process. Residents have a say in urban development projects through participatory planning, contributing to a sense of ownership and community-focused development.

[20] Milestones - www.freiburg.de/greencity - Milestones

4.1.3 Intensification

Intensification is one of the ways that sprawl can be reduced, and mixed land use developments in areas brownfields can be achieved. Intensification works to **increase density by focusing as much growth as possible within and around existing urban infrastructure, and a key is to focus growth into areas that are already well serviced by public transport, employment and education, such as city centres**. Implementing medium-density residential areas within well developed areas assists in the development of mixed land use, when employment, living and leisure are in proximity, people are more likely to combine their trips (Litman, 2023). Recently Los Angeles have developed a Transit Oriented Communities (TOC) programme, as a result they are now able **to develop beyond the density limits of the zone in order to achieve easier and faster development of housing** (Los Angeles City Planning, n.d.). Legislation within New Zealand, the National Policy Statement for Urban Development and Medium Density Residential Standards, enables development of medium density within key cities focused on city centres, metropolitan centres and rapid transit stops, these developments can go beyond the existing zone densities (Ministry of Housing and Urban Development, 2022).

4.2 Intensification Incentives

The intensification of developments needs to be targeted to enable the development of the mixed-use planning. Cities have begun adopting incentives to ensure that development occurs in proximity to major transit stops. Los Angeles, as part of their TOC program, has produced an Incentive Programme, this **encourages the construction of affordable housing near transit hubs by providing density bonuses and lowered parking requirements to developers for projects within half a mile of the major transit stop on the basis that the developer provides a set percentage of deed-restricted affordable housing units** (Los Angeles City Planning, n.d.). As part of this, Los Angeles is aiming for 57% of new dwellings to be located within approximately 450m of public transport by 2025, increasing to 75% of new dwellings by 2035 (Auckland Council, 2022). In New Zealand, Te Manatū Waka, with the support of Waka Kotahi, HUD and Kāinga Ora, are investigating ways to incentivise developments that avoid/reduce the need to travel and encourage travel by public, transport, walking and cycling (Te Manatū Waka, 2022).

4.3 Integrated Land Use and Transport Planning

Integration between land use and transport planning, including private, active, and public transport, has the greatest potential for reducing transport emissions and providing wider benefits (Te Manatū Waka, 2022). Land use and transport plans work together to enable and encourage medium density development around rapid transit stations and active mode corridors. Planning land use and transport together enables the development of integrated multi-modal transport systems. By targeting strategic transport corridors and investing into land use changes along them, urban development can be supported, whilst providing access to key destinations such as employment, leisure, health and transport corridors. Which helps not only reduce the distances people are having to travel, but the number of trips that would normally occur using private transport, supporting mode shift to public transport (Te Manatū Waka, 2022).

Vancouver is a city that has strategically aligned its land use for growth along its rapid transit network. Planning is based upon integrating the land use and transport to create alignment between the urban centres, areas for development and the frequent transit network (Auckland Council, 2022). By working through this process, they have enabled significant development in walkable catchments to their transit stations. As a result, along with additional transit investments they have managed to, as of 2018, shift half of their trips made within the city to sustainable modes (Waka Kotahi, 2019).

4.4 Public Realm Improvements

To enhance the liveability and functionality of areas designated for intensification, it is imperative to focus on creating safe and appealing public spaces. A key aspect of this approach involves aligning public

amenity provision with anticipated future growth. Drawing insights from studies conducted in Calgary, Canada, and Perth, which centred around Transit Oriented Developments, it becomes evident that the success of these locations is intricately tied to the investments made in the surrounding public spaces (Bolleter, Myres & Hooper, 2022, and Duncan, 2011). **Beyond the initial investments, the design and accessibility of streetscapes, parks, and other amenities emerge as critical factors influencing people's engagement with these spaces. The creation of an attractive, safe, and overall active environment is paramount for fostering a sense of community and desirability in these evolving urban zones.**

The superblocks in Barcelona present another noteworthy case, wherein streets have been converted into walkable plazas adorned with outdoor amenities, gardens, and green spaces (Puttkamer, 2022). This strategic transformation not only enhances the functionality of these spaces for people but also contributes to heightened safety and an improved overall quality of life. **These spaces are now locations where the community can come together, and not only utilise the space but shape it to their needs.**

Another effective strategy in achieving this transformation is through the application of **tactical urbanism—a cost-effective, short-term approach aimed at actively engaging the community in reshaping their public spaces.** This method involves reclaiming areas traditionally designated for vehicular use and repurposing them for active modes, leisure, and general public amenities. An illustrative example of this approach can be found in New Zealand's Innovating Streets for People initiative, where a series of projects employed diverse materials and aesthetics tailored to the historical, social, and physical context (Waka Kotahi, 2021). The Innovating streets projects found that **following the improvements, which were largely founded on community input, there was much greater utilisation of the spaces by those who walk or cycle**.

4.5 Enabling Infrastructure

Accelerating the development of essential infrastructure is pivotal for supporting the intensification of urban areas. This entails a **comprehensive focus on upgrading power systems, three waters infrastructure, and social amenities to lay the groundwork for sustainable urban growth and address the needs of expanding populations**. As urban intensification puts strain on existing infrastructure, improvements to power and three waters are crucial, especially when dealing with aging systems (Department of Internal Affairs, 2023). Enhancements in these areas not only **facilitate growth but also pave the way for essential public spaces and future investments in advanced public transport**.

Social amenities, including public transport, health services, education, and community spaces, are vital for supporting the needs of developing areas. **Without the provision of theses amenities in areas that are undergoing intensification, residents are compelled to rely on private modes of transportation to access services** (Te Manatū Waka, 2022). When infrastructure is strategically developed in and around intensifying areas, residents' needs are better met, contributing to a reduction in car use and ownership. As evidenced by research from MRCagney (2023) **quality public transport options play a pivotal role in diminishing VKT and the creation of transit station hubs emerges as a crucial step**, providing equitable, attractive, and safe access points that encourage residents to embrace public transport as a preferred mode of commuting.

4.6 Masterplan Implementation

To promote sustainable urban development, it is proposed to formulate and execute forward-looking masterplans for town and metropolitan centres. These comprehensive plans would emphasise the integration of land use and transport, fostering efficient and accessible urban spaces. An exemplar of such integrated planning is the **15-minute city concept, encouraging residents to fulfill the majority of their daily activities within a 15-minute radius, utilising active modes, micro-mobility, or public transport**

(Auckland Council, 2022). This model has evolved into the 20-minute neighbourhoods in Melbourne and Superblocks in Barcelona. The 20-minute city approach focuses on densifying services within accessible areas, reducing reliance on vehicles and curbing urban sprawl. **Superblocks, especially effective in established areas like Barcelona, involve closing roads within designated blocks to prioritise pedestrian and community use, resulting in a notable 40% reduction in car use** (Puttkamer, 2022).

Drawing inspiration from Ghent, Belgium, implementing a traffic circulation plan and investing in active and public transport can significantly transform urban mobility. **Ghent experienced a 13% reduction in personal vehicles during rush hour, a 37% increase in cycling, and a 40% reduction in traffic collisions through these measures** (Waka Kotahi, 2019). Further, national network plans for all modes, as outlined in initiative 1.2a.2 by Waka Kotahi, can contribute to achieving a national mode shift (Te Manatū Waka, 2022).

The initiative also recommends the removal of minimum parking requirements in development areas to reduce dependency on private vehicles. Tokyo, Japan, serves as an illustration where strict restrictions on parking, coupled with extensive public and active transport facilities, have led to **low car ownership and a household average ownership of 0.32 cars per household** (Barter, 2014; Zipper, 2022). By linking parking restrictions with VKT, these changes not only allow for the repurposing of spaces for green areas or increased density but also induce a shift in travel behaviour. Studies on commuting behaviour highlight that **reduced parking provisions can result in up to a 37% reduction in commuting by personal vehicles** (Chatman, 2013). These multifaceted strategies collectively aim to create more sustainable, accessible, and liveable urban environments.

4.7 Climate-Ready Neighbourhoods

Empowering neighbourhoods to revolve around active modes, green spaces, and effective surface water management is crucial for fostering sustainable urban environments. This entails implementing measures such as traffic calming, enhancing walking and cycling infrastructure, increasing tree coverage, and providing social and community facilities. The transformation of neighbourhoods into mixed-use spaces with easy access to daily necessities through active or public transportation modes contributes significantly to reducing dependency on cars.

The improvement of the public realm is a pivotal step in climate ready neighbourhoods, demanding safe and attractive spaces that align with the provisions for growth. A focus on pedestrian amenities, including small block sizes, accessible footpaths, safe crossings, direct connections to buildings, slower car speeds, protection from the elements, and resting places, is found to be essential for fostering walkable areas (MRCagney, 2023). Quality pedestrian facilities facilitate mode shift, particularly in well-designed mixed-use areas. Conversely, **cities with mixed-use developments but inadequate pedestrian facilities, like some areas in Los Angeles, witness a prevalence of car-dependent trips despite short travel distances** (Tomer & George, 2023). Well-designed pedestrian facilities also enhance trip chaining, encouraging active mode users to utilize public transport for longer journeys (Auckland Council, 2022). The Emissions Reduction Plan allocates resources under initiative 1.2c.1 for developing urban cycleways and creating more walkable neighbourhoods, supporting the promotion of cycling and walking as accessible modes of transportation (Te Manatū Waka, 2022).

In anticipation of future climate challenges, Hamilton, New Zealand, is taking a proactive approach by developing its first climate-ready neighbourhood. This upcoming development prioritizes the **protection of the natural environment, incorporating well-planned transport networks, wide footpaths, separated cycleways, strategic public transport networks, and medium to high-density housing** (Hamilton City Council, 2021). The emphasis is on creating a sustainable and accessible community that aligns with climate-resilient principles, setting a noteworthy example for future urban developments. **The**

development is designed to enable access to everything need within 20 minutes without the use of private vehicles.

4.8 Transit Oriented Development

Maximising the use of publicly owned land, such as golf courses and parking buildings in the vicinity of rapid transit stations, presents an opportunity for transformative urban development. Public development agencies could strategically redevelop these holdings into medium and high-density residential and commercial spaces, aligning with the concept of Transit Oriented Developments (TODs). TODs focus on planned developments characterised by increased density and accessibility, with a concentration of residential and commercial structures around rapid transit infrastructure.

(Tennøy and Hagen, 2020) examined Oslo's planning experience, where densification through co-ordinated land-use and transport planning is an important factor driving the city's development away from urban sprawl. The densification of public transport nodes is identified as an important step in strategies to reach the national government's goal of zero growth in private car traffic in Norwegian cities. Since the 1990s, there has been a professional and political consensus concerning urban densification as an overall strategy for urban development in Norway. A deliberate policy of transforming old industrial areas into housing combined with densification around public transport hubs aims to make car ownership unnecessary. A study of the three largest cities in Norway (Bergen, Kristiansand and Oslo) conducted by TOI (Institute of Transport Economics) confirms **workplaces and dwellings located in proximity to transport nodes generate less car traffic per inhabitant and per employee than dwellings and workplaces located outside the nodes** (Tennøy et al., 2017). **In many cities, however, density is already high and mixed land use is already common practice. In these contexts, the extent of car dependency is often associated with the quality of alternatives and the growth management strategy chosen**. To avoid car-oriented expansion and deal with "dysfunctional" density (i.e. high-density sprawl along motorways), some cities use investment in rail transit as a growth management strategy – rail lines extend to vacant or underdeveloped areas to lead the anticipated spatial expansion.

In Shenzhen, for example, metro alignments and station placement have been planned in non- or less-populated places with the expectation that development will rapidly follow once the metro is in operation. As a result, here and elsewhere, new metro towns have emerged on the lines that reach the outer suburbs of metro regions. Wuhan and Nanjing have also developed metro towns outside their city cores in this way. To steer new developments towards rail stations, many Chinese cities have adopted a general policy that development within 500m of rail transit can exceed the regulated maximum floor area ratio (FAR – floor space divided by the building plot area – floor area ratio). Wuhan offers a density bonus of 20% FAR for residential uses within 400m of metro stations and 30-59% FAR for commercial developments within 200m of stations (ITF, 2021).

A US-based study was undertaken to understand the role that household proximity to public transport has on VMT (California Housing Partnership Corporation & TransForm, 2014). This study specifically focused on understanding variability of impacts at different levels of household income. Other **studies have found (by way of modelling) significant differences in GHG emissions based on proximity to public transport**. For example, a modelled study in the city Chicago, Illinois, found that **living in an area within half a mile of public transportation can enable an average household to reduce GHG emissions by 43%, while living in the central city areas with the highest concentration of public transport and local services can enable average households to reduce emissions by 78%** (Center for Neighbourhood Technology, 2010). The California-based case study profiled here supports the hypothesis that TOD can potentially lead to significant GHG emissions reductions via reduced VMT of residents. The study of household travel survey **data found that proximity to public transport has a large effect on both the number of household trips and total household VMT** (California Housing Partnership

Corporation & TransForm, 2014). The study found that **all income groups living in high-quality transport areas had 25%–30% lower VMT than households with similar incomes living in areas with fewer public transport options.** Results were even stronger for TOD areas compared to non-TOD areas. Households in **TOD areas were found to have between 37% and 50% lower VMT rates compared to households with comparable income levels in non-TOD areas.**

5.0 Bibliography

Active Modes

Package 1 - Cycle Connectivity

1. Chapman, R. et al. (2018) 'A cost benefit analysis of an active travel intervention with health and carbon emission reduction benefits', International Journal of Environmental Research and Public Health, 15(5), p. 962. doi:10.3390/ijerph15050962.
2. Frank, L.D., Hong, A. and Ngo, V.D. (2021) 'Build it and they will cycle: Causal evidence from the downtown Vancouver Comox Greenway', Transport Policy, 105, pp. 1–11. doi:10.1016/j.tranpol.2021.02.003.
3. Marqués, R. et al. (2015) 'How infrastructure can promote cycling in cities: Lessons from Seville', Research in Transportation Economics, 53, pp. 31–44. doi:10.1016/j.retrec.2015.10.017.
4. Song, Y., Preston, J. and Ogilvie, D. (2017) 'New walking and cycling infrastructure and modal shift in the UK: A quasi-experimental panel study', Transportation Research Part A: Policy and Practice, 95, pp. 320–333. doi:10.1016/j.tra.2016.11.017.
5. Stanbridge, K., & Lyons, G. (2006, August). Travel behaviour considerations during the process of residential relocation. Paper presented at 11th International Conference on Travel Behaviour Research, Kyoto, Japan
6. Thorne, R. et al. (2018) 'Evaluation of Federal Street Contra-Flow Cycle Lane', Mackie Research [Preprint]. doi:https://at.govt.nz/media/1980228/federal-street-evaluation-report-mackie-research.pdf.
7. 'Innovating Streets for People Programme Evaluation' (2021) Mackie Research [Preprint].

Package 2 - Bike Hubs and Bike Parking

8. Cervero, R., Caldwell, B. and Cuellar, J. (2013) 'Bike-and-ride: Build it and they will come', Journal of Public Transportation, 16(4), pp. 83–105. doi:10.5038/2375-0901.16.4.5.
9. Fehnker, L. (2018) New Lynn Bike Hub Impact Evaluation [Preprint].
10. Hamre, A. and Buehler, R. (2014) 'Commuter mode choice and free car parking, public transportation benefits, showers/lockers, and bike parking at work: Evidence from the Washington, DC region', Journal of Public Transportation, 17(2), pp. 67–91. doi:10.5038/2375-0901.17.2.4.
11. Patterson, R., Ogilvie, D. and Panter, J. (2020) 'The social and physical workplace environment and commute mode: A Natural Experimental Study', Preventive Medicine Reports, 20, p. 101260. doi:10.1016/j.pmedr.2020.101260.

Package 3 - Walking Connectivity

12. Cambra, P. and Moura, F. (2020) 'How does walkability change relate to walking behaviour change? effects of a street improvement in pedestrian volumes and walking experience', Journal of Transport & Health, 16, p. 100797. doi:10.1016/j.jth.2019.100797.
13. 'Innovating Streets for People Programme Evaluation' (2021) Mackie Research [Preprint].
14. Knell, G.K. et al. (2018) 'If You Build It, Will They Come? A Quasi-experiment of Sidewalk Improvements and Physical Activity', Transl J Am Coll Sports Med, 3(9), pp. 66–71.
15. Manoj, M. and Verma, A. (2016) 'Effect of built environment measures on trip distance and mode choice decision of non-workers from a city of a developing country, India', Transportation Research Part D: Transport and Environment, 46, pp. 351–364. doi:10.1016/j.trd.2016.04.013.

16. Song, Y., Preston, J. and Ogilvie, D. (2017) 'New walking and cycling infrastructure and modal shift in the UK: A quasi-experimental panel study', Transportation Research Part A: Policy and Practice, 95, pp. 320–333. doi:10.1016/j.tra.2016.11.017.

Package 4 - Increased Crossings

17. Mohanty, S., Bansal, S. and Bairwa, K. (2017) 'Effect of integration of bicyclists and pedestrians with transit in New Delhi', Transport Policy, 57, pp. 31–40. doi:10.1016/j.tranpol.2017.03.019.

Package 5 - Improved Access

18. Burns, T. et al. (2022) Walking for Everyone [Preprint].
19. Dropped kerbs (no date) Dropped Kerbs | Traffic Choices - aiding traffic scheme decisions. Available at: https://www.trafficchoices.co.uk/somerset/traffic-schemes/dropped-kerbs.shtml#:~:text=Dropped%20kerbs%20are%20where%20the,to%20identify%20a%20crossing%20point. (Accessed: 30 November 2023).
20. TFL (2010) Legible London scheme evaluation in new areas [Preprint].

Package 6 - Low Traffic Neighbourhoods

21. Aldred, R. and Goodman, A. (2020) 'Low traffic neighbourhoods, car use, and active travel: Evidence from the people and places survey of Outer London Active Travel Interventions', Findings [Preprint]. doi:10.32866/001c.17128.
22. Aldred, R. and Verlinghieri, E. (2020) LTNs for all? Mapping the extent of London's new Low Traffic Neighbourhoods [Preprint].
23. Goodman, A. et al. (2023) 'The impact of 2020 low traffic neighbourhoods on levels of car/van driving among residents: Findings from Lambeth, London, UK', Findings [Preprint]. doi:10.32866/001c.75470.
24. Otara-Papatoetoe Local Board (2021) Papatoetoe West Low Traffic Neighbourhood: Monitoring & Evaluation Report [Preprint].
25. Thomas, A. and Aldred, R. (2024) 'Changes in motor traffic in London's low traffic neighbourhoods and Boundary Roads', Case Studies on Transport Policy, 15, p. 101124. doi:10.1016/j.cstp.2023.101124.

TDM

Package 1 - Parking Management

26. Bianco, M.J. (2000) 'Effective Transportation Demand Management: The Results of Combining Parking Pricing, Transit Incentives, and Transportation Management in a Commercial District of Portland, Oregon ', Transportation Research Board [Preprint].
27. Dale, S. et al. (2019) 'The impact of the Nottingham workplace parking levy on travel to work mode share', Case Studies on Transport Policy, 7(4), pp. 749–760. doi:10.1016/j.cstp.2019.09.001.
28. Greig Harvey and Elizabeth Deakin (1997), "The STEP Analysis Package: Description and Application Examples," Appendix B, in Apogee Research, Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions, USEPA (Washington DC; www.epa.gov/omswww/market.htm)
29. Hermann, G and M Kodransky (2011) Europe's parking U-turn.
30. Hess, D.B. (2001) 'Effect of free parking on commuter mode choice: Evidence from travel diary data', Transportation Research Record: Journal of the Transportation Research Board, 1753(1), pp. 35–42. doi:10.3141/1753-05.

31. Kelly, J.A., & Clinch, J. (2009). Temporal variance of revealed preference on-street parking price elasticity. Transport Policy 16(4), 193-199.
32. Knott, C.S. et al. (2019) 'Changes in workplace car parking and commute mode', Journal of Epidemiology and Community Health, 73(1).
33. Kulash, D., 1974. Parking Taxes as Roadway Prices: A Case Study of the San Francisco Experience. The Urban Institute, Paper 1212-9, Washington, D.C.
34. MRCagney (2014) Transport pricing in the ACT
35. Marsden, G (2006) The evidence base for parking policies: a review. Transport Policy 13
36. Ng, W.-S. (2014) Assessing the Impact of Parking Pricing on Transportation Mode Choice and Behaviour [Preprint].
37. 'The environmental and welfare implications of parking policies' (2019) OECD Environment Working Papers [Preprint]. doi:10.1787/16d610cc-en.

Package 2 - Road User Charging

38. Börjesson, M. and Kristoffersson, I. (2015) 'The Gothenburg congestion charge. effects, design and politics', Transportation Research Part A: Policy and Practice, 75, pp. 134–146. doi:10.1016/j.tra.2015.03.011.
39. DeCicco, J. and Gordon, D. (1993) Steering With Prices: Fuel and Vehicle Taxation as Market Incentives for Higher Fuel Economy [Preprint].
40. Greenberg, A. and Evans, J. (2017), Comparing Greenhouse Gas Reductions and Legal Implementation Possibilities for Pay-to-Save Transportation Price-shifting Strategies and EPA's Clean Power Plan, Victoria Transport Policy Institute (www.vtpi.org); at www.vtpi.org/G&E_GHG.pdf.
41. Harvey, G. and Deakin, E. (1997) 'The STEP Analysis Package: Description and Application Examples', Guidance on the Use of Market Mechanisms to Reduce Transportation Emissions [Preprint].
42. Johansson, C., Burman, L. and Forsberg, B. (2009) 'The effects of congestions tax on air quality and health', Atmospheric Environment, 43(31), pp. 4843–4854. doi:10.1016/j.atmosenv.2008.09.015.
43. Jakobsson, C., Fujii, S. and Gärling, T. (2002) 'Effects of economic disincentives on private car use', Transportation, 29(4), pp. 349–370. doi:10.1023/a:1016334411457.
44. Bordoff, J. and Noel, P. (2008), Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity, The Brookings Institution (www.brookings.edu); at www.brookings.edu/papers/2008/07_payd_bordoffnoel.aspx.
45. Ferreira, J. and Minikel, E. (2010), Pay-As-You-Drive Auto Insurance In Massachusetts: A Risk Assessment And Report On Consumer, Industry And Environmental Benefits, by the Dept. of Urban Studies and Planning, Massachusetts Institute of Technology (http://dusp.mit.edu) for the Conservation Law Foundation (www.clf.org); at https://bit.ly/2xA1N5L.
46. Institute for Transport Studies (2004), Fuel Taxes First Principles Assessment, KonSULT, Institute for Transport Studies, University of Leeds (www.socscinet.com/transport/konsult/private/level2/instruments/instrument022/l2_022b.htm).
47. L.B. Magoon (2000), Are We Running Out of Oil? US. Geological Survey (http://geopubs.wr.usgs.gov/open-file/of00-320). Also see M. King Hubbert Centre for Petroleum Supply Studies (http://hubbert.mines.edu).
48. Litman, T. (2023) 'Understanding Transport Demands and Elasticities: How Prices and Other Factors Affect Travel Behavior', Victoria Transport Policy Institute [Preprint].

49. Litman, T. (2012), “Pricing for Traffic Safety: How Efficient Transport Pricing Can Reduce Roadway Crash Risks,” Transportation Research Record 2318, pp. 16-22, TRB (www.trb.org); at www.vtpi.org/price_safe.pdf.
50. Ministry of Transport (2020) The Congestion Question: Could road pricing improve Auckland’s traffic? [Preprint].
51. Transport for London (TfL) (2012) Consultation results. Accessed 15 May 2019. https://web.archive.org/web/20120331140203/http://www.tfl.gov.uk/roadusers/congestioncharging/170 94.aspx#removal

Package 3 - Mobility Management

52. Breikers (2019) Breikers. Accessed November 2023. www.wijzijnbreikers.nl/2019/01/10/doe-ook-meemet-autoloze-dinsdag-op-12-juni/
53. Brög, W, E Erl, I Ker and J Ryle (2009) Evaluation of voluntary travel behaviour change: experiences from three continents. Transport Policy 16, no.6: 281–292.
54. Chatterjee, K and P Bonsall (2009) Special Issue on evaluation of programmes promoting voluntary change in travel behaviour. Transport Policy 16, no.6: 279–280.
55. Eriksson, L., Garvill, J., & Nordlund, A. M. (2008). Interrupting habitual car use: The importance of car habit strength and moral motivation for personal car use reduction. Transportation Research Part F: Traffic Psychology and Behaviour, 11(1), 10–23. https://doi.org/10.1016/j.trf.2007.05.004
56. Fujii, S., & Taniguchi, A. (2005). Reducing family car-use by providing travel advice or requesting behavioural plans: An experimental analysis of travel feedback programs. Transportation Research Part D: Transport and Environment, 10(5), 385–393. https://doi.org/10.1016/j.trd.2005.04.010
57. Kent, B and E Ampt (2012) Why 'building it' always means they will come – understanding reactions to behaviour change measures. sl. 35th ATRF.
58. Klöckner, AC and M Ellen (2004) How habits interfere with norm-directed behaviour: A normative decision-making model for travel mode choice. Journal of Environmental Psychology 24, no.3: 319– 327.
59. Ralph, K and A Brown (2017) The right place and the right time to change travel behaviour: an experimental study. Transportation Research Board 96th Annual Meeting
60. Sharon, B. (2001) Tools- of changes, Tools of Change. Available at: https://toolsofchange.com/en/case-studies/detail/100/ (Accessed: 30 November 2023).
61. Stanbridge, K and G Lyons (2006) Travel behaviour considerations during the process of residential relocation. Conference paper, Session 1.7 International Conference on Travel Behaviour Research, Kyoto, 16–20 August 2006.
62. Victoria Transport Policy Institute TDM encyclopaedia (2019) - transportation management associations. Available at: https://www.vtpi.org/tdm/tdm44.htm (Accessed: 30 November 2023).
63. Waerden, PvD, A Borgers and H Timmermans (2003) Key events and critical incidents influencing transport mode choice switching behaviour: an exploratory study. In Proceedings 82nd Annual Meeting of the Transportation Research Board.

Package 4 - Improved Access

64. Auckland Transport (2022) The Global Evidence Base for the Transport Emissions Reduction Pathway [Preprint].
65. Cervero, R. and Tsai, Y. (2004) ‘City CarShare in San Francisco, California: Second-year travel demand and car ownership impacts’, Transportation Research Record: Journal of the Transportation Research Board, 1887(1), pp. 117–127. doi:10.3141/1887-14.

66. Clark, J (2018) So what's next for bike share in Seattle? Accessed September 2019. https://sdotblog.seattle.gov/2018/07/13/so-whats-next-for-bike-share-in-seattle/
67. Deutscher Sprachraum (2020) Innovative Mobility Solutions in Graz: Mobil Zentral Graz - The First Austrian Mobility Centre [Preprint].
68. Engels, D. (2018). Evaluatie Circulatieplan Gent [Evaluation Circulation Plan Ghent] (Part 1). https://www.tmleuven.be/nl/project/circulatieplangent Engels, D. (2019). Evaluatie Circulatieplan Gent [Evaluation Circulation Plan Ghent] (Part 2). https://www.tmleuven.be/nl/project/circulatieplangent
69. Tsubohara, S. (2007). A traffic plan to make residential areas car-limited: traffic planning in Groningen.
70. Vancity (2018) A 2018 report by Vancouver City Savings Credit Union looked at carshare uptake in the city, including details about the financial advantages of taking part (Vancity 2018). [Preprint].
71. Wang, T and C Chen (2012) Attitudes, mode switching behaviour, and the built environment: a longitudinal study in the Puget Sound Region. Transportation Research Part A: 1594–1607

Package 5 - Policies

72. Apur (2019), Évolution du stationnement et nouveaux usages de l'espace public, www.apur.org/fr/nostravaux/evolution-stationnement-usages-espace-public
73. Auckland Transport (2022) The Global Evidence Base for the Transport Emissions Reduction Pathway [Preprint].
74. Cairns, S., C. Hass-Klau and P. Goodwin (1998), Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence, Landor Publishing, London, https://issuu.com/landorlinks/docs/cairns-hassklau-goodwin-1998
75. Chauveau, L. (2019), « A Paris, des parkings vides faute de voitures », Sciences et à venir, www.sciencesetavenir.fr/high-tech/transports/a-paris-des-parkings-inutiles-faute-de-voitures_134257
76. City of Copenhagen (2017), Copenhagen City of Cyclists: The Bicycle Account 2016, City of Copenhagen Technical and Environment Administration, https://kk.sites.itera.dk/apps/kk_pub2/index.asp?mode=detalje&id=1698
77. Hidalgo, A. (2014), Paris qui ose : Mon projet pour Paris 2014-2020, issue, https://issuu.com/oserparis/docs/prog-0412-rvb

Package 6 - Subsidies and Grants

78. Ben-Elia, E., & Ettema, D. (2011). Rewarding rush-hour avoidance: A study of commuters' travel behaviour. Transportation Research Part A: Policy and Practice, 45(7), 567–582. https://doi.org/10.1016/j.tra.2011.03.003
79. de Kruijf, J., Ettema, D., Kamphuis, C. B. M., & Dijst, M. (2018). Evaluation of an incentive program to stimulate the shift from car commuting to e-cycling in the Netherlands. Journal of Transport & Health, 10, 74–83. https://doi.org/10.1016/j.jth.2018.06.003

Package 7 – Education and Awareness

80. Cialdini, R. (2001), "The Science of Persuasion," Scientific American, Vol. 284, February, pp. 76-81; also see www.influenceatwork.com.
81. Dill, J. and Mohr, C. (2010), Long-Term Evaluation of Individualized Marketing Programs for Travel Demand Management, Portland State University (http://nitc.trec.pdx.edu) at http://nitc.trec.pdx.edu/research/project/160

82. Ma, L., Mulley, C. and Liu, W (2017), Social Marketing and the Built Environment: What Matters for Travel Behaviour Change?" Transportation, Vol. 44/5, pp. 1147–1167 (https://link.springer.com/article/10.1007%2Fs11116-016-9698-2).
83. McLaughlin, K.A. and Glang, A. (2009) 'The effectiveness of a bicycle safety program for improving safety-related knowledge and behavior in Young Elementary Students', Journal of Pediatric Psychology, 35(4), pp. 343–353. doi:10.1093/jpepsy/jsp076.
84. Rose, G. and Marfurt, H. (2007) 'Travel behaviour change impacts of a major ride to Work Day Event', Transportation Research Part A: Policy and Practice, 41(4), pp. 351–364. doi:10.1016/j.tra.2006.10.001.
85. Sahlqvist, S. et al. (2019) 'Impact of an Australian state-wide active travel campaign targeting primary schools', Preventive Medicine Reports, 14, p. 100866. doi:10.1016/j.pmedr.2019.100866.
86. Spears, S., Boarnet, M. and Handy, S. (2013) Impacts of Parking Pricing Based on a Review of Empirical Literature [Preprint].
87. Smarter Travel Sutton (2009) Smarter Travel Sutton | The NSMC. Available at: https://www.thensmc.com/resources/showcase/smarter-travel-sutton (Accessed: 30 November 2023).
88. Travel choices innovation challenge: TFNSW open data hub and developer portal (2017) Travel Choices Innovation Challenge | TfNSW Open Data Hub and Developer Portal. Available at: https://opendata.transport.nsw.gov.au/travel-choices-innovation-challenge (Accessed: 30 November 2023).
89. Victoria Transport Policy Institute TDM encyclopaedia (2019) – TDM Marketing. Available at: https://www.vtpi.org/tdm/tdm23.htm
90. Zhang, Y., Stopher, P. and Halling, B. (2013), "Evaluation of South-Australia's TravelSmart Project: Changes in Community's Attitudes to Travel" Transport Policy, Vol. 26, pp. 15-22 (https://doi.org/10.1016/j.tranpol.2012.06.008).
91. Victoria Transport Policy Institute TDM encyclopaedia (2019) – Information and Encouragement Programs Available at: https://www.vtpi.org/tdm/tdm23.htm

Public Transport

92. Monetised benefits and costs manual, June 2023 | Version 1.6.1, Waka Kotahi. Monetised benefits and costs manual v1.6 April 2023 (nzta.govt.nz)
93. RR 487 - Experience with the development of off-peak bus services FINAL TAR 08/12 23Jun13 (nzta.govt.nz)
94. Research report 434 Appraisal of factors influencing public transport patronage (nzta.govt.nz)
95. Effect of Price Reduction and Increased Service Frequency on Public Transport Travel (2017), Inge Brechan Institute of Transport Economics, Oslo.
96. Patronage effects of off-peak service improvements in regional public transport (2022), European Transport Research Review, Joel Hansson et al.
97. Understanding Transport Demands and Elasticities (2019), Victoria Transport Policy Institute, Todd Litman.
98. Auckland Transport (2022) The Global Evidence Base for the Transport Emissions Reduction Pathway [Preprint].
99. Bamberg, S. (2006). Is a residential relocation a good opportunity to change people's travel behaviour? Results from a theory-driven intervention study. Environment and Behaviour, 38(6), 820–840. https://doi.org/10.1177/0013916505285091
100. Brisbane's new Bus Network (no date) Brisbane City Council. Available at: https://www.brisbane.qld.gov.au/traffic-and-transport/public-transport/brisbanes-new-bus-network (Accessed: 30 November 2023).

101. Buehler, R., Pucher, J., Altshuler, A. 2017. „Vienna's Path to Sustainable Transport," International Journal of Sustainable Transportation. Vol. 11, No. 4.
102. Buz Services (no date) Brisbane City Council. Available at: https://www.brisbane.qld.gov.au/traffic-and-transport/public-transport/buses/buz-services (Accessed: 30 November 2023).
103. Carran-Fletcher, A. et al. (2020) 'Travel demand management: strategies and outcomes ', NZ Transport Agency research report 661 [Preprint].
104. Cats, O., Susilo, Y.O. and Reimal, T. (2016) 'The prospects of fare-free public transport: Evidence from Tallinn', Transportation, 44(5), pp. 1083–1104. doi:10.1007/s11116-016-9695-5.
105. De Borger, B. and Swysen, D. (1999) 'Public Transport Subsidies Versus Road Pricing: An Empirical Analysis for Interregional Transport in Belgium', *International Journal of Transport Economics*, 26(1).
106. Federal Ministry Republic of Austria (2021) Austria's 2030 Mobility Master Plan [Preprint].
107. Fujii, S., & Kitamura, R. (2003). What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. Transportation, 30(1), 81–95. https://doi.org/10.1023/A:1021234607980
108. Hensher, D.A. (2008) 'Assessing systematic sources of variation in public transport elasticities: Some comparative warnings', Transportation Research Part A: Policy and Practice, 42(7), pp. 1031–1042. doi:10.1016/j.tra.2008.02.002.
109. Holmgren J. and P. Ivehammar (2015), "Public transport quality as a tool for reducing car dependency", AET, www.transportportal.se/Energieffektivitet/Etapp2/Public-Transport-Quality-As-a-tool.pdf
110. Holmgren, J (2007) Meta-analysis of public transport demand. Transportation Research Part A: Policy and Practice 41, no.10: 1021–1035.
111. Mayeres, I. and S. Proost (2004), "Towards better transport pricing and taxation in Belgium", Reflets et perspectives de la vie économique, 2004/4, Tome xliii(4), 23-43, https://doi.org/10.3917/rpve.434.0023 (accessed on 19/05/2020).
112. Nijkamp, P., & Pepping, G. (1998). A Meta-analytical Evaluation of Sustainable City Initiatives. Urban Studies, 35(9), 1481–1500. http://www.jstor.org/stable/43084048
113. Paulley, N, R Balcombe, RL Mackett and H Titheridge (2006) The demand for public transport: The effects of fares, quality of service, income and car ownership. Transport Policy 13: 298–306
114. Proost, S. (2017), "Reforming Private and Public Urban Transport Pricing", International Transport Forum Discussion Papers, No. 2018/15, OECD Publishing, Paris, https://doi.org/10.1787/3567dda4-en.
115. Schrinner, A. (2021) New 'gold' CityGlider proposed to service high-growth areas, Adrian Schrinner. Available at: https://www.adrianschrinner.com.au/media-announcements/new-gold-cityglider-proposed-to-service-high-growth-areas/ (Accessed: 30 November 2023).
116. Stumpel-Vos, P., Oostrom, C., & van den Berg, V. (2013). Focus measure evaluation results: UTR 4.1 Mobility management policy. CIVITAS MIMOSA. https://civitas.eu/sites/default/files/measure_evaluation_results_4_1_mobility_management_policy.pdf
117. Transport for London | Every Journey Matters (no date) Rules of red routes, Transport for London. Available at: https://tfl.gov.uk/modes/driving/red-routes/rules-of-red-routes (Accessed: 30 November 2023).
118. Tsivanidis, N. (2019). the aggregate and distributional effects of urban transit infrastructure: Evidence from Bogotá's TransMilenio. https://www.cemfi.es/ftp/pdf/papers/pew/TransMilenio_2.2019.pdf

119. UITP (2014), Better Public Transport Fare Policy for More Resilient Funding, policy brief, International Association of Public Transport, Brussels, https://cms.uitp.org/wp/wp-content/uploads/2020/09/Policy-Brief-FullFreeFarePT-DEF-web.pdf.
120. United Nations Framework Convention on Climate Change. (n.d.-a). Project 0672: BRT Bogotá, Colombia: TransMilenio Phase II to IV. https://cdm.unfccc.int/Projects/DB/DNV-CUK1159192623.07/view?cp=1

Land Use

Land Use Rezoning

121. Cevero, R., & Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, 199-219. https://doi.org/10.1016/S1361-9209(97)00009-6
122. Currans, K. M., Abou-Zeid, G., McCahill, C., Iroz-Elardo, N., Clifton, K. J., Handy, S., & Pineda, I. (2022). Households with constrained off-street parking drive fewer miles. *Transportation*. https://link.springer.com/article/10.1007/s11116-022-10306-8
123. Litman, T. (2023). Land use impacts on transport. Victoria: Victoria Transport Policy Institute. Retrieved from www.vtpi.org/landtravel.pdf
124. Los Angeles City Planning. (n.d.). Transit Oriented Communities Incentive Program. Retrieved from Planning LA City: https://planning.lacity.org/plans-policies/transit-oriented-communities-incentive-program
125. Ministry of Housing and Urban Development (2022), Nationsal Policy statement on urban development. Retrieved from https://environment.govt.nz/acts-and-regulations/national-policy-statements/national-policy-statement-urban-development/
126. Planitzen. (2023). *What is Euclidean Zoning*. Retrieved from Planitzen: https://www.planetizen.com/definition/euclidean-zoning
127. Trubka, R., Newman, P., & Bilsborough, D. (2010). The costs of urban sprawl – predicting transport greenhouse gases from urban form parameters. Environment Design Guide, 1-16. Re

Intensification incentives

128. Los Angeles City Planning. (n.d.). Transit Oriented Communities Incentive Program. Retrieved from Planning LA City: https://planning.lacity.org/plans-policies/transit-oriented-communities-incentive-program
129. Te Manatū Waka (2022), Mahere Hohenga kia Whakakorea te Waro ā-Kawenga 2022-25 Decarbonising Transport Action Plan 2022-25. Available at: https://www.transport.govt.nz/assets/Uploads/MOT4716_Emissions-Reduction-Plan-Action-Plan-P04-V02.pdf (Accessed 1 December 2023).
130. Auckland Council (2022), The Global Evidence Base for Transport Emissions Reduction Pathway. Available at: https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/Documents/global-evidence-base-transport-emissions-reduction-pathway.pdf

Integrated Land Use and Transport Planning

131. Te Manatū Waka (2022), Mahere Hohenga kia Whakakorea te Waro ā-Kawenga 2022-25 Decarbonising Transport Action Plan 2022-25. Available at: https://www.transport.govt.nz/assets/Uploads/MOT4716_Emissions-Reduction-Plan-Action-Plan-P04-V02.pdf (Accessed 1 December 2023).
132. Auckland Council (2022), The Global Evidence Base for Transport Emissions Reduction Pathway. Available at: https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/Documents/global-evidence-base-transport-emissions-reduction-pathway.pdf

133. Waka Kotahi (2019), Keep Cities Moving. Retrieved from https://www.nzta.govt.nz/assets/resources/keeping-cities-moving/Keeping-cities-moving.pdf

Public Realm Improvements

134. Bolleter, J., Myers, Z., & Hooper, P. (2022). Overcoming the barriers to Transit-Oriented Development. Australian Planner. 57(1), 1-18. https://doi.org/10.1080/07293682.2021.2017992

135. Duncan, M. (2011), The Impact of Transit-oriented Development on Housing Prices in San Deigo CA, *Urban Studies, 48*(1), 101-127. https://doi.org/10.1177/0042098009359995

136. Puttkamer, l. (2022), Super blocks in urban planning. Available at: https://toposmagazine.com/superblocks-in-urban-planning/

137. Waka Kotahi (2022), Innovating Streets for People 2020/21 Programme Evaluation. Available at: https://www.nzta.govt.nz/assets/Roads-and-Rail/streets-for-people/innovating-streets-for-people-2020-2021-programme-evaluation-executive-summary.pdf

Enabling Infrastructure

138. Department of Internal Affairs (2023), Water Services Reform Programme. Available at: https://www.dia.govt.nz/Water-Services-Reform-Programme

139. Te Manatū Waka (2022), Mahere Hohenga kia Whakakorea te Waro ā-Kawenga 2022-25 Decarbonising Transport Action Plan 2022-25. Available at: https://www.transport.govt.nz/assets/Uploads/MOT4716_Emissions-Reduction-Plan-Action-Plan-P04-V02.pdf (Accessed 1 December 2023).

Masterplan implementation

140. Auckland Council (2022), The Global Evidence Base for Transport Emissions Reduction Pathway. Available at: https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/Documents/global-evidence-base-transport-emissions-reduction-pathway.pdf

141. Barter, P. (2014). Japan's proof-of-parking rule has an essential twin policy. Retrieved from https://www.reinventingparking.org/2014/06/japans-proof-of-parking-rule-has.html

142. Chatman, D. (2013), Does TOD Need the T? One the Importance of Factors Other Than Rail Access. *Journal of the American Planning Associaltion*, *79*(1), 17-31. https://doi.org/10.1080/01944363.2013.791008

143. Puttkamer, l. (2022), Super blocks in urban planning. Available at: https://toposmagazine.com/superblocks-in-urban-planning/

144. Te Manatū Waka (2022), Mahere Hohenga kia Whakakorea te Waro ā-Kawenga 2022-25 Decarbonising Transport Action Plan 2022-25. Available at: https://www.transport.govt.nz/assets/Uploads/MOT4716_Emissions-Reduction-Plan-Action-Plan-P04-V02.pdf (Accessed 1 December 2023).

145. Waka Kotahi (2019), Keep Cities Moving. Retrieved from https://www.nzta.govt.nz/assets/resources/keeping-cities-moving/Keeping-cities-moving.pdf

146. Zipper, D. (2022). What drove Japan's remarkable traffic safety turnaround? Retrieved from: https://www.bloomberg.com/news/articles/2022-09-06/what-drove-japan-s-remarkable-traffic-safety-turnaround

Climate Ready Neighbourhoods

147. Auckland Council (2022), The Global Evidence Base for Transport Emissions Reduction Pathway. Available at: https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/Documents/global-evidence-base-transport-emissions-reduction-pathway.pdf
148. Hamilton City Council (2021), Plans for Peacocke create climate-ready neighbourhood. Available at: https://hamilton.govt.nz/your-council/news/growing-hamilton/plans-for-peacocke-create-climate-ready-neighbourhood (Accessed 1 December 2023).
149. Te Manatū Waka (2022), Mahere Hohenga kia Whakakorea te Waro ā-Kawenga 2022-25 Decarbonising Transport Action Plan 2022-25. Available at: https://www.transport.govt.nz/assets/Uploads/MOT4716_Emissions-Reduction-Plan-Action-Plan-P04-V02.pdf (Accessed 1 December 2023).
150. Tomer, A., & George, C. (2023, June 29). Building proximity: The role of activity centres in reducing total miles traveled. Retrieved from www.brookings.edu/articles/building-for-proximity-the-role-of-activity-centers-in-reducing-total-miles-traveled/

Transit Oriented Development

151. California Housing Partnership Corporation, & TransForm. (2014). Why creating and preserving affordable homes near transit is a highly effective climate protection strategy. https://www.transformca.org/sites/default/files/CHPC%20TF%20Affordable%20TOD%20Climate%20 Strategy%20BOOKLET%20FORMAT.pdf
152. Center for Neighbourhood Technology. (2010). Transit oriented development and the potential for VMTrelated greenhouse gas emissions growth reduction. http://s15323955.onlinehomeserver.com/repository/TOD-Potential-GHG-Emissions-Growth.FINAL.pdf
153. ITF (2021), Reversing Car Dependency: Summary and Conclusions, ITF Roundtable Reports, No. 181, OECD Publishing, Paris.
154. Tennøy et al. (2017), “Effects on traffic and emissions of densification in nodes in Bergen, Kristiansand and Oslo”, TØI report 1575/2017, TØI – Institute of Transport Economics, Norwegian Centre for Transport Research, Oslo, (English summary of Norwegian-language report) www.toi.no/getfile.php/1346172/Publikasjoner/T%C3%98I%20rapporter/2017/1575-2017/1575- 2017_summary.pdf.
155. Tennøy, A. & Helen Hagen, O. 2020. "Reallocation of Road and Street Space in Oslo: Measures for Zero Growth in Urban Traffic," International Transport Forum Discussion Papers 2020/14, OECD Publishing