Austroads

Research Report
AP-R711-24

Prioritising Active Transport

Prioritising Active Transport

Prepared by

Dr Elliot Fishman, Dr Mahsa Naseri, Dr Liam Davies, Jessie Tran and Takuya Katsu

Project Manager

Andrew Somers

Publisher

Austroads Ltd.
Level 9, 570 George Street
Sydney NSW 2000 Australia
Phone: +61 2 8265 3300
austroads@austroads.com.au
www.austroads.com.au

Abstract

This report provides coverage of interventions effective in growing active transport mode share.

A prioritisation framework was developed to select the interventions that are most impactful in boosting active transport mode share. Significant increases in mode share are likely to require ambitious initiatives. Two decades of policy support for increasing active transport mode share may have stopped or slowed falls in walking and cycling levels but has not yet succeeded in achieving widespread and large increases.

In addition to impact, an intervention's *cost*, and *complexity* was also included within the prioritisation framework. For each of the prioritised actions, guidance on their suitability to different geographical contexts has been offered (e.g. inner city, suburban, regional etc.)

This report has found that to grow active transport mode share, a mix of interventions is required, including those that reduce or remove current incentives that encourage car use alongside interventions designed to encourage walking and cycling.

Keywords

Active transport, micromobility, cycle planning, pedestrian planning, pop up bike lane, Movement and Place, 30-minute city, mode share, public transport, modal filter, e-bike, e-scooter.

ISBN 978-1-922994-37-0

Austroads Project No. EAS6377

Austroads Publication No. AP-R711-24

Publication date June 2024

Pages 150

About Austroads

Austroads is the peak organisation of Australasian road transport and traffic agencies.

Austroads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

Austroads provides a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users.

Austroads is governed by a Board consisting of senior executive representatives from each of its eleven member organisations:

- Transport for NSW
- Department of Transport and Planning Victoria
- Queensland Department of Transport and Main Roads
- Main Roads Western Australia
- Department for Infrastructure and Transport South Australia
- Department of State Growth Tasmania
- Department of Infrastructure, Planning and Logistics Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
- Department of Infrastructure, Transport, Regional Development, Communications and the Arts
- Australian Local Government Association
- NZ Transport Agency Waka Kotahi.

Summary

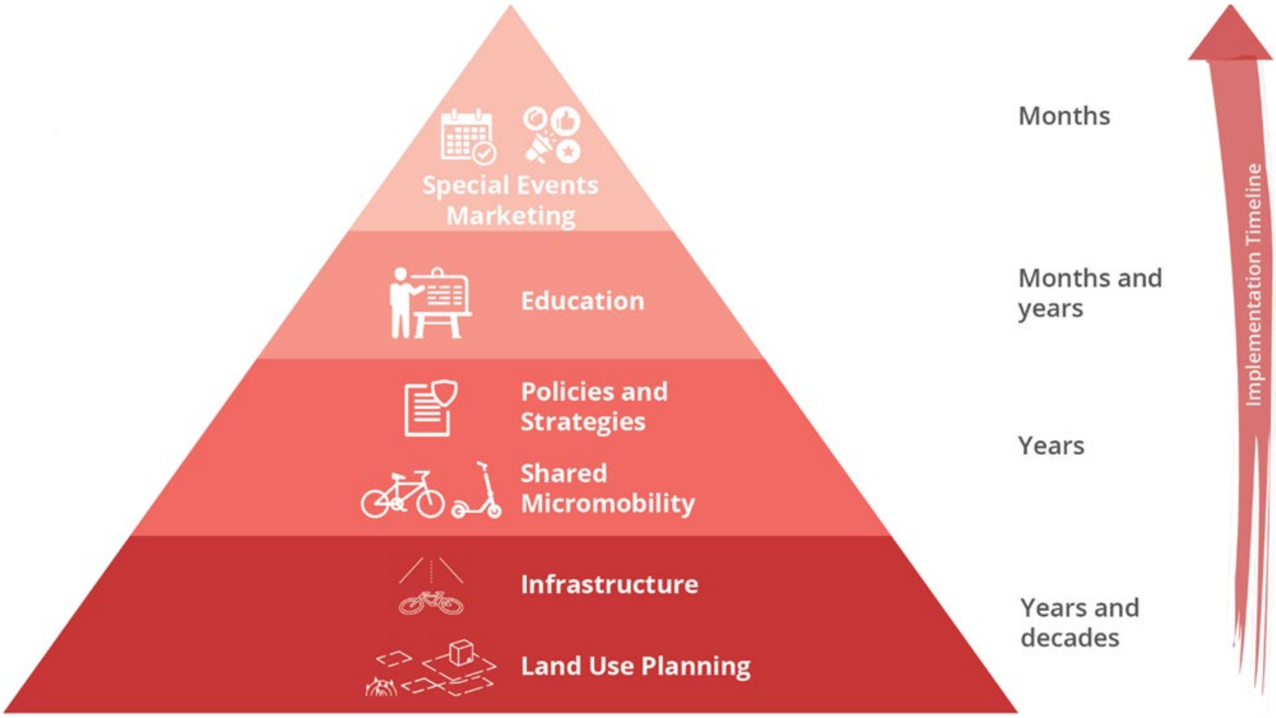
Across Australasia, an increasing number of state and local governments have identified the need to reduce car use and increase walking and cycling levels. Despite this interest, transport data shows that there are no widespread or sustained increases in active transport mode share in Australasia. This project principally focuses on interventions to grow active transport and provides coverage of the effectiveness of different intervention types to increase walking and cycling mode share. Importantly, these interventions cover both *incentives* (measures intended to make active transport more convenient, safer etc) as well as *disincentives* for car use (e.g. car parking management, road user pricing). Consideration of both incentives and disincentives emerged as critically important when seeking to grow active transport mode share. The review of the literature and the subject matter expert interviews conducted for this project both found that without the application of both incentives and disincentives, active transport mode share is unlikely to increase.

This report describes the key barriers to walking and cycling and provides an overview of active transport levels across different parts of Australasia. Safety concerns emerge as one of the most powerful barriers to achieving higher levels of active transport. Compared to many other OECD countries, Australia and New Zealand have relatively low levels of active transport mode share. Despite a wide range of policies and programs over the past two decades intended to boost active transport, this report finds walking and cycling mode share has remained at similar levels since 2006 across Australasia. This project supports transport agencies and local governments in their efforts to increase active transport mode share.

This report has used a prioritisation framework to assess the broad list of interventions intended to boost active transport mode share to arrive at those interventions most effective in terms of their:

- impact on active travel behaviour
- impact on safety
- complexity, technical difficulty and political difficulty
- cost to government, including consideration of both upfront and ongoing costs.

Detailed coverage of the prioritised actions is provided in this report, including some guidance on the geographic suitability of the different interventions. This coverage is designed to reduce pressure on agencies to undertake guidance development and seeks to avoid duplication. The results are intended to provide a practical tool to inform practitioners on which initiatives are most appropriate when seeking to increase active transport mode share. The figure below illustrates the different categories of interventions included in the report. The pyramid also shows how some intervention categories can be implemented within a matter of months, while others require years or decades to take effect.



The discussion of the prioritised interventions includes consideration of context, as illustrated in the figure below. Some interventions are better suited to inner-city environments, while other interventions can be applied across inner-city and suburban areas, as well as regional contexts.

A critical finding from this project has been that increasing active transport mode share is a significant challenge. While mode share for active transport has not changed significantly over the last 15 – 20 years, the evidence shows that a combination of actions and using a whole-of-government approach can boost levels of walking and cycling.

Contents

Tables

Figures

1. Introduction

This report provides detailed coverage of actions that governments in Australasia can take to increase active transport mode share. Consideration of both incentives and disincentives emerged as critically important when seeking to grow active transport mode share. The review of the literature and the subject matter expert interviews conducted for this project both found that without the application of both incentives and disincentives, active transport mode share is unlikely to increase.

The actions have been selected based on a prioritisation framework developed for the Australasian context. The framework has been used to shortlist the broader set of actions. The overarching objective of the prioritisation is to highlight the interventions most effective in growing active transport mode share. The actions are accompanied by guidance regarding their suitability for different parts of Australasia (e.g., inner city, suburban and regional). The report provides practitioners with guidance on the suitability and impact of different interventions to increase active transport mode share.

1.1 Purpose

The purpose of this report is to support transport agencies and local governments that are seeking to increase the mode share of active transport within their jurisdictions by providing an overview of interventions that can be implemented to achieve this.

There are many good reasons to create the conditions in which more people want to walk and cycle. These include reduced transport costs, cleaner air and less congestion, allowing people to live healthier, longer lives.

It is important to note the aim of increasing active transport is more than purely as a substitute for car use. It can also be useful to free capacity on public transport. For example, in the City of Sydney, there has been a campaign to get people in Green Square to ride to work, due to constraints on the public transport system at peak times.

This project is focused on increasing active transport *mode share.* Growing active travel mode share requires a corresponding fall in share for other modes. The objective of this report is to increase active transport mode share as a substitute for car use.

This project has the following objectives:

- support transport agencies and local governments to increase the mode share of active transport
- provide guidance that is actionable today
- provide recommendations for the better incorporation of key initiatives and actions within Austroads guides
- reduce pressure on agencies to undertake guidance development in parallel to meet emerging pressures.

1.2 Scope

The scope of this report is to provide a detailed assessment of the initiatives that have been prioritised for their effectiveness in increasing active transport mode share. The report outlines a structured approach that ensures transparency, evidence-based decision-making, and a well-informed selection process.

This project has different phases, as identified in Figure 1.1. This report is phase three of the project (research report).

Figure 1.1: Project phases

This report is structured to provide coverage across the following areas:

- Active transport in the Australasian context: Chapter 2 offers an overview of active transport participation, using available data from Australia, New Zealand, and select international counterparts, shedding light on trends and differences in active transport participation.
- Barriers to active transport: Widespread adoption of active transport faces a range of challenges and barriers that impede its integration into people's daily routines and urban planning strategies. The report explores the barriers that limit the broader uptake of active transport (Chapter 3).
- Prioritisation process: The report describes the methodology used in the prioritisation of different interventions reviewed to grow active transport mode share (Chapter 4). This involves using a framework, as well as the findings of subject matter expert interviews to rate the full list of interventions, for their effectiveness in increasing active transport mode share.
- Results of prioritisation framework: Chapter 6 describes the results of the prioritisation process.
- Detailed coverage of prioritised interventions: Chapter 7 provides detailed coverage of prioritised interventions, including their suitability for different contexts (e.g. inner city, suburban, regional).

1.3 Methodology

This report presents the results of a prioritisation framework, developed to identify the actions most effective in boosting active transport mode share. An intervention pyramid is used to classify the major intervention types. The prioritisation framework helps decision-makers allocate resources and attention to the most impactful and strategically important actions. Additionally, this report provides guidance as to the suitability of the prioritised actions for different parts of Australasia and recognises that what might be suitable in inner-city Sydney or Auckland may not be suitable in suburban or regional Australasia.

Impact, *Complexity* and *Cost* are the three key variables used in the prioritisation framework. A total of 168 documents (peer-reviewed and grey literature) were used to create a database of intervention types.

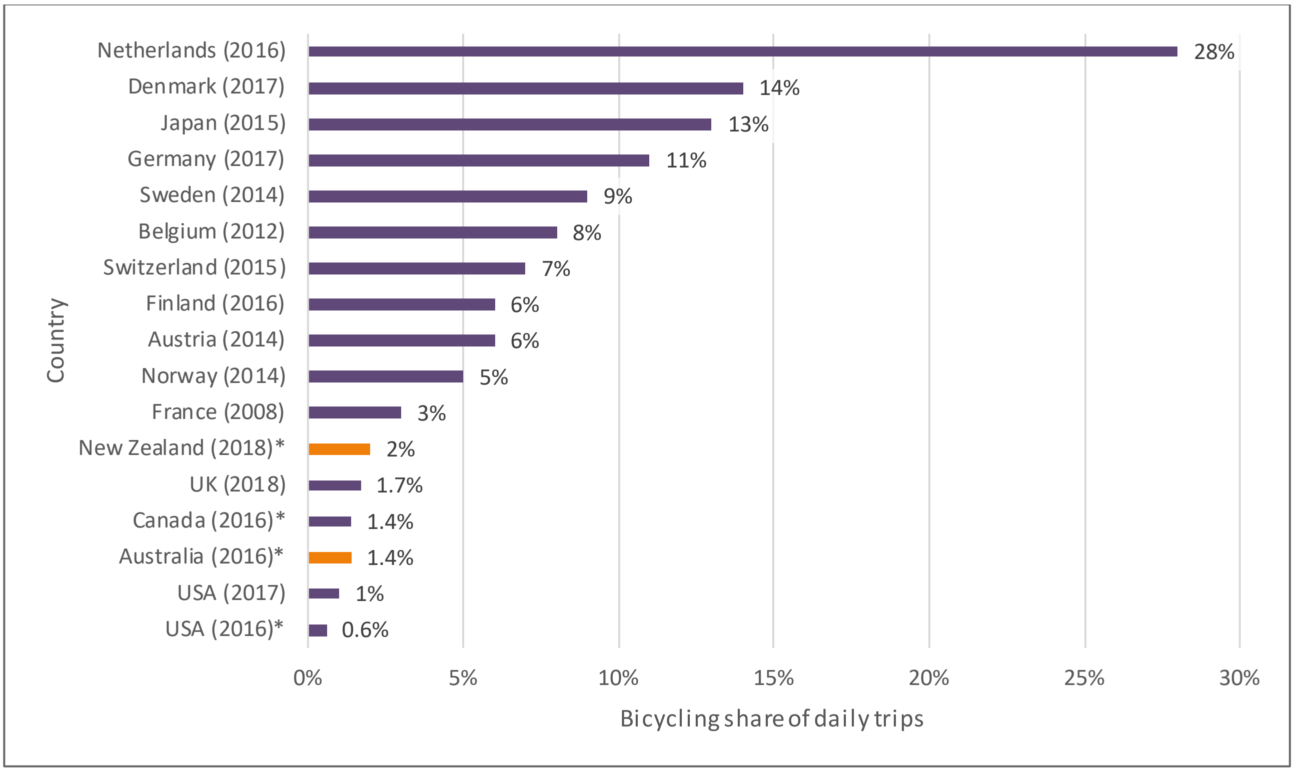
2. Active Transport in the Australasian Context

Compared to many other OECD countries, Australia and New Zealand have low levels of active transport mode share. This chapter highlights levels of active transport using available data from Australia, New Zealand, as well as selected other countries/cities.

2.1 Active transport in the international context

Australia and New Zealand have low levels of active transport mode share, compared to many other developed countries. Figure 2.1 provides a snapshot of cycling mode share for a range of OECD countries. Figure 2.2 shows cycling mode share for a range of cities across the world. In both figures, Australia and New Zealand have among the lowest number of trips completed by bike, with only 1.4% and 2% of the national population commuting by bike to work [1], respectively. Figure 2.2 shows that Melbourne and Brisbane (the only Australasian cities included in the figure) have cycling mode shares well below European cities, more in line with North American cities. The Netherlands has the greatest share of trips done by bike, at 28%, with more than 1 in 4 people riding to complete trips for *all purposes*.

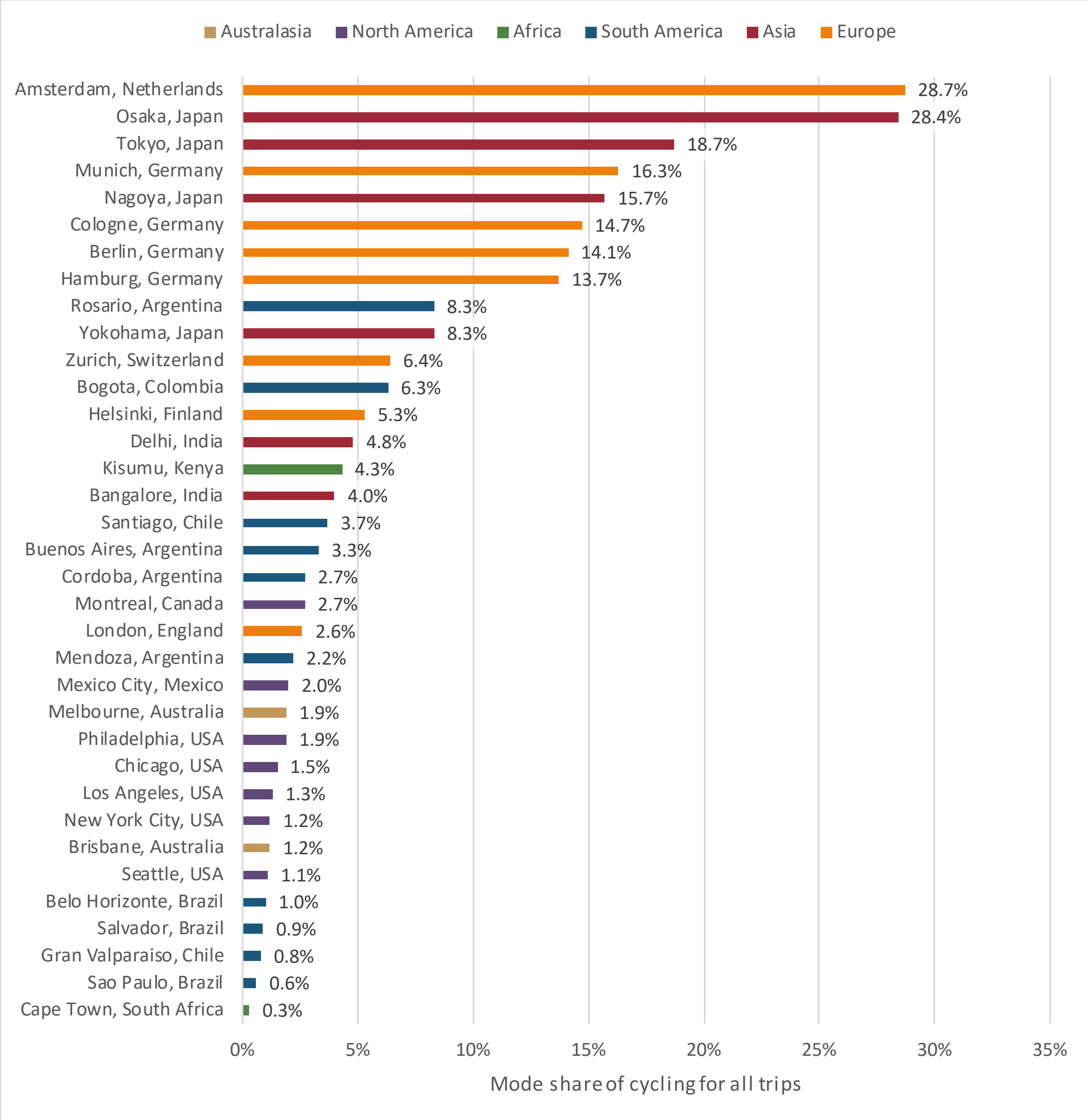
Figure 2.1: Cycling share of daily trips in OECD countries



Source: Buehler and Pucher (2021)

[1] The modal shares shown in Figure 2.1 reflect travel for all trip purposes except for those countries marked with an asterisk (*), which report only journeys to work, derived from censuses.

Figure 2.2: Cycling share of trips for cities across the world



Source: Buehler and Pucher (2021)

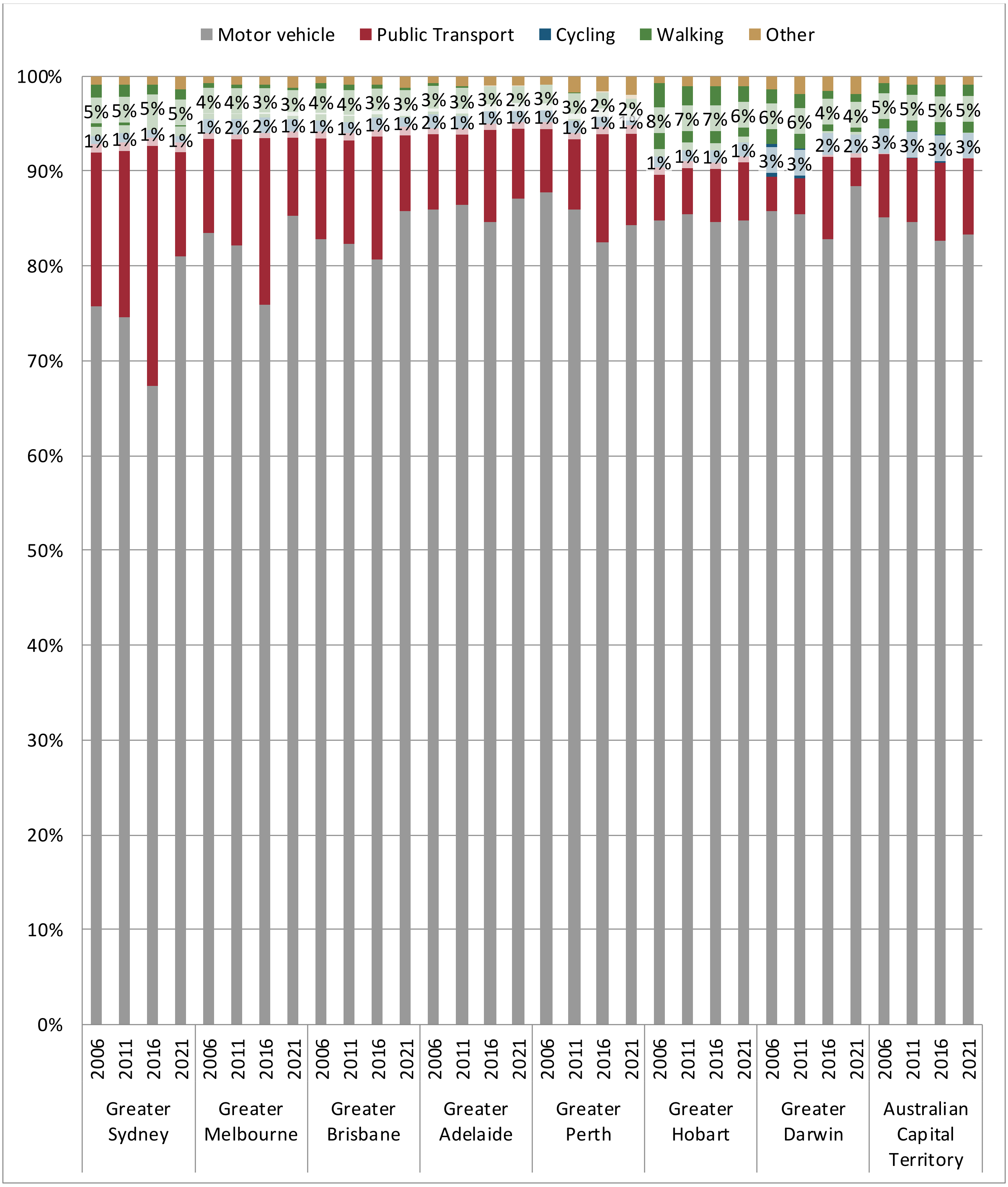
While no internationally comparable data source was found for walking mode share, Section 2.2 provides more information on walking mode share in Australasia.

2.2 How active transport varies across Australasian cities for commutes

The mode share of journeys to work in Australian capital cities, from 2006 to 2021 is shown in Figure 2.3. It should be noted that during the 2021 Census, Sydney and Melbourne were under movement restrictions due to the COVID-19 pandemic. This lowered all journeys to work significantly, and is likely to have distorted remaining movement patterns.

What Figure 2.3 demonstrates is the low levels of walking and cycling in Australian cities, and how this has not increased significantly over the last 15 years, and in many cases has not increased at all. In some cases, active transport mode share has decreased. For example, in 2006 Sydney's active transport mode share was 6.2%, decreasing to 5.5% in 2016 and 5.7% in 2021. Similarly, Melbourne's active transport mode share decreased from 5.3% in 2006 to 5.1% in 2016. The Australian Capital Territory is the only area to see an increase, albeit modest, in active transport, from 7.4% in 2006 to 8.2% in 2016.

Figure 2.3: Mode share of journeys to work of Australian capital cities, 2006 to 2021



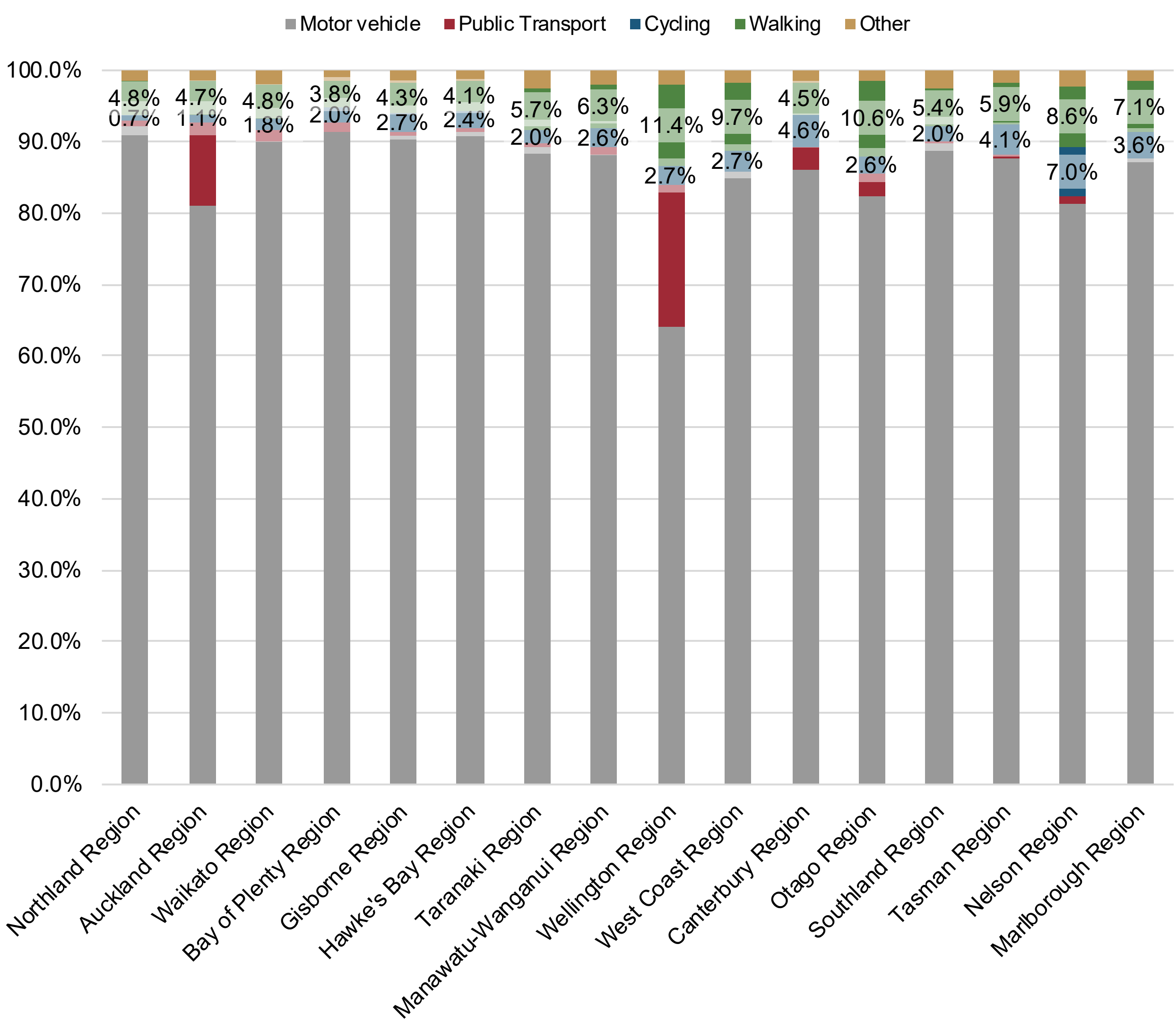
Source: Australian Bureau of Statistics (ABS, 2021)

The census data in Figure 2.3 shows decreased levels of active transport to work at a metropolitan scale. It is likely that the expanding footprint of capital cities has resulted in greater proportions of the population living in areas that lack the *destination density* that lowers trip distance and increases active travel levels. The metropolitan averages can hide increases in active travel levels *within* certain parts of cities. Some suburbs within Australasian cities can have a bike mode share of around 10% (typically in denser, inner-city areas), and fall as low as 0.1% (or less) in peri-urban outskirts.

Australian census data shows that over the past 15 years, active transport levels have not increased, and in some cases have decreased.

The mode share for journeys to work across New Zealand regional councils in 2018 is shown in Figure 2.4. Walking and cycling trips to work are highest in Nelson Region (Nelson, with 15.5%), followed by Wellington Region (Wellington, with 14.1%) and Otago Region (Dunedin, with 13.2%). The two most populous council regions of Auckland and Canterbury (Christchurch) have lower active transport mode shares, of 5.8% and 9.1% respectively. As is the case with large Australian cities, it is likely that Auckland and Canterbury have areas with higher public transport mode shares. Across New Zealand as a whole, census data shows that 8.1% of all trips to work were by walking or cycling in 2018.

Figure 2.4: Mode share of journeys to work for New Zealand regional councils, 2018

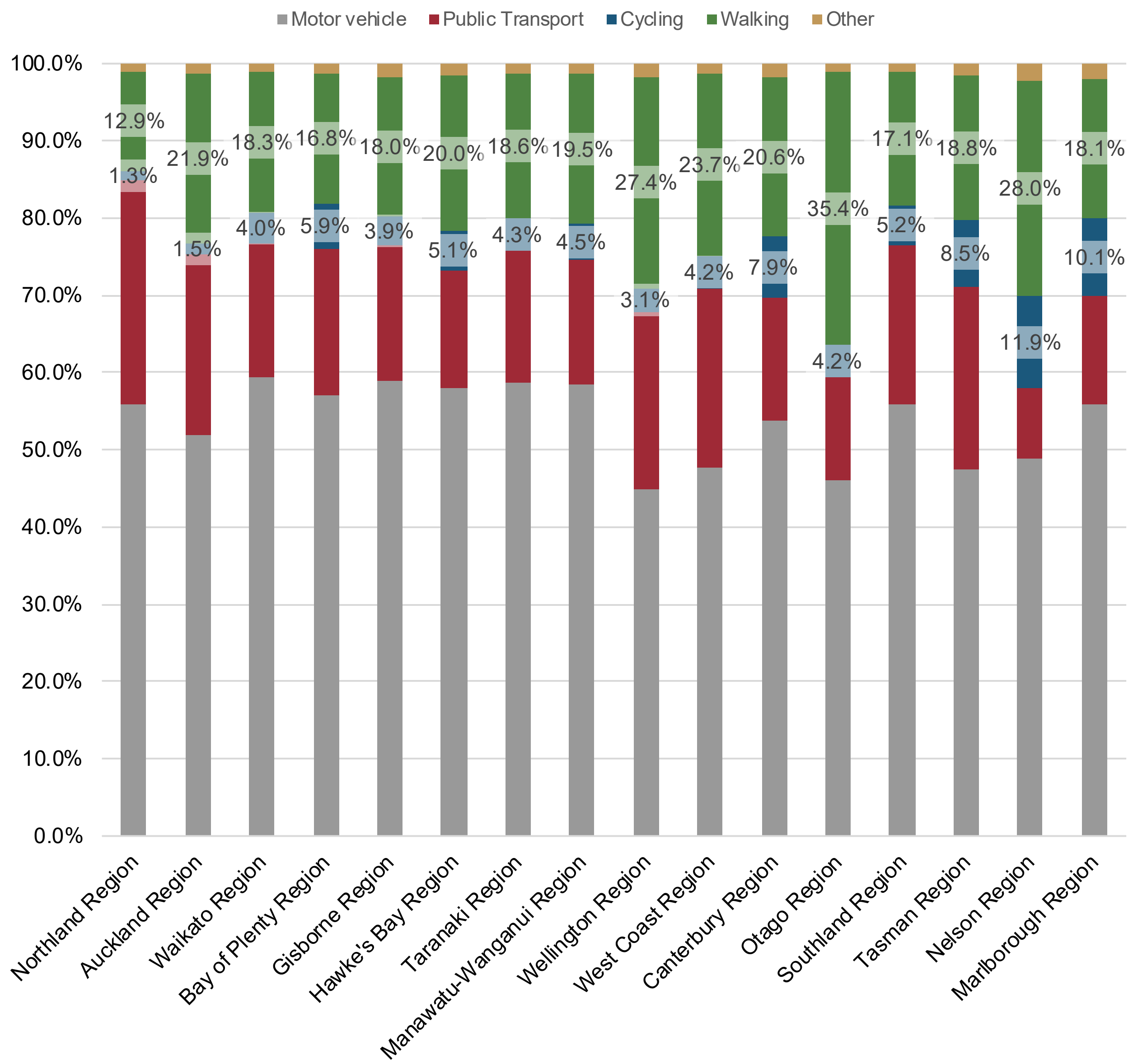


Source: Stats NZ Tatauranga Aotearoa (2018)

> Across New Zealand as a whole, census data shows that 8.1% of all trips to work were by walking or cycling in 2018.

The New Zealand Census also contains information about journeys to education (unlike Australian censuses). These results are shown in Figure 2.5. Journeys to education have a much higher active transport mode share across New Zealand than journeys to work, with 25.5% of journeys to education being walked or cycled. The top three council regions are again, Nelson (39.9%), Otago (39.5%) and Wellington (30.5%). Auckland and Canterbury were again lower, at 23.4% and 28.5% respectively.

Figure 2.5: Mode share of journey to education for New Zealand regional councils, 2018

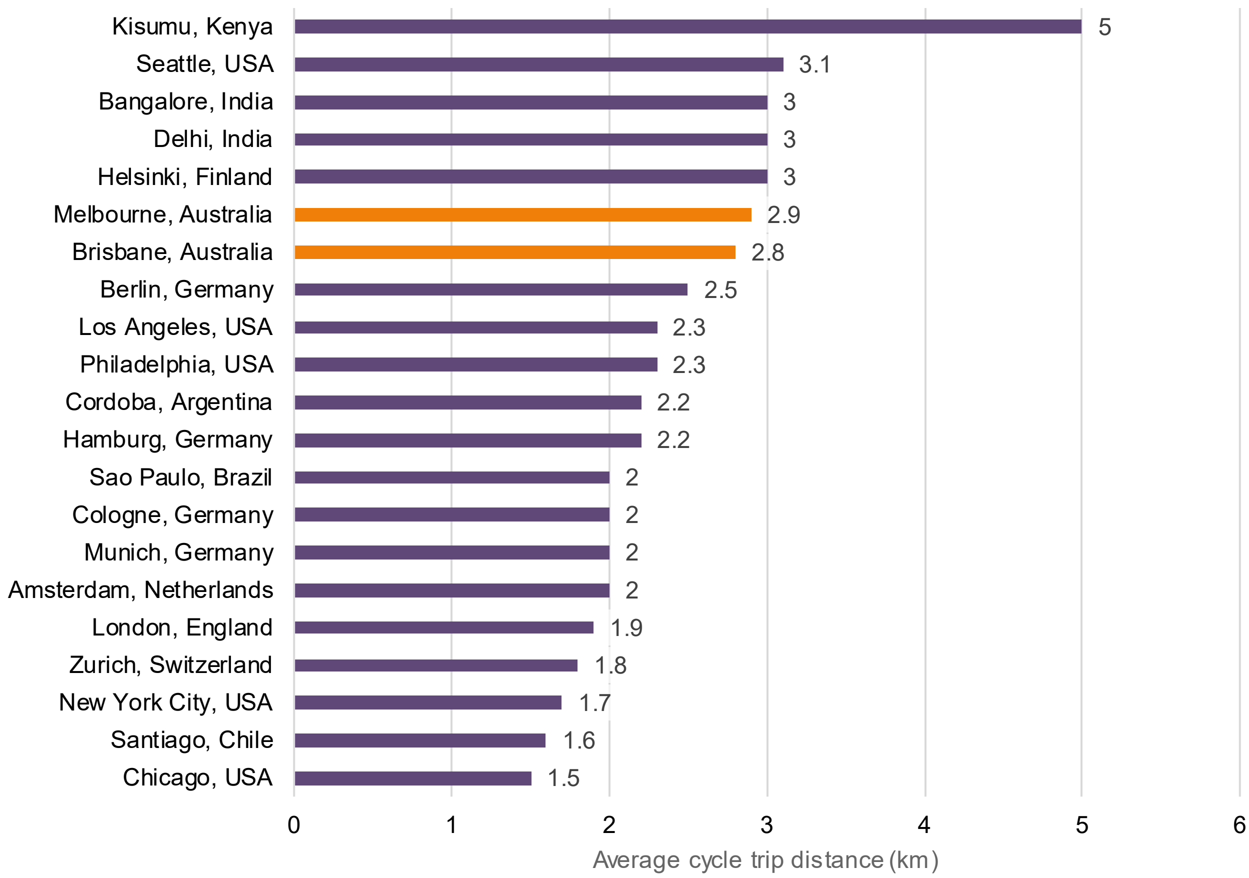


Source: Stats NZ Tatauranga Aotearoa (2018)

2.2.1 Understanding the relationship between trip distance and active transport to work

It is useful to examine mode share for trips under 5 km, as this is generally considered a comfortable distance for active transport. In Australia and across the world, average cycle trip distances are often between 2 km and 3 km, as shown in Figure 2.6.

Figure 2.6: Average bicycle trip distances for cities across the world

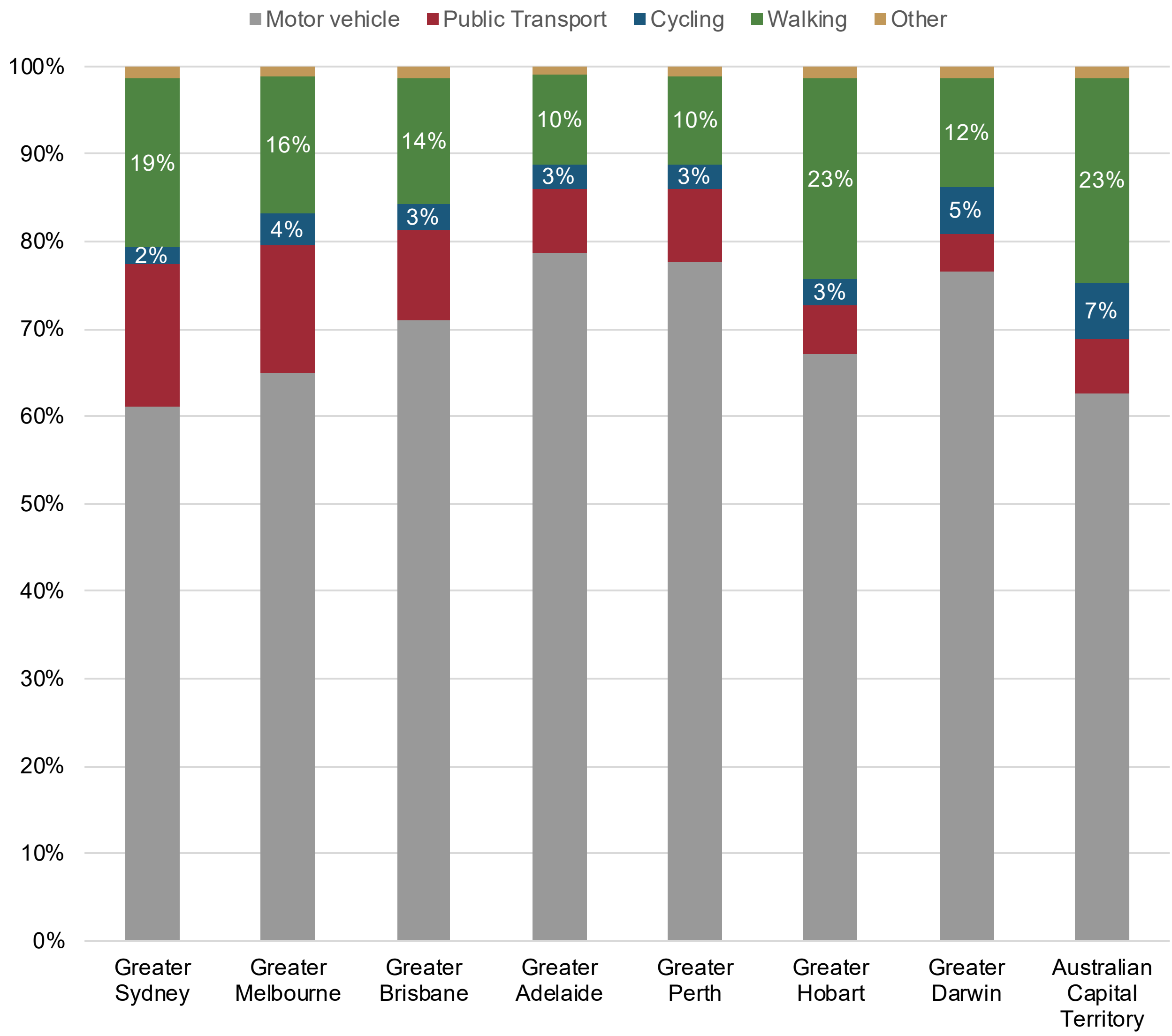


Source: Goel et al. (2022)

Australian capital city mode shares, for trips under 5 km are shown in Figure 2.7. This reveals that walking is considerably more common for trips within this distance band than cycling. Almost a quarter of people in Canberra and Hobart walk to work for trips under 5 km. Around 1 in 20 people (5%) ride for trips to work under 5 km. It is also notable that roughly one in five journeys to work in Australian capital cities are under 5 km (for trips that have a distance above nil, e.g., excluding working from home and days off). However, there can be variation in this, with inner LGAs such as Sydney, Melbourne, Adelaide, and Perth all having over 50% of journeys to work being under 5 km, while this drops to around 15% for outer LGAs such as Liverpool (NSW), Wyndham (Vic), or Salisbury (SA). In regional LGAs, such as Newcastle (NSW), Bendigo (Vic), or Geelong (Vic), typically around one third of journeys to work are under 5 km. This is important to note, as it shows how the best opportunity for mode shift is likely to be shorter trips, at 5 km or less, and the greater proportion of trips that can be under 5 km, the higher the potential shift to active travel.

> Almost a quarter of people in Canberra and Hobart walk to work for trips under 5 km.

Figure 2.7: Mode share of trips to work under 5 km by mode, 2016



Source: Australian Bureau of Statistics (2021)

2.3 Active travel participation in Australia – all purpose

The National Walking and Cycling Participation Survey 2021 (NWCPS) provides an important set of data that offers insight into walking and cycling activity in Australia for trips beyond the journey to work. The Survey is administered using telephone interviews with a sample that is representative of the Australian population. Some 4,618 households and 11,906 people were included in the survey, which asked questions regarding walking and cycling activity.

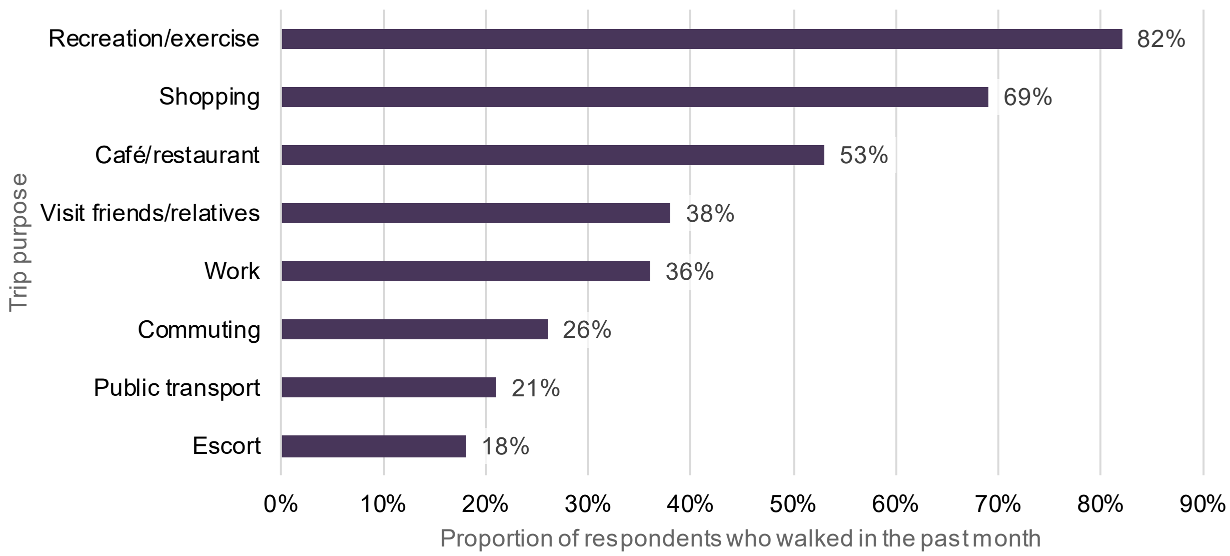
2.3.1 Walking

The NWCPS found 96.7% of Australians walk for at least five minutes in a typical week outside their home. On average, Australians walked for at least five minutes on 5.3 days per week, spending a median of 3.5 hours walking per week. South Australia, Queensland and Western Australia have a walking frequency rate lower than the national average at 5.1 to 5.2 days per week, while the Northern Territory has the greatest frequency of days walked at 5.6 days.

Trip purpose

Figure 2.8 shows the top trip purposes indicated for those who walked in Australia. Of those who walked in the past month, 82% walked for recreation or exercise and 69% walked to shopping.

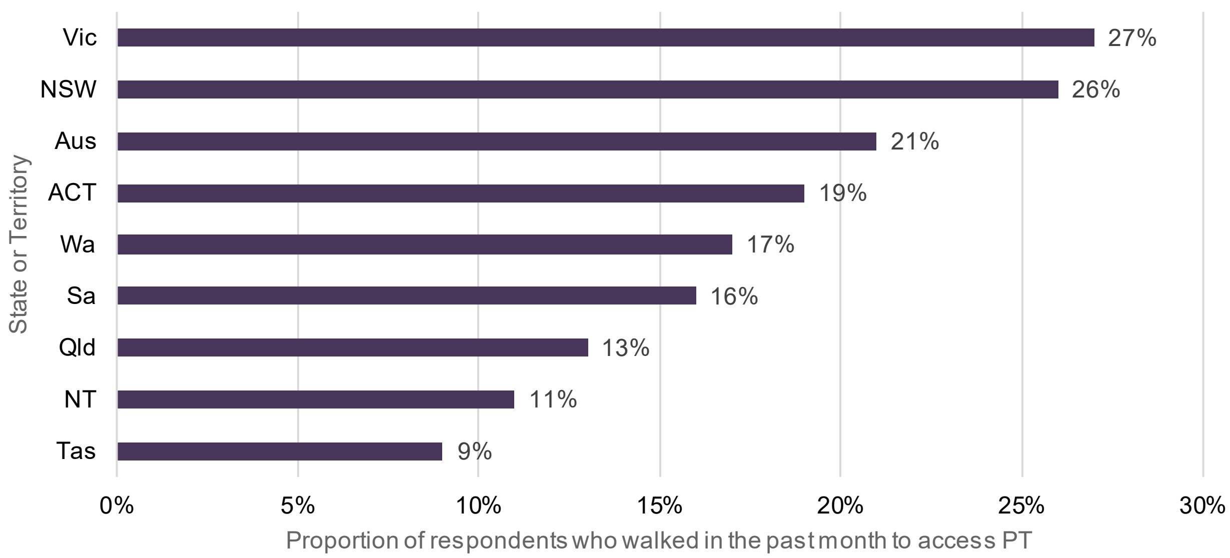
Figure 2.8: Top trip purposes for walking in Australia, 2021



Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

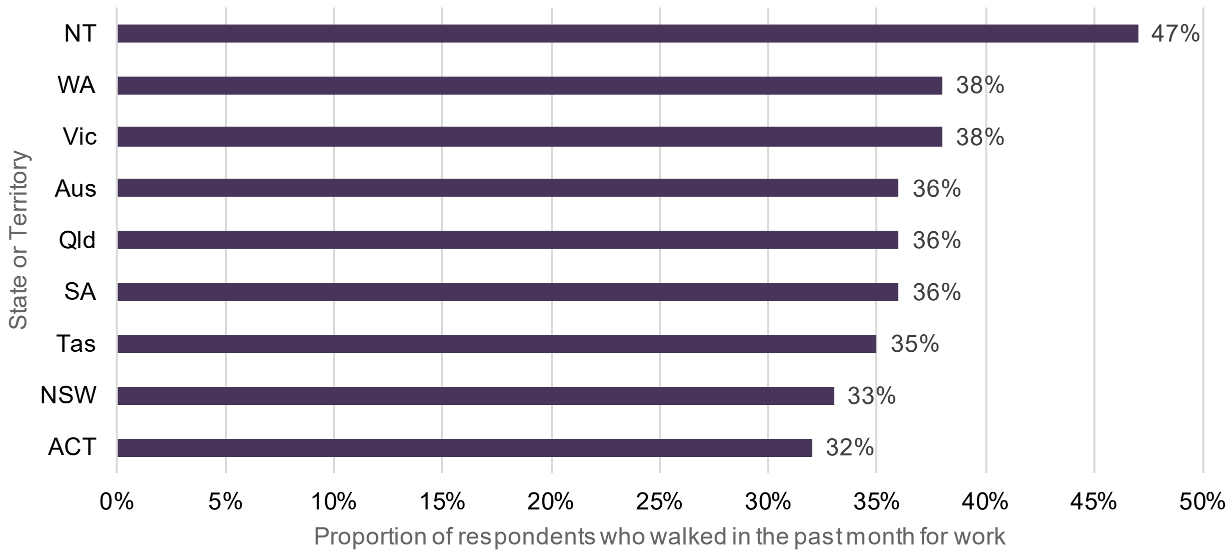
While there is little variation between states and territories for most walking trip purposes, Figure 2.9 shows the proportion of those who walked to public transport in the past month in New South Wales and Victoria was more than double of Tasmania, the Northern Territory and Queensland. This is likely a consequence of higher public transport patronage in Sydney and Melbourne, compared to other cities, as shown in Figure 2-7. Conversely, Figure 2.10 shows a significantly greater proportion of walking trips in the Northern Territory were completed for work, at 47%, compared to the national average of 36%.

Figure 2.9: Walking participation in the past month to access public transport, 2021



Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Figure 2.10: Walking participation to or from work in the past month, 2021



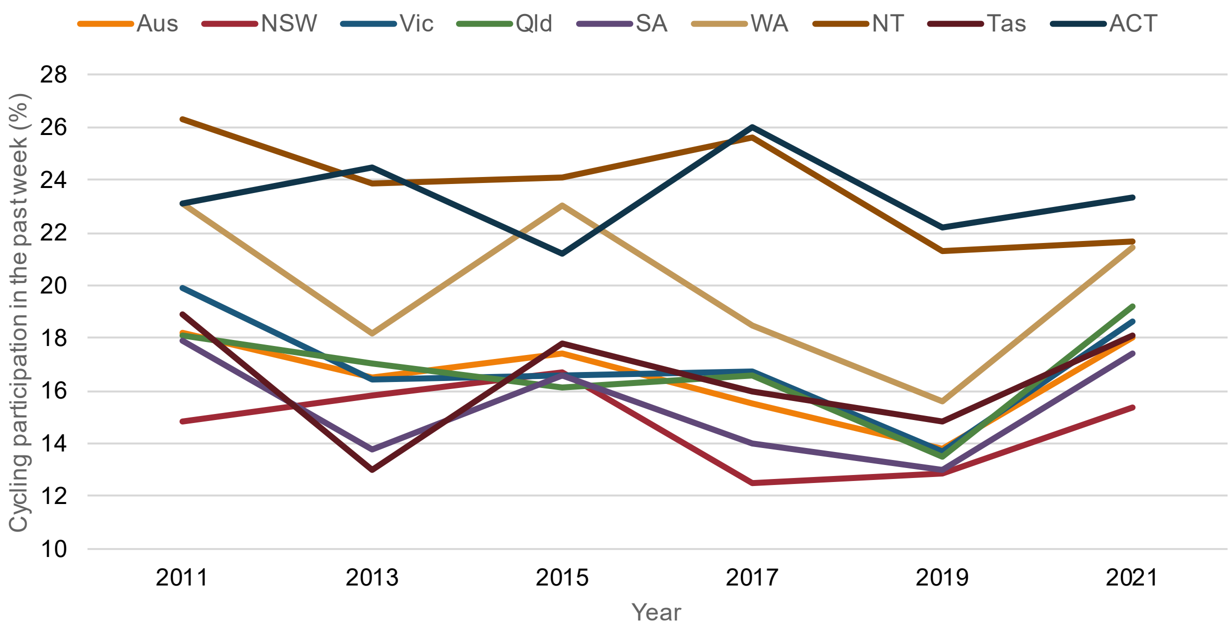
Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

2.3.2 Cycling

The cycling participation rate in 2021 was significantly lower than for walking, with only 18.2% of survey respondents indicating they rode a bicycle in the previous week, and 43% in the previous year. Participation in cycling is likely to be largely only a few trips a week, at most, meaning that the proportion of all trips taken by an individual by cycling may remain very low.

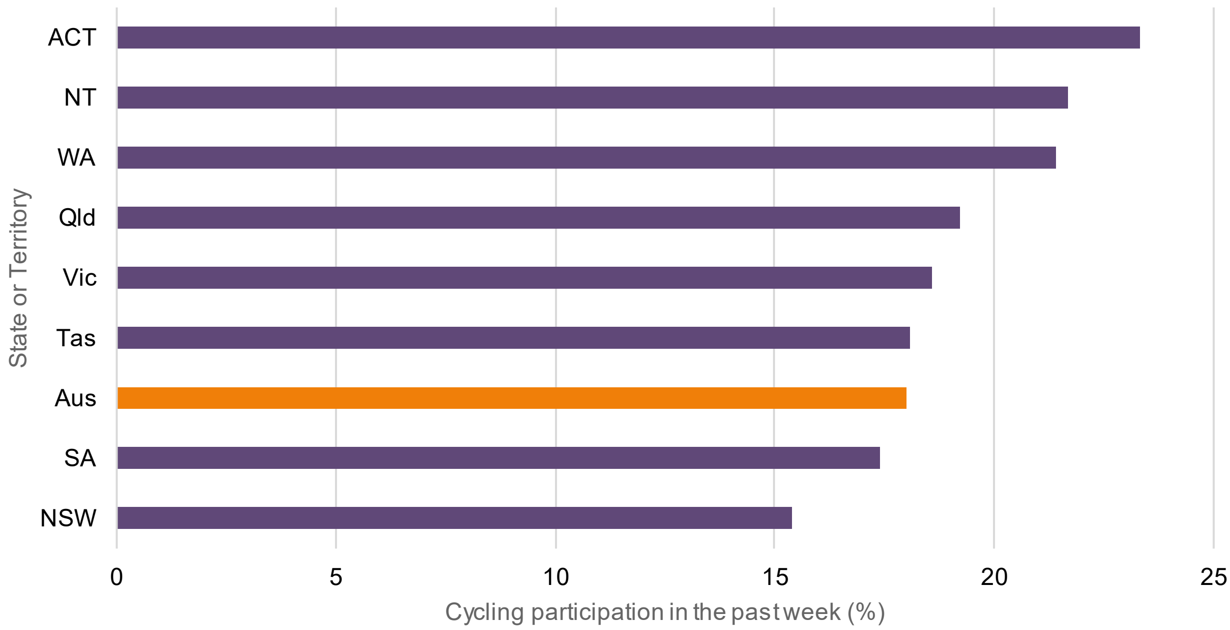
Figure 2.11 and Figure 2.12 shows New South Wales and South Australia have a cycling rate that is consistently lower than the national average. Conversely, the Northern Territory, Western Australia and the Australian Capital Territory have cycling participation rates significantly higher than the national average.

Figure 2.11: Cycling participation in Australia in the past week, 2011-2021



Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Figure 2.12: Cycling participation in Australia by week, 2021

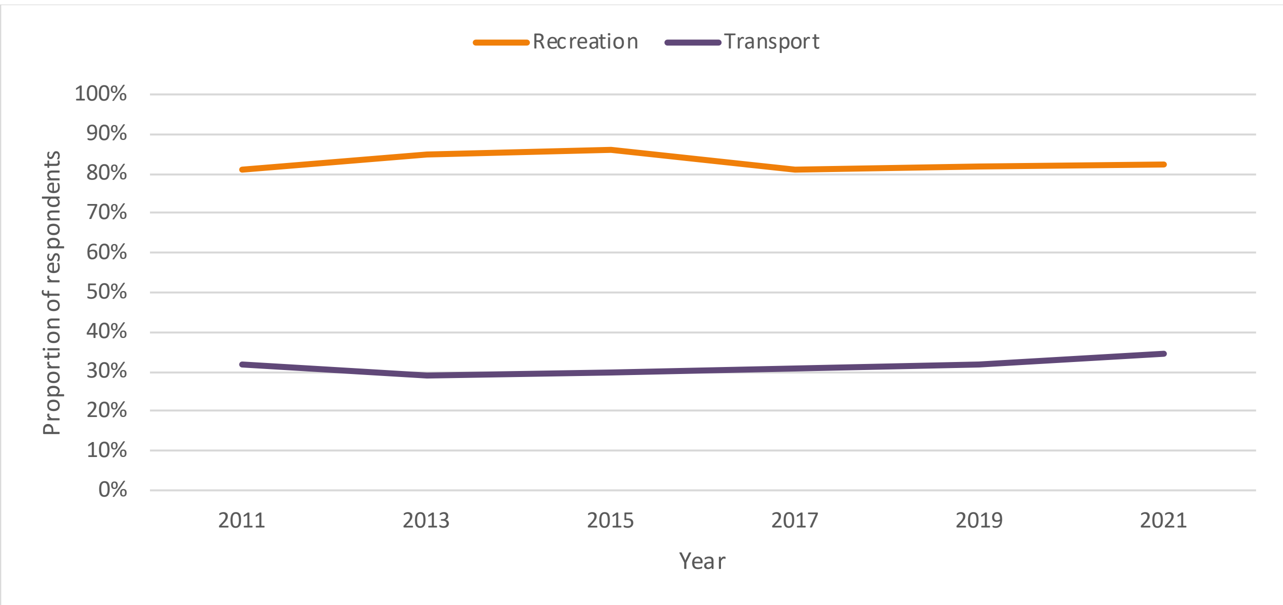


Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Trip purpose

The main purpose of cycling trips in Australia is shown in Figure 2.13. Cycling trips were classified as transport (e.g., riding to work, shops or to visit friends) or recreation (e.g., exercise). These trip purposes are not mutually exclusive; some survey respondents travelled for only transport or recreational purposes while others reported cycling for both. As such, the proportions add to more than 100%. This data shows that the majority of cycling trips in Australia are recreational, with less than a third being for transport. The data also suggests there has been no significant change between 2011 to 2021, with the majority cycling as recreation (80% - 86%), and approximately one third cycling as transport (29% - 34.5%).

Figure 2.13: Primary purpose of cycling trips in Australia



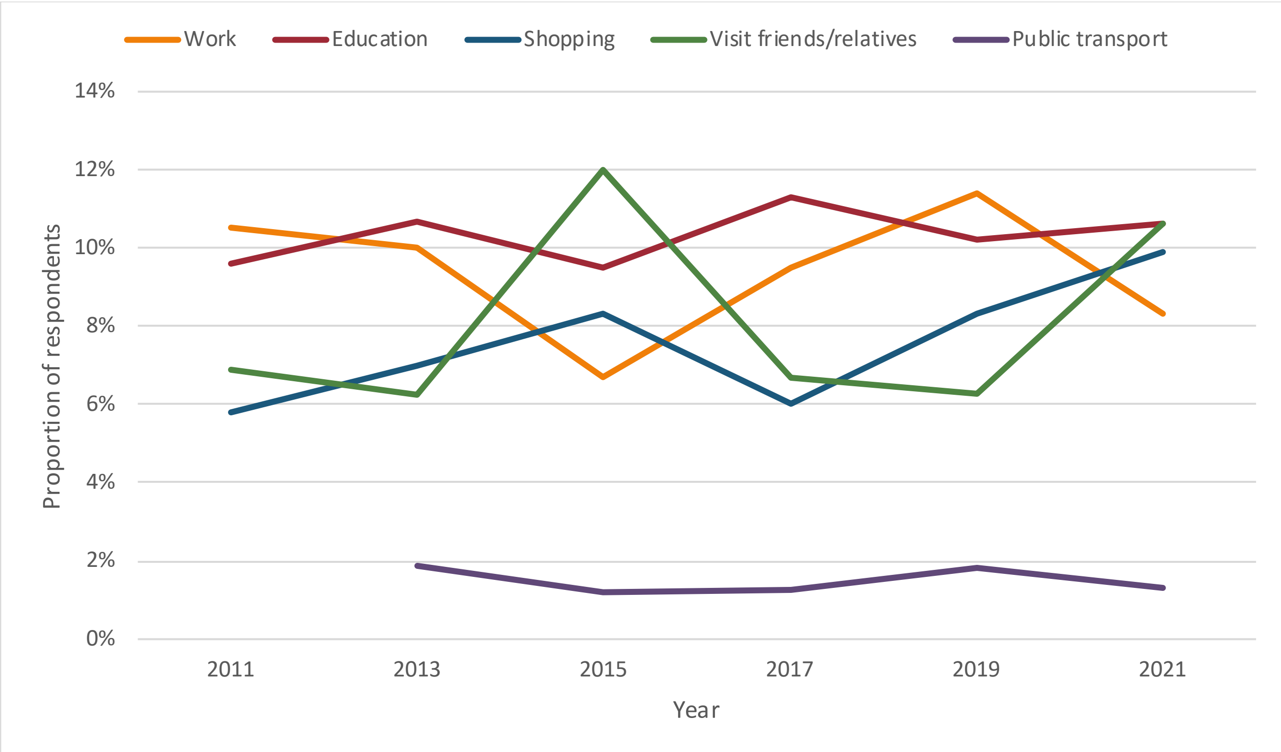
Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Most cycling trips in Australia are recreational, with less than a third being for transport.

For those who indicated cycling for transport, the most cited purposes were riding to school, commuting to work, shopping and visiting friends or relatives. Cycling is least used to access public transport.

The purposes of cycling trips used for transport in Australia are shown Figure 2.14. The proportion riding to school has been largely stable over time, ranging from 9% to 13% between 2011 to 2021. The proportion who rode to work increased steadily from 6.5% in 2015 to 11.4% in 2019. However, riding to work decreased from 2013 to 2015, and has decreased again from 11.4% in 2019 to 8.3% in 2021. This latter decrease is likely attributed to the COVID-19 pandemic and movement restrictions that resulted in a shift towards working from home. Cycling to public transport is significantly lower than other transport purposes, remaining steadily below 2%.

Figure 2.14: Cycling for transport purposes in Australia

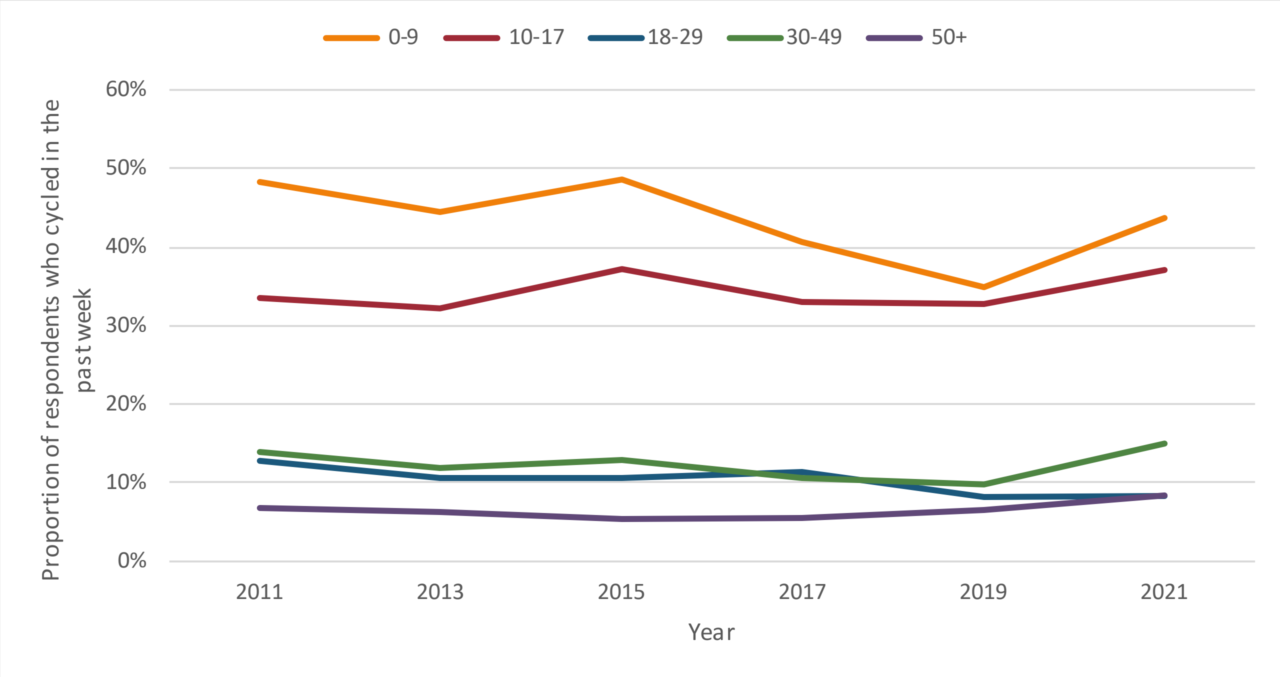


Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Age and gender

The trend in Australian cycling participation by age group is shown in Figure 2.15. Cycling participation is consistently much higher among children 0 to 9 years old and teenagers 10 to 17 years old. While cycling participation rates for the 30 to 49 age group are significantly lower than children and teenagers, cycling participation rate in this age group has increased markedly from 10% in 2019 to 15% in 2021. For young adults in the 18 to 29 age group, the participation rate has gradually declined from 13% in 2011 to 8% in 2021, while the participation rate for adults over 50 years old has steadily increased from 5% in 2015 to 8% in 2021.

Figure 2.15: Cycling participation in Australia by age group by week

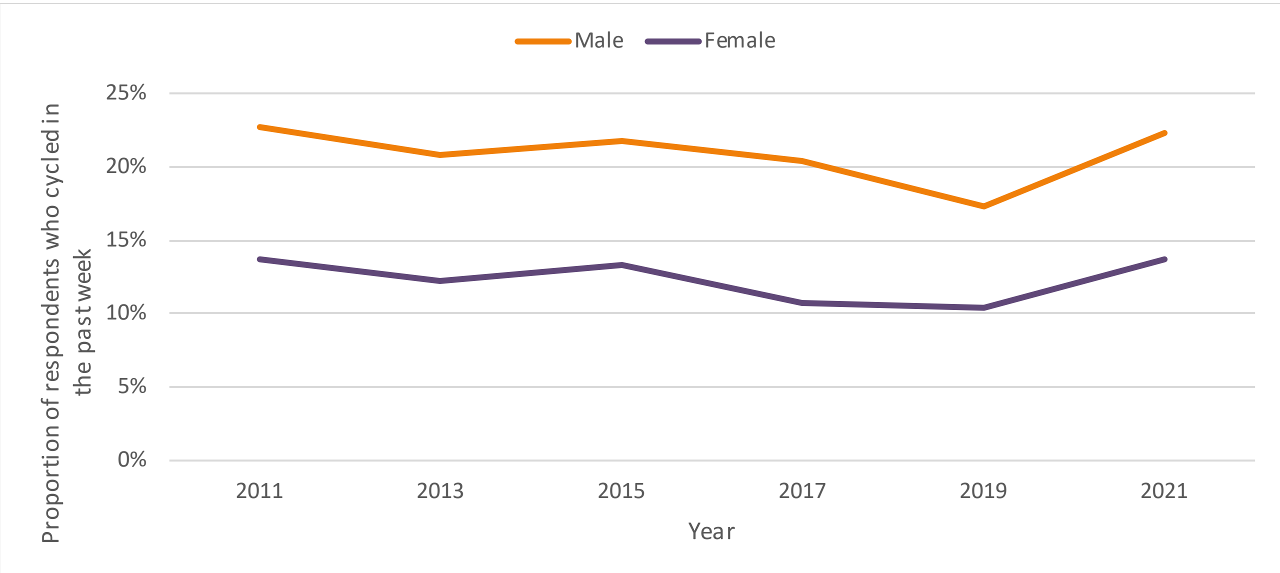


Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

The Australian national trend in cycling participation rate by gender is shown in Figure 2.16. Cycling participation for men is consistently higher than for women. In 2021, almost 1 in 4 men indicated they rode a bike in the previous week, whilst just over 1 in 8 women reported riding a bike in the previous week. Following the COVID-19 pandemic in 2019, cycling participation rates for both genders have increased from 17.3% to 22.9% for men, and from 10.4% to 13.6% for females.

In 2021, almost 1 in 4 men indicated they rode a bike in the previous week, whilst just over 1 in 8 women reported riding a bike in the previous week.

Figure 2.16: Cycling participation in Australia by gender by week

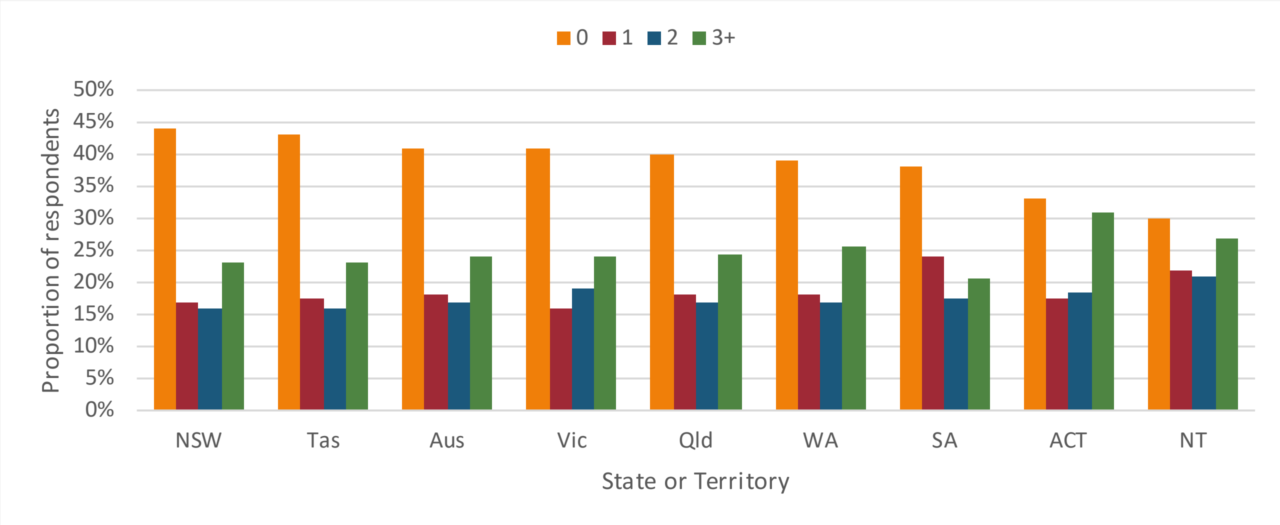


Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Bicycle ownership

The proportion of Australian households that do not own a bicycle has remained fairly stable at around 42% to 45% between 2011 and 2021. The number of bicycles owned by Australian households in 2021 is shown in Figure 2.17 (55-58%) it could be a representative of people's interest in riding a bike. New South Wales and Tasmania have the lowest bicycle ownership rates. Conversely, the Australian Capital Territory and the Northern Territory have the highest levels of bicycle ownership. Interestingly, in all states and territories except for South Australia, a greater proportion of households own three or more bicycles than households that own one or two bicycles.

Figure 2.17: Bicycle ownership by Australian states and territories, 2021

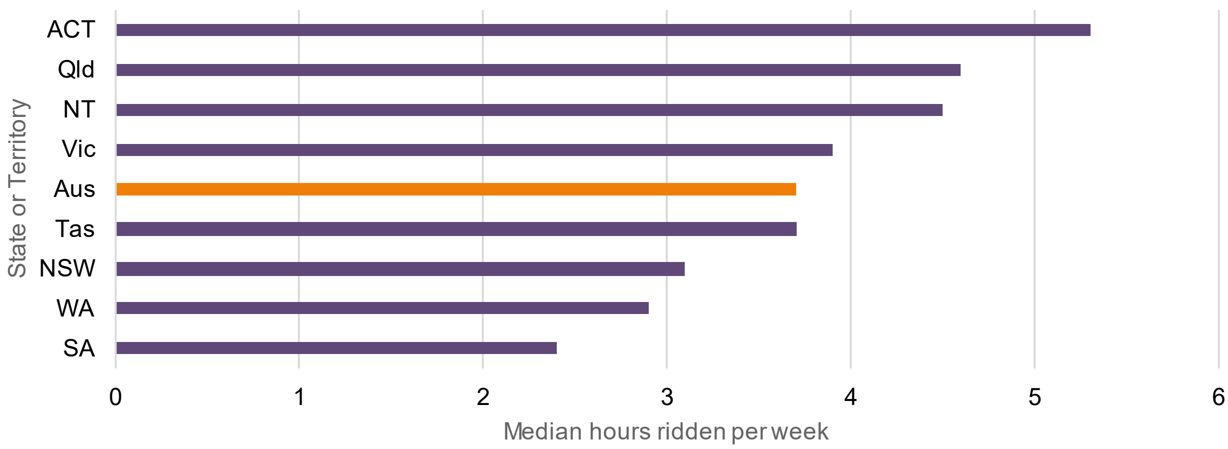


Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Time cycled

The number of hours ridden per week by Australian states and territories in 2021 is shown in Figure 2.18. Compared to the national median, people who rode in the Australian Capital Territory, Queensland, the Northern Territory and Victoria spent more time cycling per week, whilst New South Wales, Western Australia and South Australia spent less time riding per week.

Figure 2.18: Hours ridden per week by state and territory, 2021



Source: Cycling and Walking Australia and New Zealand (CWANZ) (2021)

Between 2019 and 2021, all regions except for South Australia saw an increase in the number of hours ridden per week. The Australian Capital Territory and the Northern Territory reported the greatest increase from 3.1 to 5.3 hours per week and 2.6 to 4.5 hours per week, respectively. The median hours ridden per week in South Australia decreased from 3.6 to 2.4 hours.

2.4 Variations in active transport within the same city

This section uses Australian census data to understand variation in active travel participation at the suburb level, across each of the major capital cities. The general pattern is for the central and inner-city areas having higher levels of active transport.

2.4.1 Walking to work

The following set of tables identifies both the walking mode share and the total number of people who walked to work in the 2016 census.

Table 2.1: Top ten walking mode share (journey to work) suburbs, Sydney

Suburb	Walk share (%)	Total walked
Sydney - Haymarket - The Rocks	46.8%	6,309
Pyrmont - Ultimo	42.3%	4,236
Darlinghurst	39.4%	2,518
Surry Hills	35.7%	3,257
Potts Point - Woolloomooloo	30.8%	3,366
Redfern - Chippendale	23.8%	2,461
Paddington - Moore Park	20.4%	1,573
Glebe - Forest Lodge	19.1%	1,769
North Sydney - Lavender Bay	18.9%	1,058
Newtown - Camperdown - Darlington	16.1%	2,014

Table 2.2: Top ten walking mode share (journey to work) suburbs, Melbourne

Suburb	Walk share (%)	Total walked
Melbourne	41.3%	5,726
Southbank	36.6%	3,510
Carlton	32.6%	1,798
East Melbourne	32.5%	817
North Melbourne	28.3%	2,397
Fitzroy	27.8%	1,295
Docklands	27.6%	1,429
Collingwood	22.4%	906
Parkville	20.4%	560
South Melbourne	20.0%	1,066

Table 2.3: Top ten walking mode share (journey to work) suburbs, Brisbane

Suburb	Walk share (%)	Total walked
Spring Hill	47.2%	1,426
Brisbane City	47.1%	2,178
Fortitude Valley	35.4%	1,437
South Brisbane	31.3%	1,022
Newstead - Bowen Hills	17.9%	1,074
Highgate Hill	17.2%	494
St Lucia	16.0%	574
New Farm	15.6%	959
Kelvin Grove - Herston	13.1%	499
West End	13.1%	596

Table 2.4: Top ten walking mode share (journey to work) suburbs, Perth

Suburb	Walk share (%)	Total walked
Perth City	21.8%	3,318
Carabooda - Pinjar	12.4%	32
Subiaco - Shenton Park	11.0%	756
Nedlands - Dalkeith - Crawley	8.6%	554
Fremantle	7.6%	456
Claremont (WA)	5.9%	175
Wembley - West Leederville - Glendalough	5.6%	441
Midland - Guildford	5.3%	207
North Perth	5.3%	215
Mount Hawthorn - Leederville	4.8%	243

Table 2.5: Top ten walking mode share (journey to work) suburbs, Adelaide

Suburb	Walk share (%)	Total walked
Adelaide	39.6%	2,004
North Adelaide	18.0%	484
Norwood (SA)	10.8%	455
Virginia - Waterloo Corner	6.7%	86
Unley - Parkside	5.9%	478
Lobethal - Woodside	5.0%	176
St Peters - Marden	4.8%	266
Toorak Gardens	4.8%	280
Goodwood - Millswood	4.4%	329
Richmond (SA)	4.2%	295

Table 2.6: Top ten walking mode share (journey to work) suburbs, ACT

Suburb	Walk share (%)	Total walked
Duntroon	69.4%	907
Acton	43.4%	181
Civic	41.0%	674
Barton	31.4%	270
Reid	30.4%	205
Braddon	29.2%	893
Turner	29.1%	596
Phillip	23.3%	372
Greenway	21.5%	197
Belconnen	18.0%	577

Table 2.7: Top ten walking mode share (journey to work) suburbs, Hobart

Suburb	Walk share (%)	Total walked
Hobart	43.8%	1,415
West Hobart	32.9%	843
Sandy Bay	16.0%	688
South Hobart - Fern Tree	15.6%	358
New Town	11.6%	264
Mount Nelson - Dynnyrne	8.7%	148
Lenah Valley - Mount Stuart	7.3%	264
Moonah	6.6%	129
Bellerive - Rosny	4.0%	91
Glenorchy	3.9%	135

Table 2.8: Top ten walking mode share (journey to work) suburbs, Darwin

Suburb	Walk share (%)	Total walked
Darwin City	23.7%	864
Berrimah	15.3%	68
Larrakeyah	11.8%	234
Howard Springs	9.1%	253
Brinkin - Nakara	8.2%	132
Tiwi	7.5%	76
Wagaman	4.5%	42
Weddell	4.3%	73
Fannie Bay - The Gardens	4.2%	68
Alawa	3.7%	34

2.4.2 Cycling to work

The following set of tables identify the top-performing suburbs in terms of trips to work by bike, expressed as both mode share and total number of people who reported they cycled as their mode of transport to work at the 2016 Census.

Table 2.9: Top ten cycling mode share (journey to work) suburbs, Sydney

Suburb	Bike share (%)	Total Cycled
Erskineville - Alexandria	3.9%	528
Newtown - Camperdown - Darlington	3.6%	679
Redfern - Chippendale	3.4%	522
Glebe - Forest Lodge	3.3%	428
Leichhardt - Annandale	2.9%	468
Waterloo - Beaconsfield	2.9%	569
Randwick - North	2.8%	320
Petersham - Stanmore	2.8%	408
Lilyfield - Rozelle	2.6%	221
Bondi - Tamarama - Bronte	2.6%	329

Table 2.10: Top ten cycling mode share (journey to work) suburbs, Melbourne

Suburb	Bike share (%)	Total cycled
Carlton North - Princes Hill	9.4%	683
Fitzroy North	9.1%	984
Brunswick	8.3%	1842
Yarra - North	7.6%	520
Brunswick East	7.2%	716
Northcote	6.7%	1296
Parkville	6.1%	287
Brunswick West	6.0%	622
Collingwood	5.9%	389
Fitzroy	5.8%	457

Table 2.11: Top ten cycling mode share (journey to work) suburbs, Brisbane

Suburb	Bike share (%)	Total cycled
West End	5.5%	386
Fairfield - Dutton Park	5.5%	176
Highgate Hill	5.5%	234
St Lucia	4.5%	209
Toowong	4.3%	293
East Brisbane	4.1%	169
Taringa	4.0%	205
Enoggera	4.0%	187
Auchenflower	3.9%	154
Annerley	3.8%	297

Table 2.12: Top ten cycling mode share (journey to work) suburbs, Perth

Suburb	Bike share (%)	Total cycled
Subiaco - Shenton Park	4.0%	389
Mount Hawthorn - Leederville	3.9%	253
North Perth	3.5%	189
Nedlands - Dalkeith - Crawley	3.5%	301
Floreat	3.4%	127
Swanbourne - Mount Claremont	2.9%	117
Wembley - West Leederville - Glendalough	2.9%	306
South Perth - Kensington	2.9%	265
Mount Lawley - Inglewood	2.7%	275
Fremantle	2.7%	248

Table 2.13: Top ten cycling mode share (journey to work) suburbs, Adelaide

Suburb	Bike share (%)	Total cycled
Unley - Parkside	3.8%	470
St Peters - Marden	3.6%	275
Goodwood - Millswood	3.4%	375
Norwood (SA)	3.3%	216
Toorak Gardens	3.1%	285
Adelaide	3.0%	249
Richmond (SA)	2.9%	293
Colonel Light Gardens	2.6%	203
North Adelaide	2.4%	105
Walkerville	2.4%	93

Table 2.14: Top ten cycling mode share (journey to work) suburbs, ACT

Suburb	Bike share (%)	Total cycled
O'Connor (ACT)	10.4%	418
Ainslie	9.4%	325
Acton	8.2%	72
Hackett	7.9%	160
Downer	7.6%	187
Dickson	7.3%	137
Lyneham	7.2%	275
Turner	6.2%	206
Braddon	5.6%	275
Cook	5.5%	92

Table 2.15: Top ten cycling mode share (journey to work) suburbs, Hobart

Suburb	Bike share (%)	Total cycled
South Hobart - Fern Tree	5.3%	187
Taroona - Bonnet Hill	3.8%	63
West Hobart	2.8%	99
New Town	2.6%	70
Lenah Valley - Mount Stuart	2.1%	97
Sandy Bay	2.0%	106
Mount Nelson - Dynnyrne	1.8%	41
Derwent Park - Lutana	1.6%	27
Moonah	1.5%	40
Hobart	1.5%	78

Table 2.16: Top ten cycling mode share (journey to work) suburbs, Greater Darwin

Suburb	Bike share (%)	Total cycled
Larrakeyah	3.6%	111
Rapid Creek	3.5%	103
Tiwi	3.1%	54
Jingili	3.0%	43
Fannie Bay - The Gardens	2.8%	79
Nightcliff	2.5%	104
Darwin City	2.2%	143
Millner	2.1%	42
Moil	2.0%	23
Parap	2.0%	46

2.5 How do travel distances vary by mode of transport and trip purpose?

The Victorian Integrated Survey of Travel and Activity (VISTA), provides the most comprehensive picture in Australia of all-purpose trips. This is an important advance on the census, which only covers the journey to work. Given that journeys to work only constitute around 20% of all travel, the census provides a limited picture of travel characteristics in Australia. When looking at the VISTA dataset, it is possible to examine travel distance, as a function of mode of travel, and purpose of travel. This highlights the journey length differences between travel modes. It shows walking distances are very similar across trip purposes. On the other hand, cycling distance does vary considerably across purposes, with work trips typically much longer (6.7 km) than non-work trips (~2 – 4 km). These findings can have implications for interventions designed to increase active transport mode share. The design of an intervention should be aware of the typical travel distance of walking and cycling.

Table 2.17: Average distance (km) by Mode and Trip Purpose

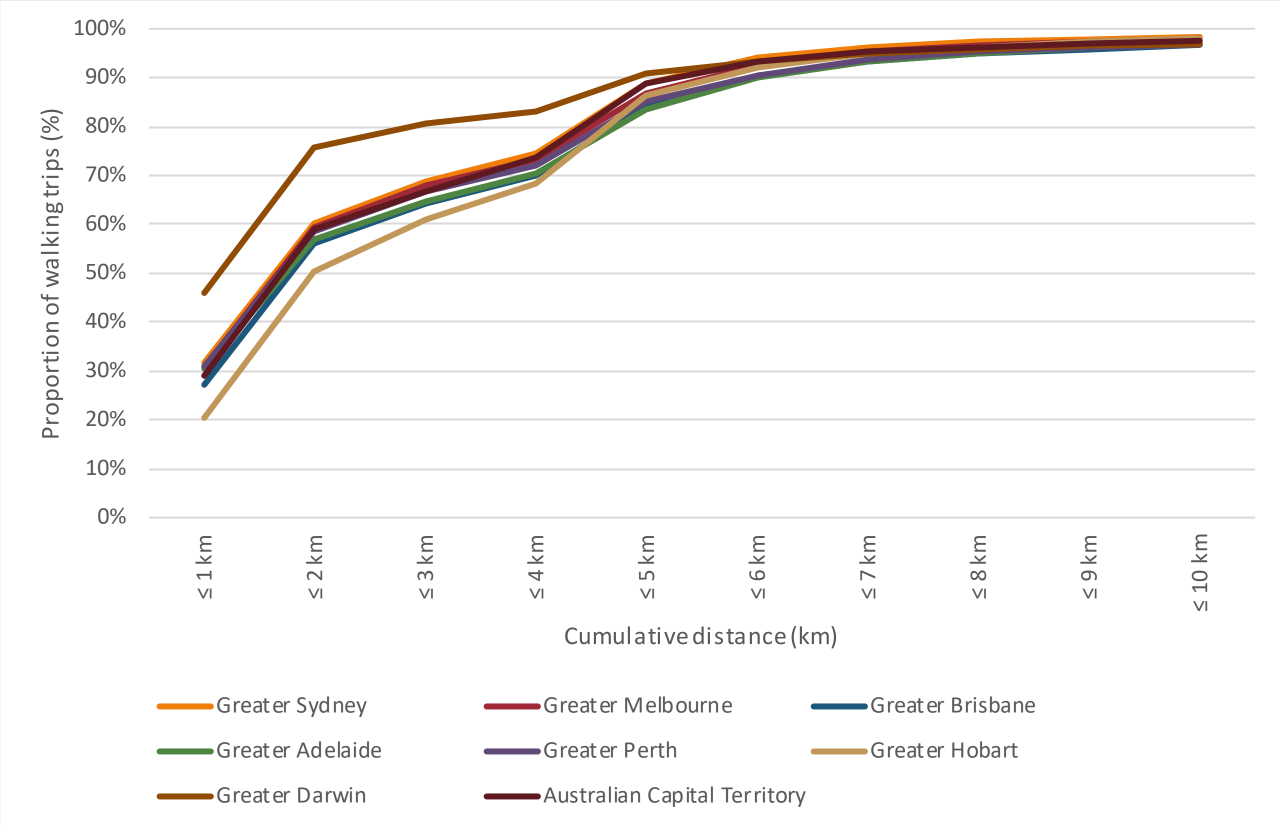
Mode	Accompany someone	Buy something	Education	Personal business	Pick-up or deliver something	Pick-up or drop-off someone	Recreation	Social	Work related	All trips
Bicycle	2.2	2.8	2.5	4.2	3.3	1.8	5.1	5.3	6.7	4.8
Bus	7.1	6.6	10.9	18.3	11.8	9.9	11.6	15.7	11.7	10.7
Other	3.6	3.7	7.7	9.7	7.1	7.2	9.2	13.9	16.7	12.5
Train	18.6	19.3	20.5	26.5	20.7	24.0	27.3	21.7	22.4	22.3
Tram	4.0	5.3	8.0	7.8	5.6	7.1	6.3	5.4	7.2	6.7
Vehicle Driver	9.0	5.9	12.3	12.3	8.8	6.9	9.4	12.8	16.1	11.0
Vehicle Passenger	6.7	7.4	4.8	16.4	11.5	7.9	11.4	13.8	14.3	10.1
Walking	0.9	0.8	1.1	1.2	0.9	0.8	1.3	0.9	1.0	1.1

Source: Victorian Department of Transport and Planning (2022)

The design of an intervention should be cognisant of the typical travel distance of walking and cycling.

Figure 2.19 shows the cumulative distance to work for walking, in each Australian capital city. On average, 59% of walking trips are 2 km or less, with 87% of trips less than 5 km. These findings are important because it reinforces the impact that travel distance has on active transport take-up.

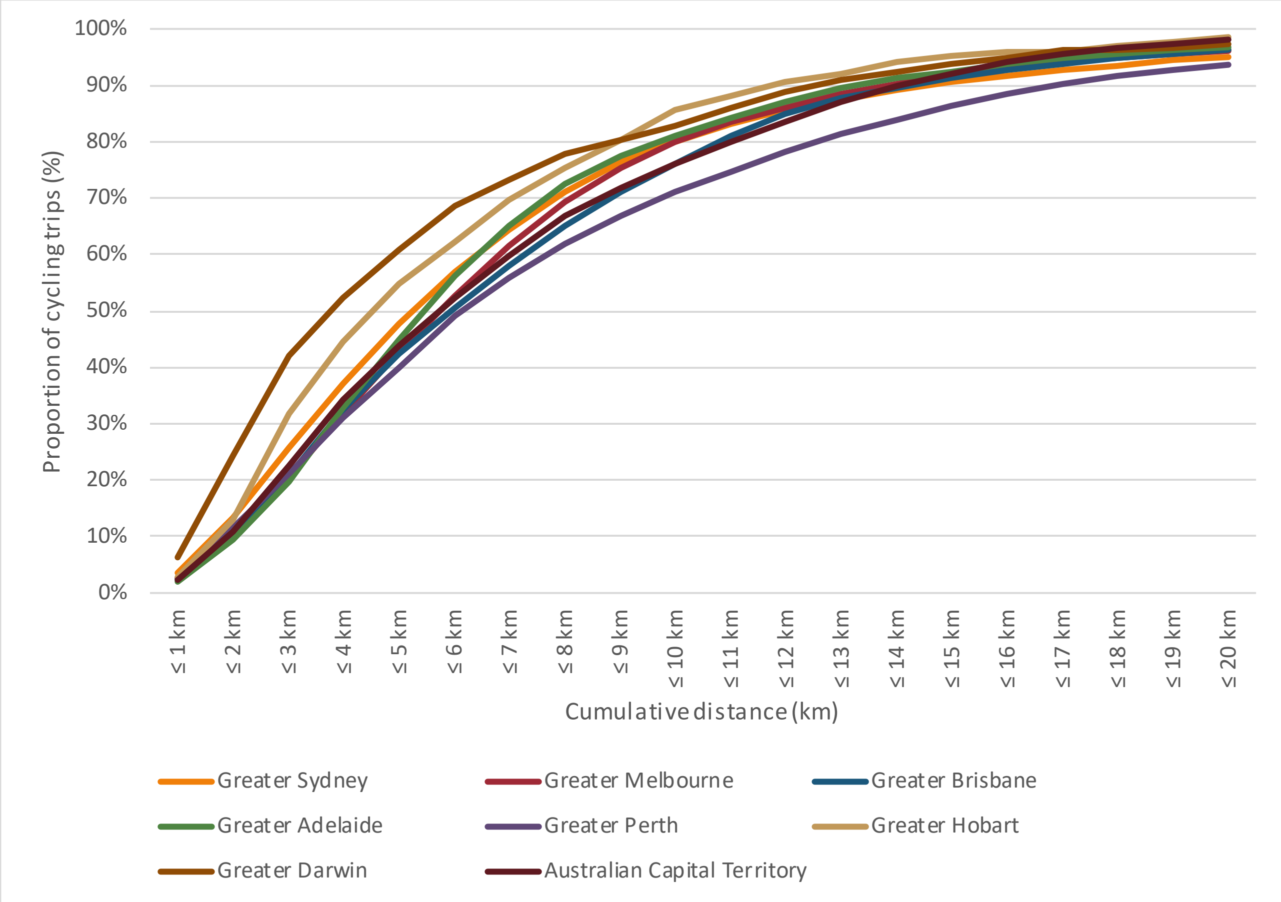
Figure 2.19: Cumulative distance to work - walking, 2016 Census



Source: ABS

Figure 2.20 shows the cumulative distance people cycle to work in Australian capital cities. It shows that around 50% of trips are within a 4 – 5 km band and that about 80% of journeys are under ~10 km. It is reasonable to expect that as the adoption of e-bikes will increase in future years, the length of cycle trips may also grow. E-bike trips are generally longer than trips on conventional bicycles, and more effective in replacing trips by car (Fyhri et al. 2017; Fyhri and Beate Sundfør 2020). E-bikes are discussed in greater detail in Section 7.5.3.

Figure 2.20: Cumulative distance to work – cycling, 2016 Census



Source: ABS

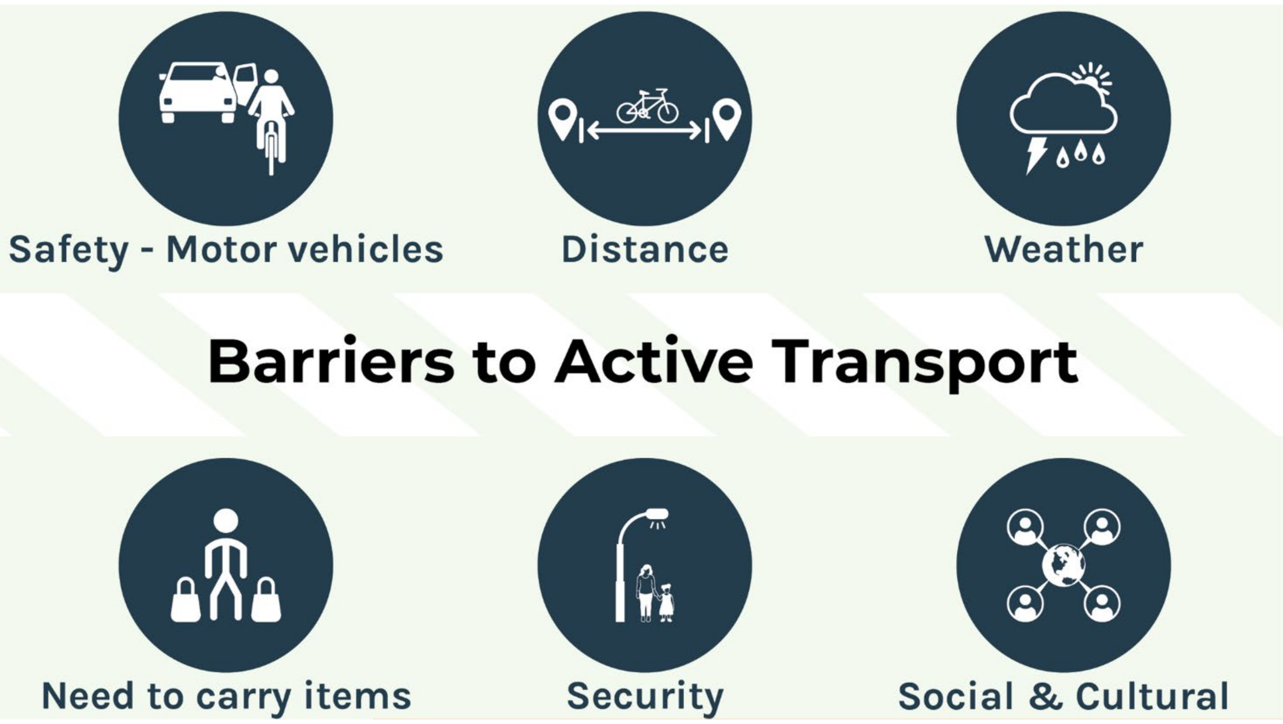
3. Barriers to Active Transport

Active transport mode share is low compared to many other developed countries. There have been no sustained increases in walking and cycling levels in Australasia over the past two decades, despite an increasing number of policies over this period calling for a growth in active transport. This chapter provides an overview of some of the key barriers to walking and cycling. Concerns around safety are the most commonly stated barrier to cycling. Primarily, this relates to concerns about interacting with motor vehicles. While there are some overlaps with cycling, barriers to walking are different. Security concerns and distance are key barriers to walking. This chapter briefly explores the spectrum of barriers for both walking and cycling.

3.1 Summary of barriers

A synthesis of the major barriers to active transport has been captured in Figure 3.1. In many cases, the magnitude of the barrier will differ for walking and cycling. For instance, distance will generally be a more powerful barrier for walking than cycling (up to a point), and mixing with motor vehicles will typically be a more front-of-mind concern for people considering cycling than walking. A summary of key barriers and facilitators to cycling, encompassing a range of different studies on the subject can be found in Boufous et al. (2021).

Figure 3.1: Major barriers to active transport



3.2 Safety

In the realm of active transport, safety emerges as an important factor shaping participation levels. Concerns related to safety are likely to vary between walking and cycling. Section 3.2.1 presents safety barriers for walking. Section 3.2.2 provides coverage of the literature on safety barriers related to cycling.

3.2.1 Walking

Crossing streets with fast-moving motor vehicles can present a barrier to walkability (Zahnow et al. 2022). A study from the United States found that motor vehicle traffic was perceived as a major barrier to walking, with vehicle speed being of greatest concern (Soto et al. 2022).

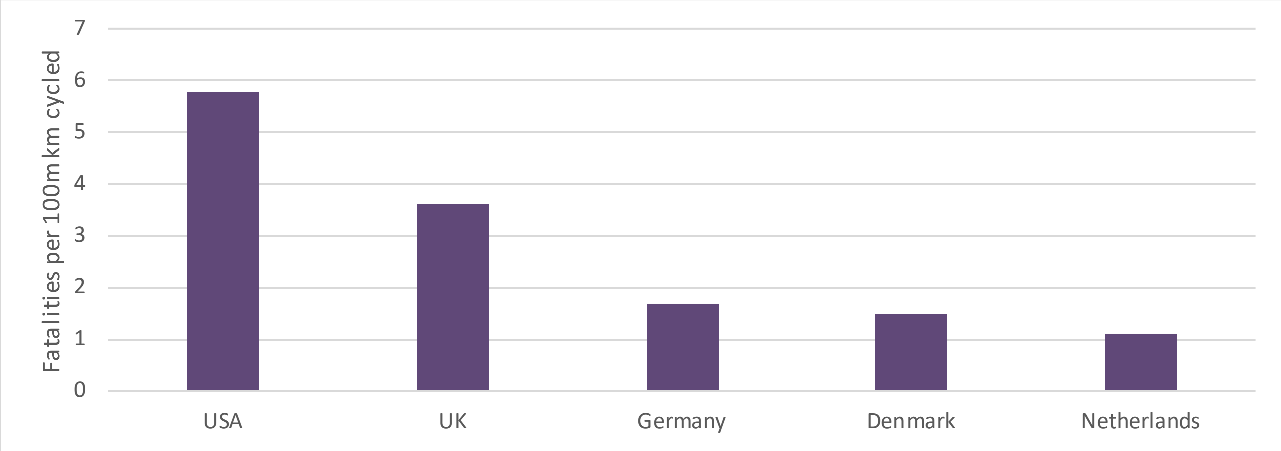
There is a relationship between walking participation and safety. Analysis of pedestrian crash data in Austin, Texas, has revealed that as walking rates increase, the pedestrian crash rate per distance walked decreases (Y Wang and Kockelman 2013). This means that in areas with low levels of walking, the risk of a pedestrian being involved in a crash is higher than in areas with higher walking. This relationship could be related to 'safety in numbers', whereby greater numbers of pedestrians increase visibility and therefore driver's awareness of pedestrians (Y Wang and Kockelman 2013). However, it may also be the case that more pedestrian activity occurs in places that are inherently safer. For example, areas with traffic calming interventions in the Netherlands have reduced crash risk by 20% to 70% (Southworth 2005). Further, an awareness of safe walking routes is associated with increased walking activity (Southworth 2005).

3.2.2 Cycling

Cycling in environments mixed with motor vehicle traffic is a major barrier to cycling (City of Sydney 2020; Hull and O'Holleran 2014; Pearson et al. 2023; Teschke et al. 2012). An online survey of 717 Greater Melbourne residents held in 2021-2022 found several barriers to cycling for transport (Pearson et al. 2023). Over half (56%) of the respondents identified not wanting to mix with motorised traffic. A similar percentage (54%) stated a fear of a collision prevented them from cycling. The researchers concluded that dedicated infrastructure, protected from motor vehicles and connected to the rest of the network is essential for overcoming barriers to cycling. This is also especially important for diversifying participation across all ages and abilities (Pearson et al. 2023). Section 7.2 provides content relating to the role of infrastructure in boosting levels of cycling.

The risk of fatality while cycling varies considerably between countries, as highlighted in Figure 3.2 (Pucher and Buehler 2008). These differences cannot be explained by helmet wearing, because in the European countries shown in Figure 3.2, helmet wearing amongst adults is low (Teschke et al. 2012). In Germany, Denmark and the Netherlands, a host of supportive policies and infrastructure help to reinforce safer outcomes for people on bicycles (Pucher and Buehler 2008). In addition to the 'encouragement' such as bicycle lanes and parking, these three countries also have more restrictive policies regulating the use of motor vehicles, and this combination of policies can help explain the higher levels of safety in Germany, Denmark and the Netherlands (Pucher and Buehler 2008).

Figure 3.2: Fatalities while cycling, per 100 million kilometres cycled



Source: Pucher and Buehler (2008)

There is some evidence that women are more sensitive to the riding environment, which may explain their lower levels of cycling participation in countries without a high-quality bicycle infrastructure network (Buehler and Pucher 2021). A study of those aged over 50 in New South Wales found that safety concerns were commonly stated barriers to cycling (Boufous et al. 2021). As with previous research, females were found to be more sensitive to the riding environment and exhibit more concern about riding in mixed traffic. A study conducted in Montreal, Canada found that women view safety as a greater barrier than men (Manaugh and El-Geneidy 2015).

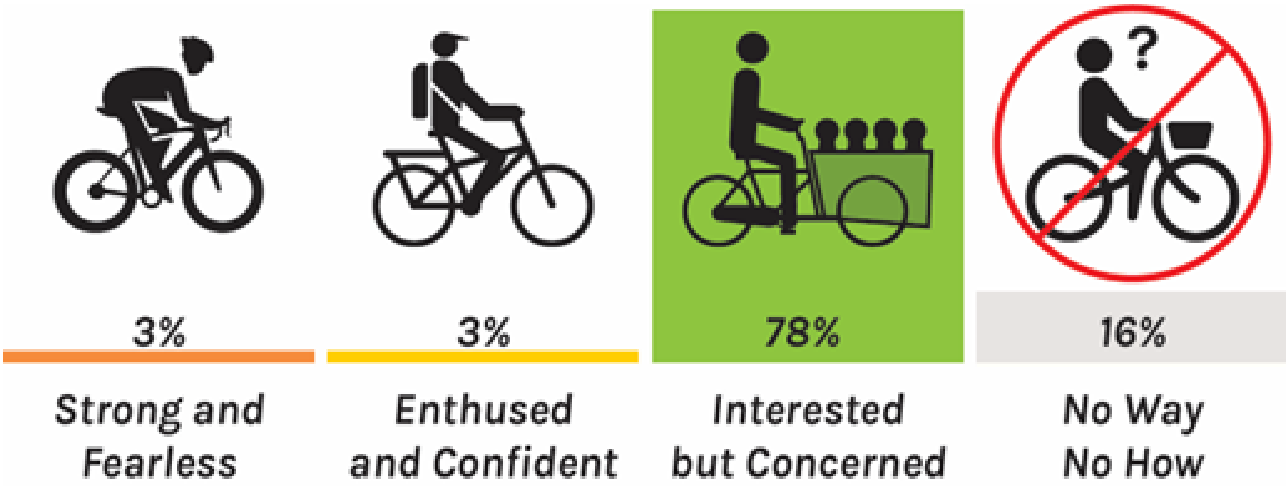
Safety barriers vary depending on the type of cyclist

Safety concerns for cycling will vary depending on the level of confidence of the rider. Confident riders will experience fewer barriers, while those who cycle less, or not at all, are likely to find more barriers preventing them from cycling. This is important because two people faced with the same conditions may interpret them differently. This has implications for the targeting of interventions.

A well-accepted understanding within the cycling literature is that there are said to be four different types of cyclists, from a network planning perspective. Roger Geller, a bicycle planner from the City of Portland, Oregon, distilled four types of cyclists, as shown in Figure 3.3, and outlined briefly below:

- *Strong and fearless* riders are those who are comfortable riding in any road environment, including mixed-traffic environments.
- *Enthused and confident* cyclists are comfortable in most traffic environments but will seek out separated cycling infrastructure and low-traffic alternative routes.
- *Interested but concerned* make up the majority of the population. They are unlikely to consider riding unless trips can be made along safe and separate cycling infrastructure. They are likely to ride shorter distances than the previous two groups.
- *'No way no how'* are people that are not interested in cycling at all, regardless of the relative ease or safety. They are also people who may not be physically able to ride a bike.

Figure 3.3: Four types of cyclists



Source: City of Portland (USA) and (Pearson et al. 2021)

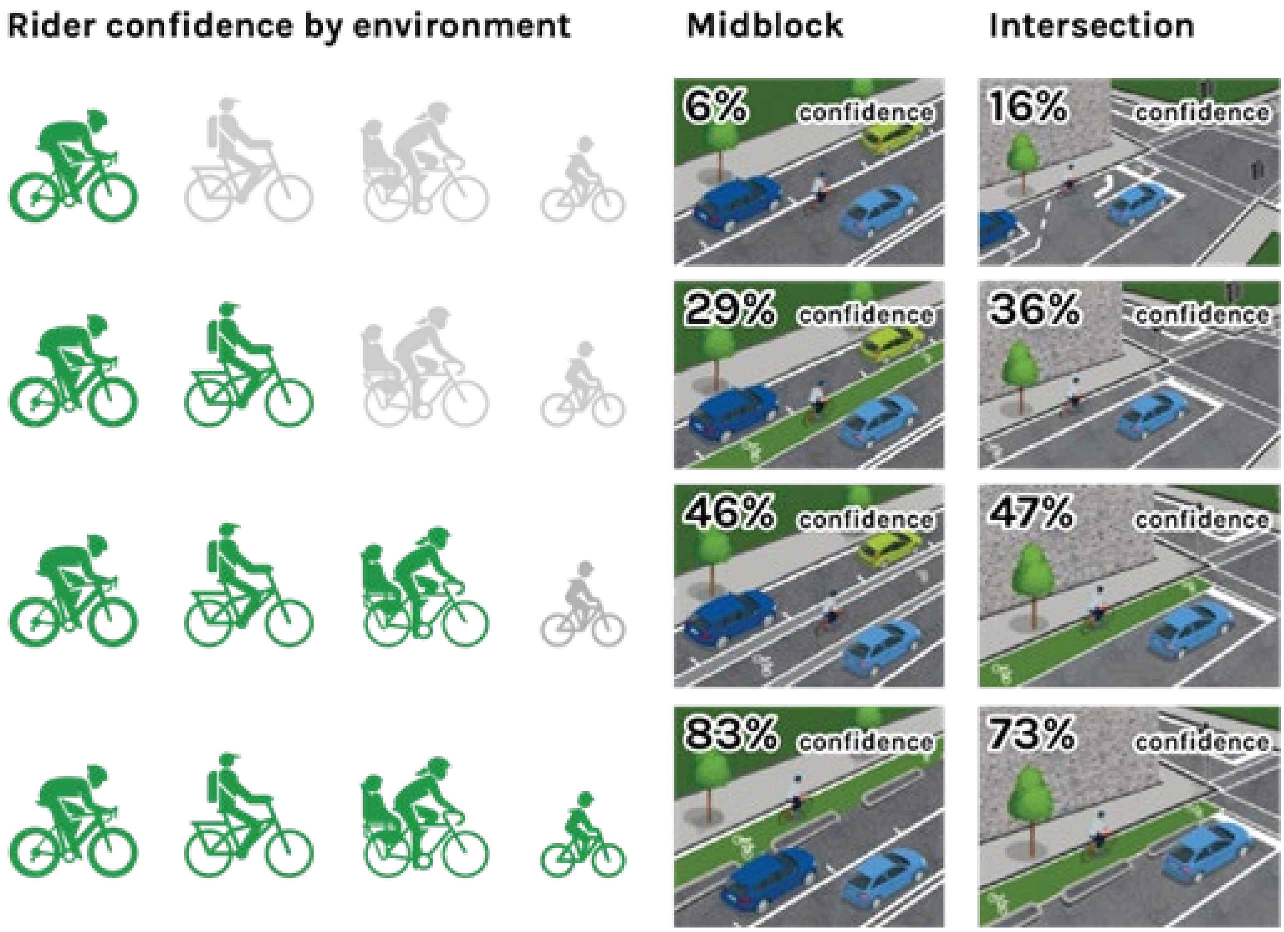
The results show that only 3% of the population identify as either 'Strong and fearless' or 'Enthused and confident'. Almost 80% of the survey respondents identified as 'Interested but concerned', while only 16% said they would not consider cycling under any circumstances.

It is also important to recognise that some people will occupy one category for some of their riding and move into another category for certain trips. For instance, a regular cycle commuter might describe themselves as 'enthused and confident', but when riding on the weekend with young children, may fall into an 'interested but concerned' category.

Confidence levels vary by different types of infrastructure

The City of Melbourne commissioned work to measure stated levels of confidence for different types of riding environments (shown in Figure 3.4). The respondents, who were not regular cyclists, were asked to identify in which of the riding environments they would feel confident riding. The results indicate that only 6% of respondents said they would feel comfortable riding in mixed traffic, without any form of cycling infrastructure. At the other end of the spectrum, some 83% of respondents indicated they would feel comfortable cycling on a street with protected bicycle infrastructure. Figure 3.4 has been adapted to include the types of riders likely to be attracted by the different forms of riding environments.

Figure 3.4: Riding confidence – different infrastructure



Source: CDM Research and ASDF Research (2017)

Only 6% of people say they feel confident riding in mixed traffic without bicycle infrastructure.

3.3 Security

Personal security concerns are a stated barrier to walking (Evers et al. 2014). It is likely that personal security concerns may be less of a barrier to cycling because it is faster than walking (Lynch and Atkins 1988). However, women are more likely to have personal security concerns cycling than men (Garrard et al. 2006). In a study of adolescents in both New Zealand and the Netherlands, personal security was not an issue for males, but was a stated issue for females, in both countries, at night (Frater and Kingham 2020).

3.4 Need to carry items

Carrying heavy items reduces the convenience of active travel, and is stated as a barrier (Heinen et al. 2010). The need to carry items is likely to be more of a barrier for walking, as individuals can more easily attach items to their bicycles, which reduces the exhaustion associated with the carriage of heavy items.

Given the prevalence of cycle use for carrying everyday items (e.g., supermarket shopping) in places with widespread cycle use and bicycle infrastructure provision (e.g., The Netherlands), it is possible that social/cultural factors may also influence people's attitude that carrying items is a barrier to cycling. For instance, carrying items featured as a more significant barrier among New Zealand adolescents than for adolescents who had grown up in a non-cycling country and had subsequently moved to the Netherlands (Frater and Kingham 2020). Social/cultural factors that act as barriers to cycling can often go unrecognised (Buehler and Pucher 2021). It is plausible that when people mention the need to carry items as a barrier to cycling, it is actually more deeply held views around cycling that may influence these reasons. This may apply to other barriers, such as weather. Section 3.7 briefly discusses the social/cultural factors that can act as a barrier to cycle use.

3.5 Weather

Active transport participation is known to be highly sensitive to weather (Böcker et al. 2019). Poor weather is a common reason for not engaging in cycling, but commuting cycling is less impacted than cycling for other purposes (Heinen et al. 2010). Interestingly, some cities with cold, wet winters, such as Copenhagen and Amsterdam actually have some of the highest levels of cycling (Buehler and Pucher 2021), suggesting that other factors have a more powerful impact on participation.

It is common for 'poor weather' to be a stated barrier to cycling in Australia (Pearson et al. 2023). While there are a growing number of days in which it may be too hot to comfortably cycle, even during the Australian Census month (August/winter), low levels of cycling are reported (as highlighted in Chapter 3), even in subtropical cities such as Brisbane.

During periods of ice, snow, and rain, cycling remains a common mode of transport in the Netherlands (see Figure 3.5). The quality of the infrastructure network makes cycling in these conditions less of a barrier than in cities without an extensive network of protected bicycle infrastructure. Thus, while poor weather will reduce active travel, the provision of high-quality infrastructure will boost the degree to which people are willing to cycle.

Figure 3.5: Cycling is common in the Netherlands, even when weather conditions are poor

Source: Institute for Sensible Transport

3.6 Distance and hills

Travel distance is a major influence on the propensity to engage in walking (Institute for Transportation and Development Policy, 2018) and cycling (Heinen et al. 2010). A study in Sydney found that hills can have an influence on people's decision to cycle (Waitt and Stanes 2022).

The design of the street network and its permeability is a known influence on walkability. In neighbourhoods of South American cities that lack permeability, rates of walking were significantly less than in areas with a denser network of streets (Ferrari et al. 2020). This relates directly to distance, as a more permeable street network allows pedestrians to minimise the distance between their origin and destination.

Finally, as the growth in the use of e-bikes continues, it is likely the barriers of distance and hills will begin to diminish. Researchers have established that those riding e-bikes are willing to ride further and are less deterred by topography than those riding regular bicycles (Popovich et al. 2014).

3.7 Social and cultural factors

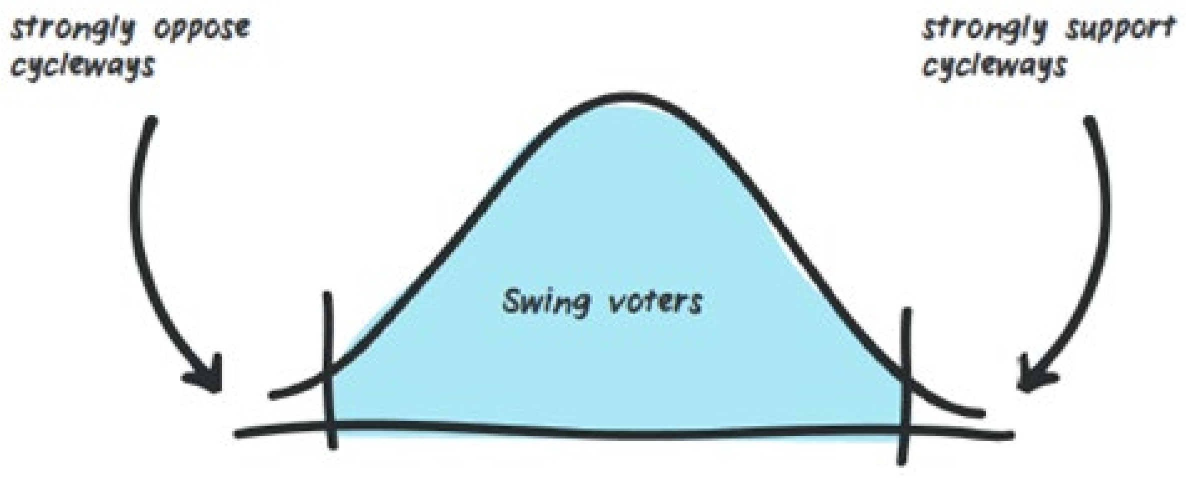
There are important social and cultural factors that can act as barriers to active travel. The socio-ecological model has been used by researchers as a framework for understanding determinants of active travel (Buehler and Pucher 2021). A component of this model focuses on the social-cultural environment (Sallis et al. 2006). Social-cultural factors are often subtle, indirect and unrecognised (Garrard et al. 2006). The status of cycling is an example of an important social influence on whether people view active transport as an option when deciding their mode of transport (Frater and Kingham 2020). In countries in which there is no social stigma or negative status attached to active transport (e.g., Denmark or the Netherlands), people are less likely to experience social and cultural barriers to walking or cycling (Frater and Kingham 2020). Conversely, where active travel is a minor contributor to mode share, social and cultural factors are likely to diminish people's willingness to see these modes of transport as attractive. In these cases, drivers can perceive cyclists to form a minority 'outgroup', and be viewed negatively (Basford et al. 2002). Australian research has revealed similar findings, with cyclists being dehumanised by other road users (Delbosc et al. 2019).

A study comparing adolescents in New Zealand, and in the Netherlands, but originating from countries with low levels of cycling, found that social/cultural factors feature heavily (Frater and Kingham 2020). The New Zealand respondents reported that their friends would consider it 'ridiculous', 'crazy' and 'fun to watch' if they were to cycle to school. This indicates that social norms are likely to play a role as a barrier to cycling. Conversely, the adolescents located in the Netherlands were more likely to identify positive social implications with riding to school.

Cultural/social resistance to cycling can also extend beyond the personal choice to cycle, to also include opposing plans for bike infrastructure. The New Zealand Transport Agency has labelled a disproportionate negative reaction to cycleway projects as bikelash (NZ Transport Agency 2019). This is not unique to New Zealand and has been documented in other locations, including most notably in New York during their period of introducing buffered and protected bicycle lanes (e.g. see Solomonow and Sadik-Khan 2017).

The report commissioned by the New Zealand Transport Agency to better understand bikelash captured community concern along a conceptual graph shown in Figure 3.6. Bikelash comes from a minority of the community that strongly oppose cycleways. The majority of the community are not reported to have strong views one way or the other (NZ Transport Agency 2019).

Figure 3.6: The spectrum of community views on cycleways



Source: NZ Transport Agency (2019)

The New Zealand Transport Agency commissioned study engaged with both professional stakeholders, as well as 24 'swing voters' from across New Zealand cities. The key insights from the study are summarised below:

- people support solutions that work for the majority of people
- *perceived reality* is more powerful than facts they are told are true
- personal action is driven by *connection* to something people care about
- focusing on *'cycling'* can be problematic, as it is seen to favour one group over another. This aligns with a consistent theme to emerge from the subject matter expert interviews
- a lack of trust is at the heart of all community backlash.

The study found the main opportunities to mitigate against *bikelash* include:

- listen to what the community is saying
- be transparent
- build trust.

4. Prioritisation Methodology

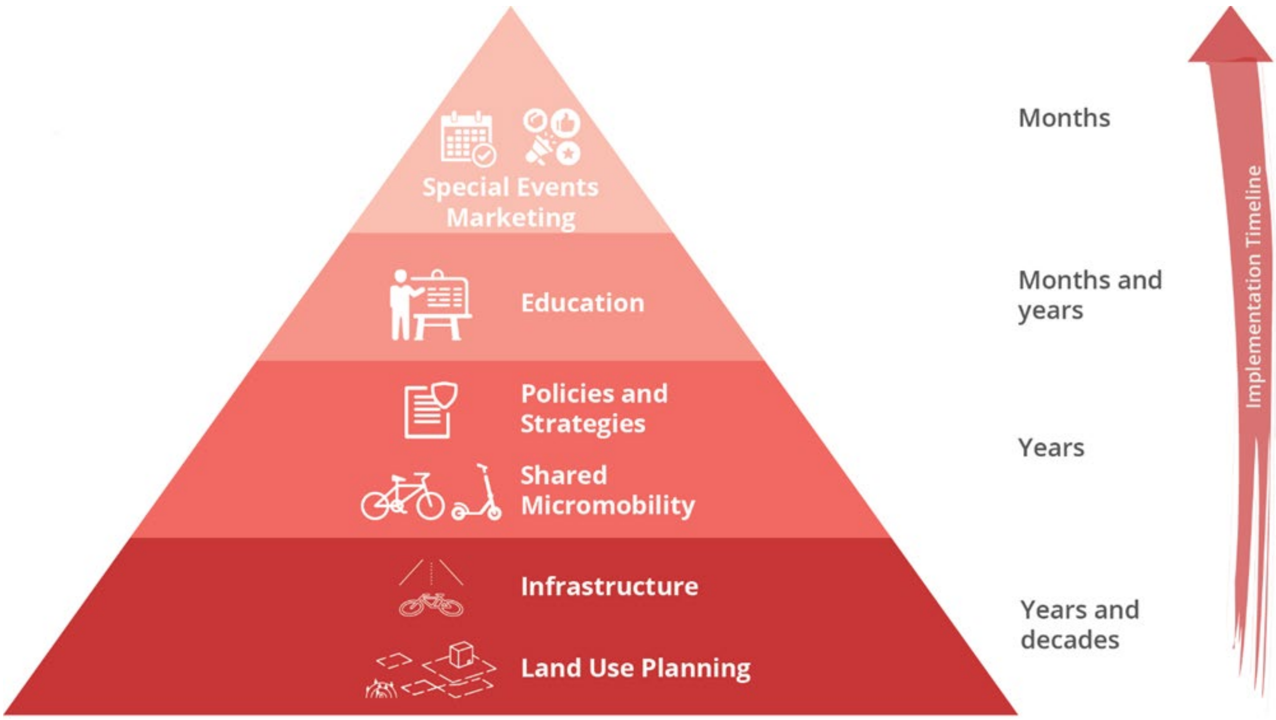
In this chapter, interventions aimed at increasing active transport mode share have been prioritised. A prioritisation framework was developed to offer a transparent, consistent method of identifying which actions are most effective in boosting active transport mode share. The full set of actions has been ranked based on specific criteria and objectives described below. An intervention pyramid is used to classify the major intervention types, as shown in Figure 4.1. The prioritisation framework helps decision-makers allocate resources and attention to the most impactful and strategically important actions. Additionally, this report provides guidance as to the suitability of the prioritised actions for different parts of Australasia; it recognises that what might be suitable in inner-city Sydney or Auckland may not be suitable for suburban or regional Australasia.

The prioritisation framework is designed to help decision makers allocate resources and attention to the most impactful and strategically important actions.

Land use planning and infrastructure form the base of the pyramid, and act as a foundation for boosting active transport mode share. Without a supportive transport network and a level of land use density and mix to enable shorter trip distances, significant growth in active transport mode share is unlikely. The interventions at the top of the pyramid can be thought of as ‘icing on the cake’ and will generally be more successful once progress has been made on actions at the base of the pyramid.

The timeline shown on the right-hand side of Figure 4.1 indicates an approximate timeframe for each of the different layers of intervention. Land use planning to boost density and the mix of land uses will take decades to achieve, as does a mature network of bicycle infrastructure.

Figure 4.1: Intervention pyramid and implementation time

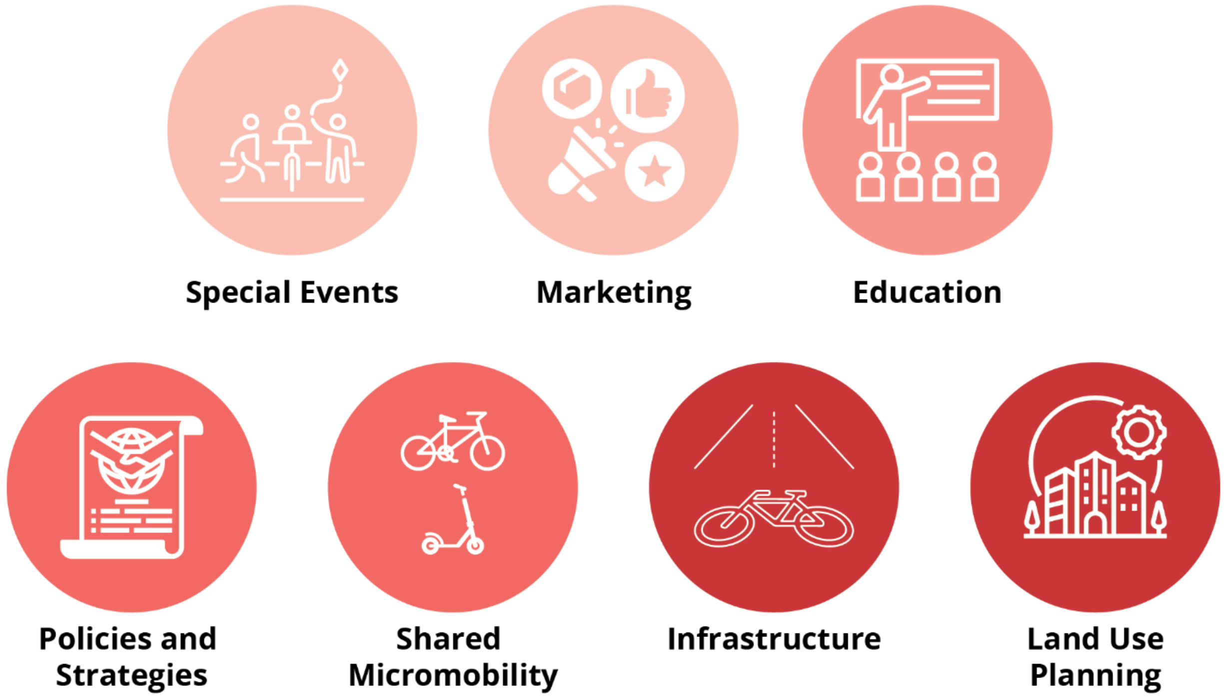


In the remainder of Section 4.1, this report begins by describing the different intervention categories based on those identified in the pyramid captured in Figure 4.1. This report then describes the variables that make up the prioritisation framework. This includes impact (Section 4.2.1), complexity (Section 4.2.2) and cost (Section 4.2.3).

4.1 Intervention categories

The interventions have been systematically categorised using the intervention pyramid shown in Figure 4.2. This categorisation allows for a comprehensive and standardised comparison within each pyramid tier, for all actions reviewed as part of this project. The intervention pyramid serves as a hierarchical structure that classifies interventions based on their characteristics, scope, and potential impact. An overview of all interventions categorised within each layer of the intervention pyramid is presented below, and this is then followed by a description of the variables that make up the prioritisation framework.

Figure 4.2: Intervention categories



Note: colours are based on pyramid

4.1.1 Land use planning

Land use planning refers to the way that land is planned for, with some uses permitted and others excluded. An outcome of land use planning is that there is spatial variability in the degree to which land use functions are separated or mixed. Interventions in this category include:

- transit-oriented development (TOD)
- pedestrian-oriented development (POD)
- car parking supply in the planning system.

4.1.2 Infrastructure

There is a close relationship between active transport infrastructure and levels of walking and cycling. For instance, high-quality infrastructure helps to overcome a key barrier preventing more people from cycling. Interventions in this category include:

- walking infrastructure: footpaths, crossings, and placemaking
- cycling infrastructure: painted lanes, shared lanes, separated lanes, pop-ups, quiet ways
- bike parking and end-of-trip facilities: bike parking at railway stations, in building bike parking, and end-of-trip facilities such as showers
- pedestrianisation/ car-free zones
- super blocks.

4.1.3 Shared micro-mobility

Shared micro-mobility is a specific category of intervention that encompasses shared two-wheeled transport options (e.g., bike share, e-scooter share). Shared micro-mobility initiatives aim to provide convenient, flexible, and more sustainable transport choices to individuals. This category typically includes:

- bike share
- E-scooter share.

4.1.4 Policies and strategies

Within the prioritisation framework, various policies and strategies which may have an impact on increasing active transport have been included in the prioritisation framework. The policies and strategies reviewed include:

- motor vehicle speed reduction
- public transport integration with walking and cycling
- road-user pricing
- car parking user fees: on-street parking cost and off-street taxes and levies
- cycling incentives: e-bike incentive, and e-bike trial
- free public transport passes
- car share.

4.1.5 Education

Education interventions focus on promoting awareness, knowledge, and behavioural change around the use of active modes. The programs that formed part of the reviewed interventions included:

- travel behaviour change program
- school-based interventions: walking programs and cycling programs.

4.1.6 Special events and marketing

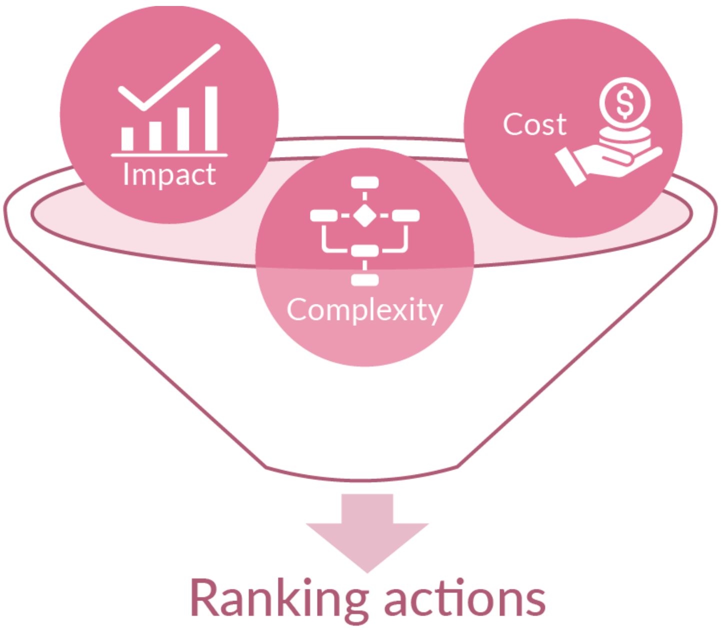
Special events typically involve temporary alterations in the use of streets or a network of streets for short periods, often occurring on specific days or weekends (e.g., car-free Sundays). These events can attract public attention and participation, creating a heightened sense of awareness regarding the benefits of active transport and placemaking. Special events and marketing reviewed as part of the prioritisation included:

- Ride2Work Day, Walk to Work Day, and other workplace interventions to increase active travel
- Ciclovias
- PARK(ing) Day
- Digital platforms and gamification.

4.2 Variables included in prioritisation framework

Impact, Complexity and Cost are the three key variables used in the prioritisation framework. A total of 168 documents (peer-reviewed and grey literature) were used to create a database of intervention types. Researchers have used a variety of different outcome metrics to express the impact of different interventions. As a consequence, this report has harmonised the diversity of factors researchers and government reports have used when describing the impact of different interventions. For comparative analysis, this report collates studies that share similar metrics within each layer of the pyramid shown in Figure 4.1. For example, all the studies reporting their effects on the mode share within a layer of the pyramid are compared together and categorised into "Low", "Medium", and "High" categories. This similar approach is also employed for other assessments of impact with other metrics, such as time spent in active travel. The factors considered in the prioritisation framework are shown conceptually in Figure 4.3 and described immediately below.

Figure 4.3: Variables included in prioritisation framework



4.2.1 Impact

Impact is a key variable within the prioritisation framework and is divided into two elements:

- impact on increasing active transport mode share
- impact on enhancing safety.

Understanding the extent to which specific actions influence *travel behaviour* and *safety* is essential to growing active transport mode share. The two elements of *impact* identified above are described in more detail below.

Impact on travel behaviour

Impact on travel behaviour refers to the degree to which a specific action or intervention influences walking or cycling as a mode of transport. This impact is often quantified through mode shift analysis, which assesses the proportion of individuals who switch from other modes of transport to walking or cycling in response to the intervention. Mode shift can be expressed as an elasticity, representing the percentage change in walking or cycling participation resulting from a unit change in the intervention. Additionally, impact can be measured in terms of Vehicle Kilometres Travelled (VKT) reduction, indicating the distance of car travel avoided due to increased walking or cycling. In certain cases, the impact on travel behaviour may also be evaluated by the amount of time individuals spend engaging in walking or cycling activities as a result of the intervention. An accurate assessment of the impact on travel behaviour is essential for gauging the effectiveness of interventions and their contribution to promoting sustainable and active transport choices.

Impact on travel behaviour metrics in the interventions catalogue includes:

- time spent walking and cycling
- increase in walking and cycling mode share
- decrease in car mode share.

Impact on Safety

The impact on safety is a crucial aspect of the prioritisation framework. It refers to the degree to which an action or intervention affects the safety of individuals using active modes. Safety is a paramount concern in promoting active transport as it directly influences people's willingness to choose these modes of transport. The metrics used in the prioritisation framework to measure safety are:

- crash numbers
- serious injury numbers
- speed reduction.

Serious injury is a subset of crash numbers. However, due to the variance in reporting metrics across studies, both categories are retained within this report.

4.2.2 Complexity

The complexity of an intervention has been included in the prioritisation framework and has two elements: *technical difficulty* and *political considerations*, both of which are described below. The evaluation of complexity was made based on the intervention category and professional judgement (as the literature very rarely offers objective metrics regarding an intervention’s complexity to implement).

Technical Difficulty

The framework prioritises interventions based on a professional judgement of the technical difficulty of implementing the intervention. For instance, implementing permanently separated cycleways on existing streets may require significant engineering and construction work, posing technical complexities in terms of design, safety, and integration with the existing infrastructure. By comparison, behaviour change programs are likely to be less technically challenging to implement.

Political Considerations

Recognising the importance of community support, the prioritisation framework evaluates the political considerations associated with the interventions this report considers. Some initiatives, such as congestion charging (road user pricing) or the removal of car parking may face political resistance. Conversely, school behaviour change programs, which aim to promote active transport among students and parents, are often widely supported by the community and educational institutions.

4.2.3 Cost

The prioritisation framework considers cost as a multi-dimensional factor made up of up-front costs, ongoing costs, as well as possible revenue generation. Cost, for the purposes of this prioritisation assessment, is cost to the government. Interventions that may be costly but borne primarily by the private sector are not rated as costly (although they may have larger political considerations), compared to projects that are financed by the government alone. Finally, the duration of impact is also integrated into the cost rating.

Monetary cost

This aspect of cost refers to the financial expenditure associated with planning, implementing, and maintaining a specific action or intervention. It includes up-front costs (initial capital investment required to start the intervention) and ongoing costs (continuous expenses for maintaining and operating the intervention). For some interventions, it also includes revenue generation (e.g., road user pricing).

- Up-front Cost: This aspect involves analysing the initial capital investment required to initiate an action or intervention. For instance, the implementation of a behaviour change program aimed at promoting active transport may involve an up-front cost of $50,000, while the creation of a new bike lane could require a significantly higher capital expenditure of $5,000,000 per kilometre. Understanding the up-front costs helps decision-makers in setting budgetary allocations and identifying interventions that align with financial capabilities.
- On-going Cost: The framework also considers the ongoing costs associated with maintaining each action or intervention over time. For example, the continued operation of a behaviour change program may incur annual expenses of $15,000, while maintaining a bike lane might require $5,000 per year per kilometre. This evaluation is essential for ensuring the financial sustainability of interventions and assessing their long-term viability.
- Revenue Generation: Potential revenue generated by specific actions or implementations is the third part of the cost variable. Congestion charging, aimed at reducing traffic congestion and increasing the value proposition for active transport, may generate income. Understanding revenue opportunities assists decision-makers in identifying self-sustaining interventions that could partially or fully offset associated costs.

Duration of impact

The *duration of impact* associated with an intervention is another important element within the cost variable. This refers to the timescale over which the intervention remains effective. Some interventions may have short-term impacts, lasting months, before requiring further funding or modifications to sustain their benefits. On the other hand, other interventions may have long-lasting impacts. Understanding the duration of impact helps in identifying interventions that yield lasting benefits and contribute to the long-term sustainability of active transport initiatives. Since the duration of impact is not consistently reported across the studies, the assessment of impact duration in this report relies on professional judgment.

Time required for implementation

The implementation lead time represents the duration to plan, develop, and execute a particular action or intervention. Some interventions, such as behaviour change programs, may be relatively quick to implement, taking several months to put into action. In contrast, infrastructure projects, especially those focused on changing urban form and land use take years or even decades. Evaluating the time required for implementation aids decision-makers in setting realistic timelines, prioritising interventions that can be executed efficiently, and planning for the effective deployment of resources. The time required for implementation assessment is based on professional judgment in this report.

4.3 Approach to ranking actions

Each action (the interventions are discussed in detail in Chapter 7) was given a score comprising impact, cost, and complexity. The score weighs an action's impact against its cost and complexity. This prioritises actions that have a medium impact, and medium cost and complexity over actions that have a medium impact, but high cost and complexity.

For each action, its impact, cost, and complexity were assessed as high, medium, or low. These assessments were converted to numeric values, as shown in Table 4.1. The overall score was calculated as:

$$\sqrt{(2i \times (p + c))}$$

In the equation above, i is impact, p is cost, and c is complexity.

The impacts of an intervention are compared against the cost and complexity of the intervention. For this reason, impact is weighted double, so that it is equal to the cost and complexity. This ensures that each intervention's prioritisation score balances impact on one hand, with cost and complexity on the other.

A *mean square* calculation is used to provide a composite score of impact against cost and complexity. The advantage of a *mean square* over simply adding the scores together is that it weighs projects that have more even scores across all criteria higher. As an example, a project with medium impact and medium cost and medium complexity would score an 8 if all values were added (and impact worth double), and score 4 under the mean square equation above. However, a project with low impact, low cost and low complexity would also score 8 if all scores were added (and impact worth double), but score 3.5 using the mean square equation.

Table 4.1: Prioritisation ranking

	Impact	Cost	Complexity
High	3	1	1
Medium	2	2	2
Low	1	3	3

Our threshold for prioritising interventions was a score higher than four. Detailed coverage of these prioritised actions is presented in Chapter 7.

4.4 Research evidence ranking

In recent years, urban areas have witnessed a growing emphasis on sustainable and active transport modes, such as walking and cycling, to address the challenges posed by increasing traffic congestion, air pollution, and sedentary lifestyles. Encouragement and discouragement interventions have emerged as key strategies in shaping the mode share of active transport within cities and towns. These interventions encompass a diverse array of initiatives, ranging from infrastructure improvements to policy measures, all aimed at promoting and prioritising walking and cycling while discouraging excessive car use.

The methodology employed to rank all interventions is visually represented in Figure 4.4. Initially, all interventions were categorised and organised based on a hierarchical pyramid structure. Subsequently, a meticulous evaluation of each intervention's impact, cost, and complexity was conducted within their respective pyramid layers. As a concluding step, the geographical context was taken into account to inform the final prioritisation.

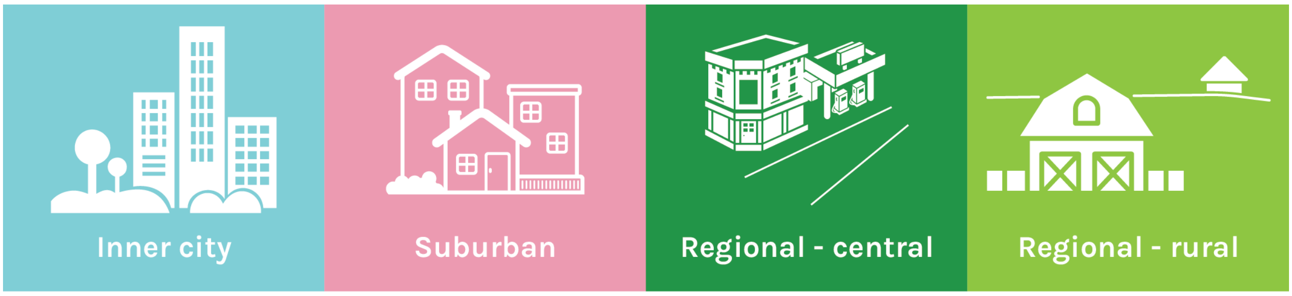
Figure 4.4: Prioritisation framework steps

In this framework, this report presents a comprehensive multi-layered evaluation to assess the impact, cost, and complexity of various encouragement and discouragement interventions for active transport. Each layer is carefully evaluated, and interventions are categorised into "Low," "Medium," and "High" levels based on their potential to influence mode share, safety, associated financial implications, and complexity. The list of interventions reviewed as part of this project has been assessed for their suitability to different contexts, and the results of this exercise can be found in Chapter 6. This also provides an indication of the degree to which the various interventions are suitable for inner city, suburban, and regional areas, as discussed in Chapter 5.

5. Locational Context for Recommendations

The suitability of an intervention may vary significantly depending on the context in which it is implemented. Figure 5.1 provides an overview of the different geographical contexts that have been used in this report. Some interventions may be suitable in the CBD of Melbourne or Auckland, but are unlikely to be appropriate for a regional town. A description of these geographic regions is offered below.

Figure 5.1: Different geographical context



5.1 Inner city

- Population density: Inner cities are typically densely populated with a concentration of residential, commercial, and institutional buildings.
- Mixed land uses: Inner cities often feature a mix of residential, commercial, industrial, and cultural spaces within a relatively small area.
- Traffic Congestion: High population density and commercial activities can lead to traffic congestion, necessitating traffic management measures and increasing the competitiveness of active transport compared to private motorised transport.
- Public transport accessibility: Inner cities generally have better public transport options than outer areas.
- Average trip distance: In inner cities, the average trip distance tends to be relatively short due to the proximity of various amenities and destinations.

5.2 Suburban

- Population density: Suburban areas have lower population densities compared to inner cities. The residential focus, larger lots, and more open spaces contribute to a less intensive mix of land uses.
- Mixed land uses: Suburban areas often have a more limited land use diversity, with a focus on residential spaces and dedicated commercial centres.
- Traffic Congestion: Suburban areas may experience traffic congestion on major roads during peak times, but it is often less severe than in inner cities.
- Public transport accessibility: Suburban areas may have limited public transport accessibility, with fewer options compared to inner cities.
- Average trip distance: In suburban areas, the average trip distance is typically longer than in inner cities, as destinations are more spread out.

5.3 Regional – central

- Population density: Low overall population density, although some regional centres have higher population density than outer areas.
- Mixed land uses: Regional-central areas have a mix of land uses, primarily concentrating on commercial, office, and retail spaces, with limited residential areas.
- Traffic Congestion: Low
- Public transport accessibility: Generally low, with the exception of towns that have a high-frequency rail service.
- Average trip distance: The average trip distance in regional-central areas can vary, depending on the concentration of businesses and offices and the proximity of residential areas. There is often a high proportion of car trips within a 3 – 5 km distance band.

5.4 Regional – rural

- Population density: Regional rural areas have the lowest population densities among the four types, with scattered settlements and larger expanses of agricultural land and natural landscapes.
- Mixed land uses: Regional rural areas are predominantly characterised by agricultural land and natural landscapes, resulting in a more uniform land use pattern.
- Traffic Congestion: Regional rural areas have minimal traffic congestion due to the low population density and limited development.
- Public transport accessibility: Regional rural areas often have limited or no fixed public transit options due to low population density and dispersed settlements.
- Average trip distance: Regional rural areas generally have longer average trip distances due to the dispersed nature of settlements and the need to access services and amenities in neighbouring towns or cities.

Each type of area has distinct characteristics that influence population density, land use diversity, traffic congestion, public transport accessibility, and average trip distance. Effective active transport prioritisation frameworks require tailored interventions that consider these specific factors to create sustainable and efficient transport networks that meet the unique needs of each context.

6. Results of Prioritisation

This chapter presents the results of the prioritisation process. Table 6.1 provides the intervention prioritisation results, with those in bold achieving above the inclusion threshold of four. Table 6.1 also identifies if the intervention is considered *discouraging* of car use or *encouraging* of active transport, or both (discussed in more detail below). As highlighted previously, as well as briefly in this report, interventions that work to both discourage car use and increase active travel are often the most impactful in boosting active transport mode share. It is worth noting that the identification of intervention packages with the highest impact on active transport prioritisation is a valid consideration. This aspect could be potentially investigated in a separate project to further enhance the effectiveness of the initiatives. The scores in Table 6.1 are calculated as set out above, in Chapter 4.

Table 6.1: Intervention categories

Intervention	Pyramid category	Discouragement / encouragement	Score
Transit/Pedestrian Orientated Development	**Land use planning**	**Encouragement**	**4.9**
Car parking supply in the planning system	**Land use planning**	**Discouragement**	**4.0**
Bike modal filter	**Infrastructure**	**Encouragement and discouragement**	**5.5**
Bike lane - shared lanes	**Infrastructure**	**Encouragement**	**4.9**
Bike lane – painted lanes	**Infrastructure**	**Encouragement**	**4.0**
Bike lane – separated lanes	**Infrastructure**	**Encouragement**	**3.5***
Bike lane – separated lanes (pop-up)	**Infrastructure**	**Encouragement**	**4.9**
Bike lane - quietways	**Infrastructure**	**Encouragement**	**4.0**
Shared paths	**Infrastructure**	**Encouragement**	**3.5***
Walking - footpath	**Infrastructure**	**Encouragement**	**4.9**
Walking – crossings	**Infrastructure**	**Encouragement**	**4.5**
Walking - placemaking	**Infrastructure**	**Encouragement**	**4.5**
Pedestrianisation/ car free	Infrastructure	Encouragement and discouragement	2.8
Super blocks	Infrastructure	Encouragement and discouragement	3.4
Bike racks on buses	**Infrastructure**	**Encouragement**	**3.4***
Bike parking at stations / shower	**Infrastructure**	**Encouragement**	**4.9**
In building bike parking and end of trip facility	**Infrastructure**	**Encouragement**	**4.9**
Bike share	**Shared micromobility**	**Encouragement**	**5.5**
E-scooter share	**Shared micromobility**	**Encouragement**	**3.2***
Motor vehicle speed reduction	Policies and strategies	Encouragement	2.8
Public transport integration with walking and cycling	**Policies and strategies**	**Encouragement**	**4.0**
Road-user pricing	**Policies and strategies**	**Discouragement**	**4.9**
Car parking cost - on street parking cost	Policies and strategies	Discouragement	2.8
Car parking cost – off street taxes and levies	Policies and strategies	Discouragement	3.2
E-bike incentive	Policies and strategies	Encouragement	4.0
Cycling incentive – e-bike trial	Policies and strategies	Encouragement	3.5
Parking cash out scheme	Policies and strategies	Encouragement	3.5

Intervention	Pyramid category	Discouragement / encouragement	Score
Free public transport passes	Policies and strategies	Encouragement	2.8
Car share	Policies and strategies	Encouragement	3.2
Travel behaviour change programs	**Education**	**Encouragement**	**5.5**
School-based interventions – walking programs	**Education**	**Encouragement**	**3.5***
School-based interventions – cycling programs	**Education**	**Encouragement**	**3.5***
Ride 2 work day/ walk to work day/ walk in to work out	**Special events and marketing**	**Encouragement**	**4.9**
Clclovias	**Special events and marketing**	**Encouragement**	**4.2**
PARK(ing) Day	Special events and marketing	Encouragement	3.2
Digital platforms and gamification	Special events and marketing	Encouragement	3.5

*Note 1: Interventions with a rank greater than 4 are considered as prioritised intervention (shown in **bold**).*

*Note 2: Interventions marked with an * were assessed as lower than 4 but included in the prioritised list as part of a cluster with other actions.*

In the next section a comparison of the interventions across each pyramid layer is provided.

6.1 Land use planning

Figure 6.1 captures the prioritisation outcome for the land use planning layer from the conceptual pyramid shown earlier in Figure 4.1.

Figure 6.1: Land use planning interventions ranking

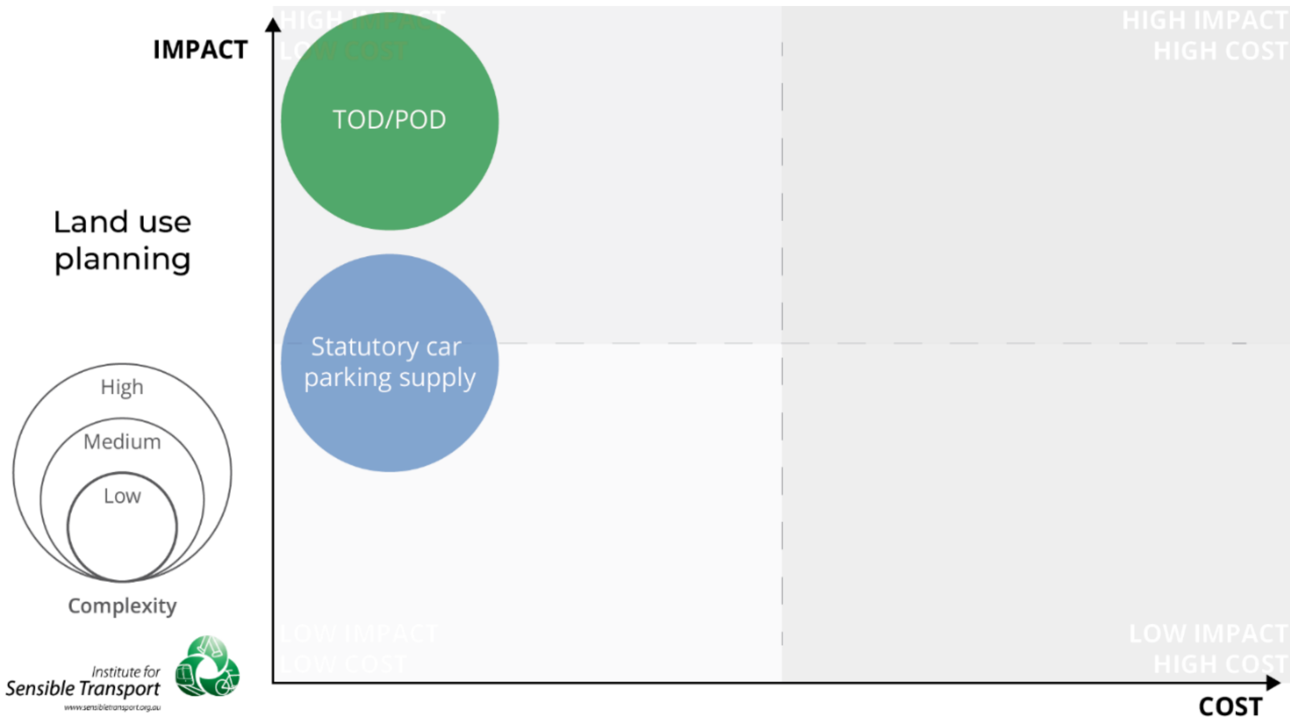


Table 6.2 presents the geographical context considerations for these actions. Three stars represents high levels of applicability, while one star indicates low levels of applicability.

Table 6.2: Geographical context consideration for land use planning interventions

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
TOD/POD	★★★	★★	★★	★
Car parking supply in the planning system	★★★	★★	★★	★

6.2 Infrastructure

Figure 6.2 represents the prioritisation result for the infrastructure layer from the conceptual pyramid shown earlier in Figure 4.1.

Figure 6.2: Infrastructure interventions ranking

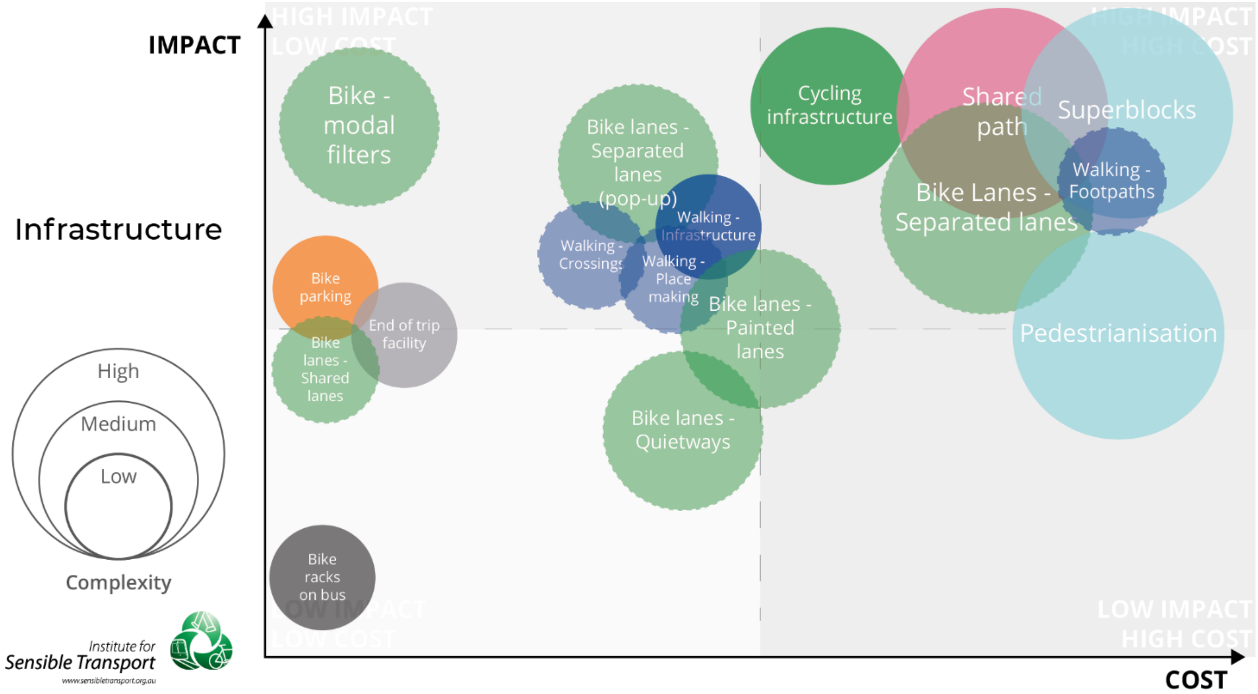


Table 6.3 presents the geographical context considerations for these actions. Three stars represent high levels of applicability, while one star indicates low levels of applicability.

Table 6.3: Geographical context consideration for Infrastructure interventions

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Bike - modal filters	★★★	★★	★★★	★
Bike lanes - Shared lanes	★★★	★★	★★	★
Bike lanes - Painted lanes	★★★	★★★	★★★	★★
Bike lanes - Separated lanes	★★★	★★	★★	★
Bike lanes - Separated lanes (pop-up)	★★★	★★★	★★	★
Bike lanes - Quietways	★★★	★★	★★★	★

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Shared path	★★★	★★★	★★★	★★★
Walking - Footpaths	★★★	★★★	★★★	★★★
Walking - Crossings	★★★	★★★	★★★	★★★
Walking - Placemaking	★★★	★★	★★★	★
Pedestrianisation / car free zones	★★★	★★	★★★	★
Super blocks	★★	★	★	★
Bike racks on buses	★★★	★★★	★★★	★★★
Bike parking at stations/ destination	★★★	★★★	★★★	★★★
In building bike parking and end of trip facility	★★★	★★	★★	★

6.3 Shared micro-mobility

Figure 6.3 represents the outcome of the prioritisation framework for the shared micro-mobility layer of the conceptual pyramid shown earlier in Figure 4.1. The reason bike sharing received a higher prioritisation score than e-scooter share is that e-scooters are often used for short trips, mostly replacing walking, rather than replacing car trips. Increasing active transport mode is the main objective of this project and thus bike share has been rated as having a higher impact than e-scooter share.

Figure 6.3: Shared micro-mobility interventions ranking

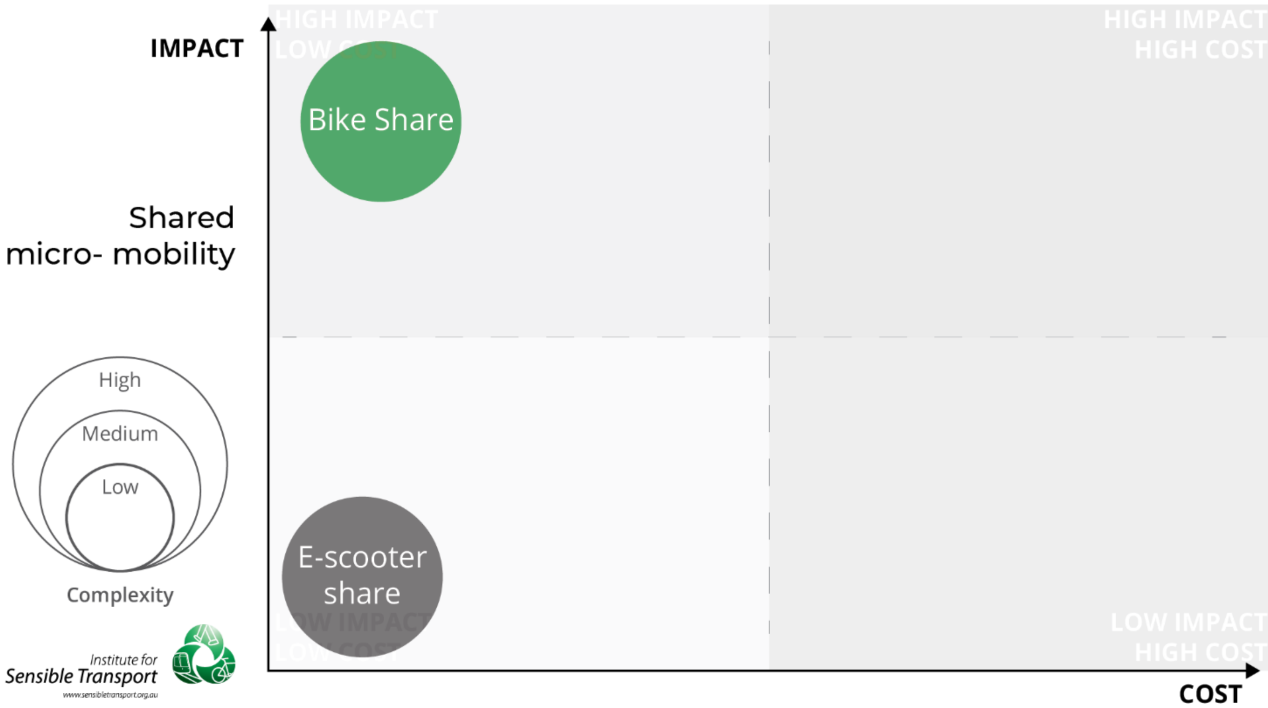


Table 6.4 presents the geographical context considerations for these actions. Three stars represent high levels of applicability, while one star indicates low levels of applicability.

Table 6.4: Geographical context consideration for shared micro-mobility interventions

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Bike share	★★★	★	★★	★
E-scooter share	★★★	★	★★	★

6.4 Policies and strategies

Figure 6.4 represents the outcome of the prioritisation framework for the policies and strategies layer of the conceptual pyramid shown earlier in Figure 4.1. The rationale behind the lower cost assessment for road-user pricing is because, unlike most of the other interventions, road-user pricing raises revenue. Consequently, despite the presence of significant capital and operational expenses, these costs are likely to be outweighed by the revenue generated.

Figure 6.4: Policies and strategies interventions ranking

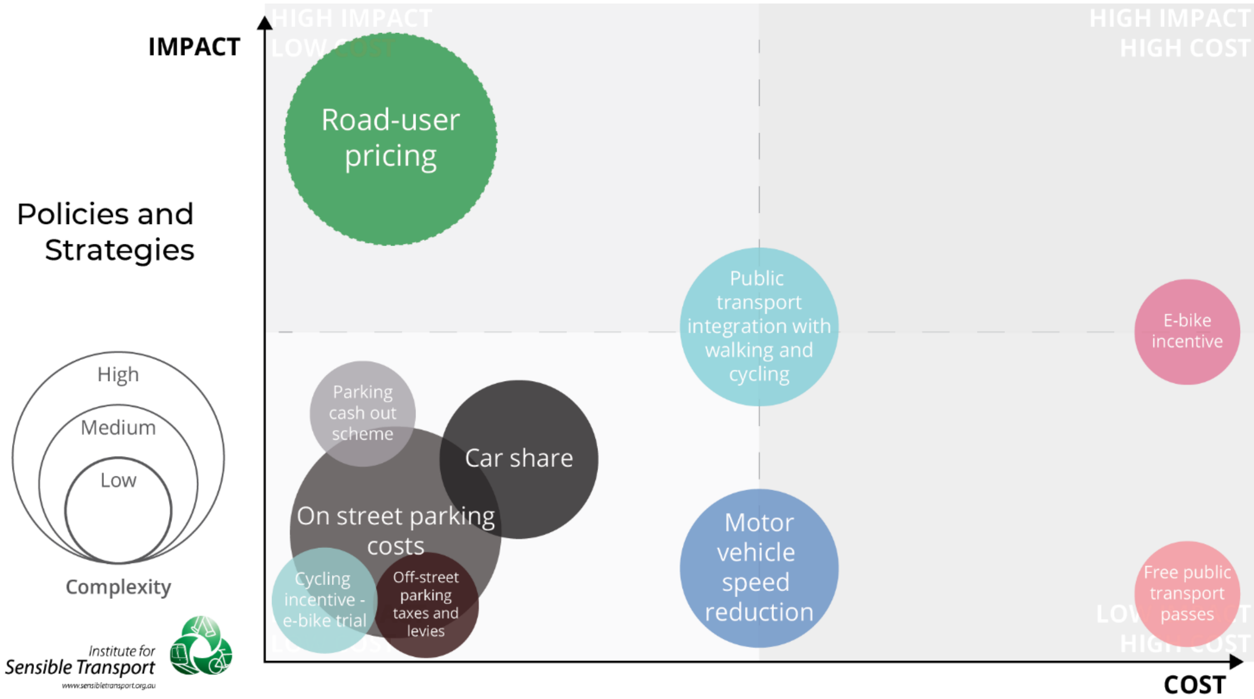


Table 6.5 presents the geographical context considerations for these actions. Three stars represent high levels of applicability, while one star indicates low levels of applicability.

Table 6.5: Geographical context consideration for policies and strategies interventions

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Motor vehicle speed reduction	★★★	★★★	★★★	★★★
Public transport integration with walking and cycling	★★★	★★★	★★★	★★★
Road-user pricing	★★★	★★	★★	★

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Car parking cost- on street parking costs	★★★	★★	★★	★
Car parking cost- off street taxes and levies	★★★	★★	★★	★
E-bike incentive	★★★	★★★	★★★	★★★
Cycling incentive - e-bike trial	★★★	★★★	★★★	★★
Parking cash out scheme	★★★	★★	★★	★
Free public transport passes	★★★	★★	★★	★
Car share	★★★	★★	★★★	★

6.5 Education

Figure 6.5 represents the outcome of the education layer of the prioritisation framework.

Figure 6.5: Education interventions ranking

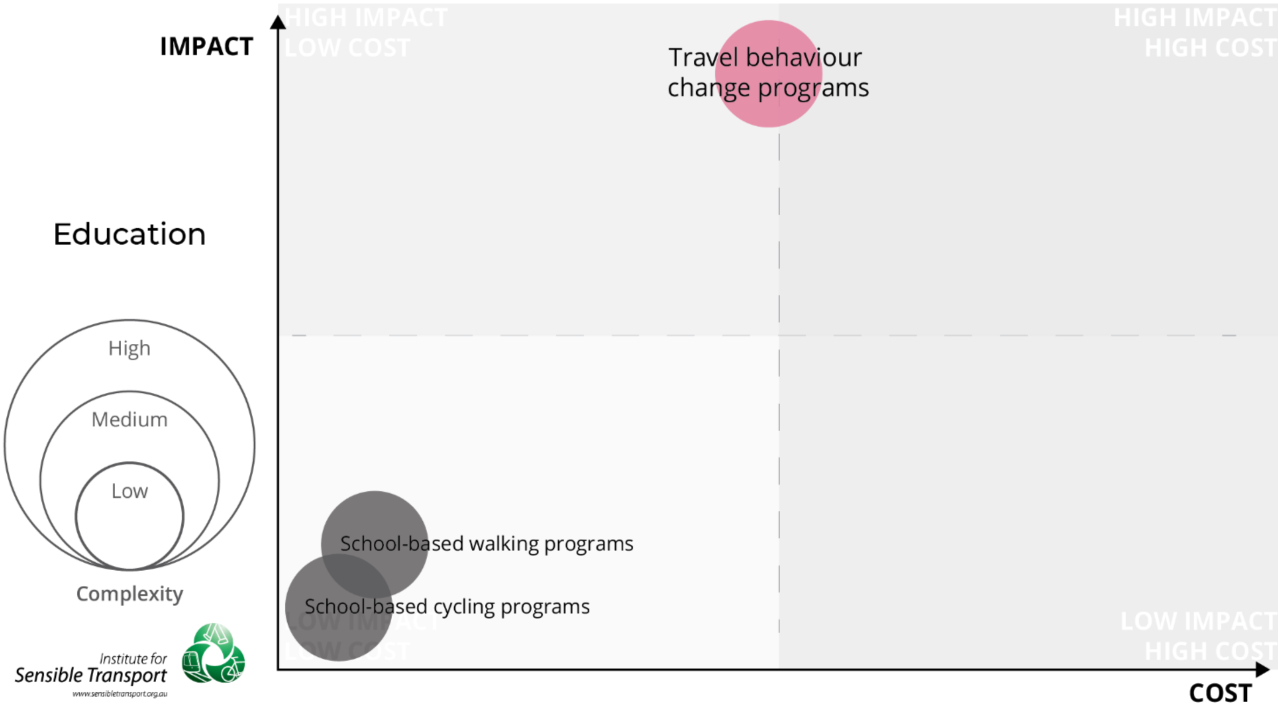


Table 6.6 presents the geographical context considerations for these actions. Three stars represent high levels of applicability, while one star indicates low levels of applicability.

Table 6.6: Geographical context consideration for education interventions

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Travel behaviour change programs	★★★	★★★	★★★	★★
School-based interventions - walking programs	★★★	★★★	★★★	★★
School-based interventions - bicycle programs	★★★	★★★	★★★	★★

6.6 Special events and marketing

Figure 6.6 represents the outcome of the prioritisation framework for the special events and marketing layer of the pyramid. Table 6.7 indicates geographical context considerations for them.

Figure 6.6: Special events and marketing interventions ranking

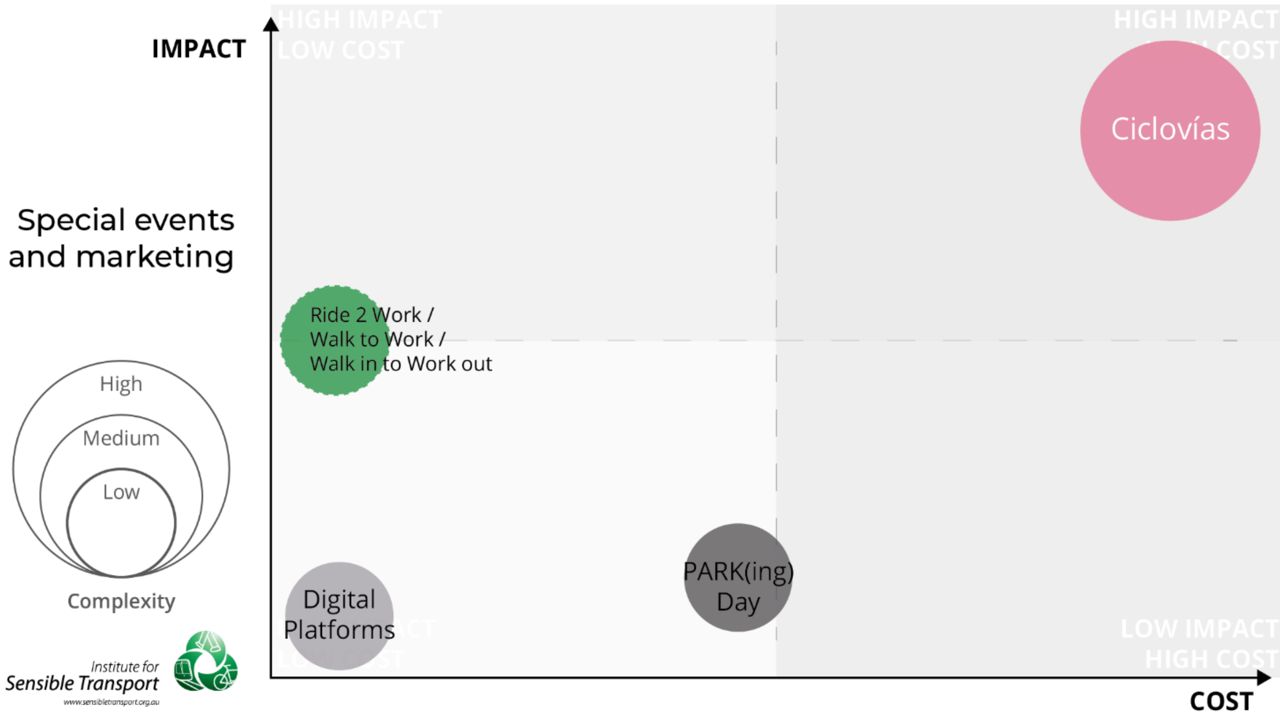


Table 6.7: Geographical context consideration for special events and marketing interventions

Intervention name	Inner city	Suburban	Regional – central	Regional – rural
Ride 2 Work Day / Walk to Work Day / Walk in to Work out	★★★	★★★	★★★	★★
Ciclovias	★★★	★★	★★★	★
PARK(ing) Day	★★★	★	★★★	★
Digital platforms and gamification	★★★	★★	★★★	★

6.7 Expert interview ranking

In accordance with our project methodology, interventions were prioritised through a series of subject matter expert interviews. Table 6.8 provided the expert interview ranking by considering pyramid layers.

Table 6.8: Expert interview ranking

Intervention name	Category (pyramid)	Expert interview ranking
TOD/POD	Land Use Planning	High
Car parking supply in the planning system	Land Use Planning	High
Bike - modal filters	Infrastructure	High
Bike lanes - Shared lanes	Infrastructure	Medium
Bike lanes - Painted lanes	Infrastructure	Medium
Bike lanes - Separated lanes	Infrastructure	High
Bike lanes - Separated lanes (pop-up)	Infrastructure	High
Bike lanes - Quietways	Infrastructure	Medium
Shared path	Infrastructure	Medium
Walking - Footpaths	Infrastructure	Medium
Walking - Crossings	Infrastructure	Medium
Walking - Placemaking	Infrastructure	Medium
Pedestrianisation / car free zones	Infrastructure	Medium
Super blocks	Infrastructure	High
Bike racks on buses	Infrastructure	Low
Bike parking at stations/ destination	Infrastructure	Low
In building bike parking and end of trip facility	Infrastructure	Low
Bike share	Shared micromobility	Low
E-scooter share	Shared micromobility	Low
Motor vehicle speed reduction	Policies and strategies	High
Public transport integration with walking and cycling	Policies and strategies	Low
Road-user pricing	Policies and strategies	High
Car parking cost- on street parking costs	Policies and strategies	Low
Car parking cost- off street taxes and levies	Policies and strategies	Low
E-bike incentive	Policies and strategies	Low
Cycling incentive - e-bike trial	Policies and strategies	Low
Parking cash out scheme	Policies and strategies	Low
Free public transport passes	Policies and strategies	Low
Car share	Policies and strategies	Low
Travel behaviour change programs	Education	Low
School-based interventions - walking programs	Education	Low
School-based interventions - bicycle programs	Education	Low
Ride 2 Work Day / Walk to Work Day / Walk in to Work out	Special events and marketing	Low
Ciclovias	Special events and marketing	Low
PARK(ing) Day	Special events and marketing	Low
Digital platforms and gamification	Special events and marketing	Low

7. Detailed Coverage of Prioritised Interventions

This chapter offers detailed coverage of the prioritised interventions listed earlier in Table 6-1. Each intervention type includes a graphic that identifies how the intervention was categorised in the prioritisation framework, in terms of implementation timeline, geographic context, impact, cost and complexity. For each of these, more stars indicate better performance against these metrics (e.g., three stars for cost indicate low cost). For implementation timeframe, this has been assessed based on the completion of the action, across a metropolitan or township level (rather than the installation of one individual component, such as a single pedestrian crossing).

7.1 Land use planning

Land use planning interventions can create supportive environments for walking and cycling, thereby having the potential to increase active transport mode share. These types of interventions can have large impacts but can take decades to be fully realised in established areas. In greenfield sites, the timelines can be shorter than for established areas.

7.1.1 Transit oriented development and pedestrian oriented development

Transit Oriented Development (TOD) and Pedestrian Oriented Development (POD) emphasise the role of public and active transport in built form and land use. They aim to support intensified development of housing and activity centres around public transport infrastructure. These developments are typified by having lower car ownership but greater transport choice. These principles can also be adopted in growth areas, in situations where there is proximity to quality public transport or centres of activity (either currently or in the future). A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.1.

Figure 7.1: TOD/POD in prioritisation framework

Implementation time	Impact	Cost	Complexity
Decades	★★★	★★★	★

Actions

The following provides some example actions that encompass Transit Oriented Development and Pedestrian Oriented Development interventions:

- Planning system changes to support Transit-Oriented Development, such as higher density and mixed-use development around railway stations and other forms of high-quality public transport.
- Planning system changes to support Pedestrian-Oriented Development near activity centres and other areas in which high levels of walkability are desired.
- Planning system changes to encourage land use mix at a neighbourhood scale.

Evidence base

There is a strong relationship between built form, land use, and active transport levels (Nieuwenhuijsen 2020). An individual's propensity to walk is shaped by numerous factors, including provisions of infrastructure and the diversity of destinations in the surrounding neighbourhood (Kavanagh et al. 2007). Having destinations within a walkable distance of someone's home (measured as 400 metres) is one of the most important factors in how frequently, and for how long, someone walks (Kavanagh et al. 2007). At a macro urban level, higher walking and cycling participation rates are associated with areas that have a higher mixture of land use, better connectivity, and quality walking and cycling networks (Sallis et al. 2015). A study of eight Latin American countries, which undertook an analysis of urban factors found that people living in areas with a high land use diversity are almost twice as likely to walk for transport as people who do not (Ferrari et al. 2020). This relationship was also clear in the Australian Census data that showed suburbs in the inner city have higher levels of walking and cycling, as described in Chapter 2. In Brisbane, people who lived in proximity to an area with a higher land use diversity had a higher rate of using active transport (Yen et al. 2020).

Higher population densities (alongside a higher land use mix, as discussed above) are associated with increased participation in walking (Yang et al. 2022). Interestingly, when population densities increase beyond a certain point, there appears to be a decrease in cycling participation (Yang et al. 2022). It is likely that trip distances become short enough at this point, favouring walking over cycling.

Neighbourhood factors such as density, mix and employment access are most associated with increased participation in active travel (Alexander et al. 2021). School students in California are more likely to walk or cycle to school in areas with higher population density (Braza et al. 2004). The density of intersections on the street network surrounding schools is also associated with increased walking and cycling rates to school (Braza et al. 2004). Intersection density is usually thought to be associated with tighter, more permeable transport networks, which allow for greater flexibility in route choice. This serves to reduce trip distance, which is particularly important in people's decision to use active transport, as walking is highly sensitive to trip distance.

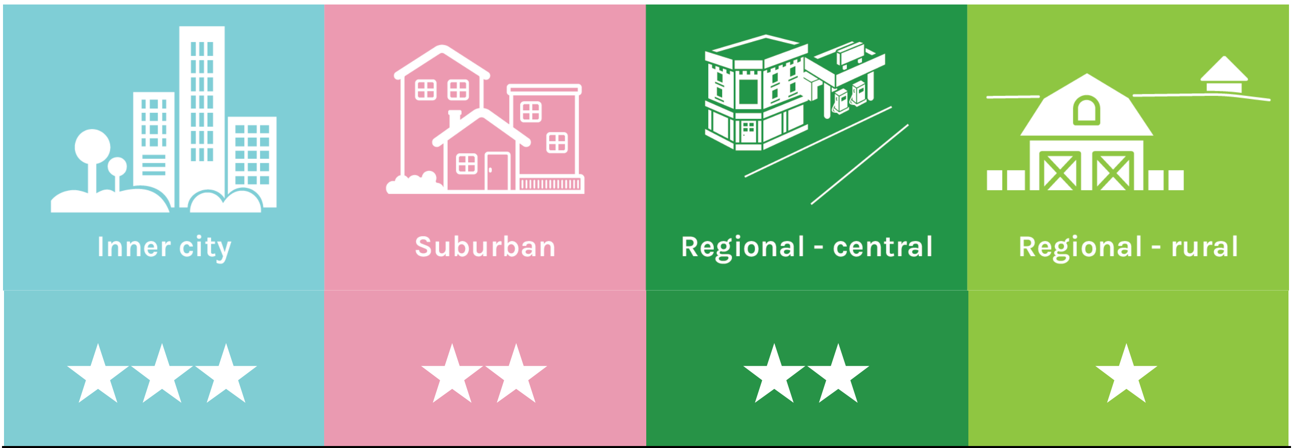
There are a number of tools that can be used to measure walkability. The website Walk Score provides scores from 0 to 100 on the walkability of an area, based on the number of services and amenities within a five to 30-minute walking radius (applying a decay factor to weigh closer services and amenities higher) (Walk Score Methodology 2023). The website also has a score for cycling, based on similar metrics. Another Index, known as LUM (Land Use Mix) developed by Duncan et al. (2010), has been developed using ABS Census Mesh Block data. The LUM Index determines the land mix of an area based on different land uses coded to the Mesh Blocks. The LUM has proved capable of estimating walking participation based on land use (Duncan et al. 2010). Giles-Corti, et al. (2014) also developed a tool to measure walkability. The tool uses three environmental characteristics of street connectivity: residential or dwelling density and land use mix (Giles-Corti et al. 2014).

The above tools can be useful to planners for two reasons. Firstly, they can help identify areas where walking and cycling participation or potential (latent) participation is highest. These areas could support increased population while continuing to support walking and cycling. Secondly, they can be used by planners to understand what land uses are missing from an area, in order to make it more active transport friendly (Duncan et al. 2010). This second use allows planners to be more proactive in supporting walking and cycling in areas with low participation, by increasing land use mix in the way that best supports people to participate in active transport.

7.1.2 Car parking supply in the planning system

Car parking can influence transport choice and as such, can affect active transport mode share. The supply of both off-street and on-street parking can have an impact on travel choices. When car parking is plentiful and low cost, active travel levels are typically low. In cities with very high levels of active transport, such as Copenhagen, Amsterdam, Utrecht, New York City, and London, car parking is generally more expensive and has higher occupancy than cities with lower levels of active transport (e.g., Houston, Christchurch, Adelaide). Planning reforms to reduce rates or parking supply can be an effective technique to support the mode shift to active transport. Due to the long lifespan of buildings, these reforms can have long timelines in established areas, however, these timelines are much shorter in areas of high change. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.2.

Figure 7.2: Car parking supply in the planning system in prioritisation framework



Implementation time	Impact	Cost	Complexity
Years (impacts can be decades)	★★	★★★	★

Actions

The following provides some examples of car parking-related interventions:

- Remove/reduce minimum parking requirements
- Implement maximum parking requirements near public transport and other areas of identified high-transport choice
- Increase requirements for secure bicycle parking in new developments (suggested rate of one bicycle parking space per bedroom for residential)
- Adopt a framework for evaluating whether to maintain on-street parking or reallocate the space to a mode that better serves the strategic objectives of the local government/transport agency etc.

Evidence base

Planning systems in most cities stipulate minimum rates of off-street car parking in developments (Shoup 2011). The amount of off-street car parking often varies based on land use (Shoup 2011). The minimum car parking requirements in planning systems and regulations can result in an oversupply of car parking (Shoup 2011). Research in Australia has found that car parking in new residential developments is over-supplied, relative to demand. A high percentage of bays are empty overnight (De Gruyter et al. 2023). Some apartment buildings in Melbourne have up to 53% of car parks vacant overnight (De Gruyter et al. 2015). Conversely, bicycle parking is typically at capacity, resulting in bicycles being informally parked as a type of ‘overflow’ (De Gruyter et al. 2015).

The supply of off-street car parking is likely to have an effect on mode choice, with developments containing fewer car parks typically having lower car mode shares (and higher active transport mode shares) (De Gruyter et al. 2015). However, there may be self-selection, whereby those who buy dwellings with few car parking spaces do so because they have less demand for them. For example, proximity to quality public transport has been shown to reduce car ownership in Melbourne (De Gruyter et al. 2020). Replacing parking minimums with maximums has led to developers better matching supply and demand in London (Guo and Ren 2013), while a study in Melbourne found replacing minimum parking requirements with maximum parking requirements generally provides a more appropriate level of parking provision (De Gruyter et al. 2021).

> Replacing minimum parking requirements with maximum parking requirements generally provides a more appropriate level of parking provision.

Another aspect of car parking is the effect on car ownership. In Barcelona, it has been found that increasing the number of car spaces that are regulated per 1,000 residents by 1 results in a 0.26 increase in registered vehicles per 1,000 residents (Albalate and Gragera 2020). ’Regulated’ is a term used by the authors to describe spaces that are permitted for special uses, such as resident-only parking, commercial users etc. Similarly, in Amsterdam, having to wait for one extra year for a residential parking permit reduces car ownership by 2% (Groote et al. 2016). Both cases demonstrate the role that the supply of car parking spaces has on car ownership, and that removal of car parking can be an effective way to reduce the number of vehicles in cities.

> Removal of car parking can be an effective way to reduce the number of vehicles in cities.

7.2 Cycling infrastructure

One of the most consistent findings from the field of active travel research is that protection from motor vehicles is an important precondition before most people are willing to consider cycling (Buehler and Pucher 2021). As highlighted previously, potential users prefer greater levels of separation from motor vehicles (Standen 2017). Bicycle paths and protected on-road lanes are preferred over painted on-road lanes, as was shown in Figure 3.4 (CDM Research and ASDF Research 2017). A demonstration of desire for protected lanes and quiet streets can be seen from the research showing that people on bikes are willing to divert a certain distance from their quickest route to maximise their use of paths over on-road painted lanes (Heinen et al. 2010).

> One of the most consistent findings from the field of active transport research is that protection from motor vehicles is an important precondition before most people are willing to consider cycling.

7.2.1 Cycling networks

A growing number of Australasian jurisdictions have developed infrastructure planning frameworks and design guides for the development of user-focused bicycle networks. Many of these newly developed guidance documents are based on the principles developed in the Netherlands. The Dutch *Design Manual for Bicycle Traffic* identifies five network design principles for bicycle planning, shown in Figure 7.3 (CROW 2017).

Figure 7.3: Five network design principles for bicycle planning

Cohesion

A comprehensive network of bicycle routes that connect origin and destination.

Directness

Avoiding circuitous routes and prioritising the shortest practice route possible.

Safety

Facilities that minimise risk of collision with other road users as well as considering issues of personal security.

Comfort

Conditions conducive to the efficient and comfortable to the flow of bicycle traffic.

Attractiveness

Offering routes that are pleasant to cycle.

The application of these principles is considered effective in encouraging a high level of cycling mode share, with the Netherlands consistently rated as having the highest share of trips by bicycle of any nation (Buehler and Pucher 2021).

Actions

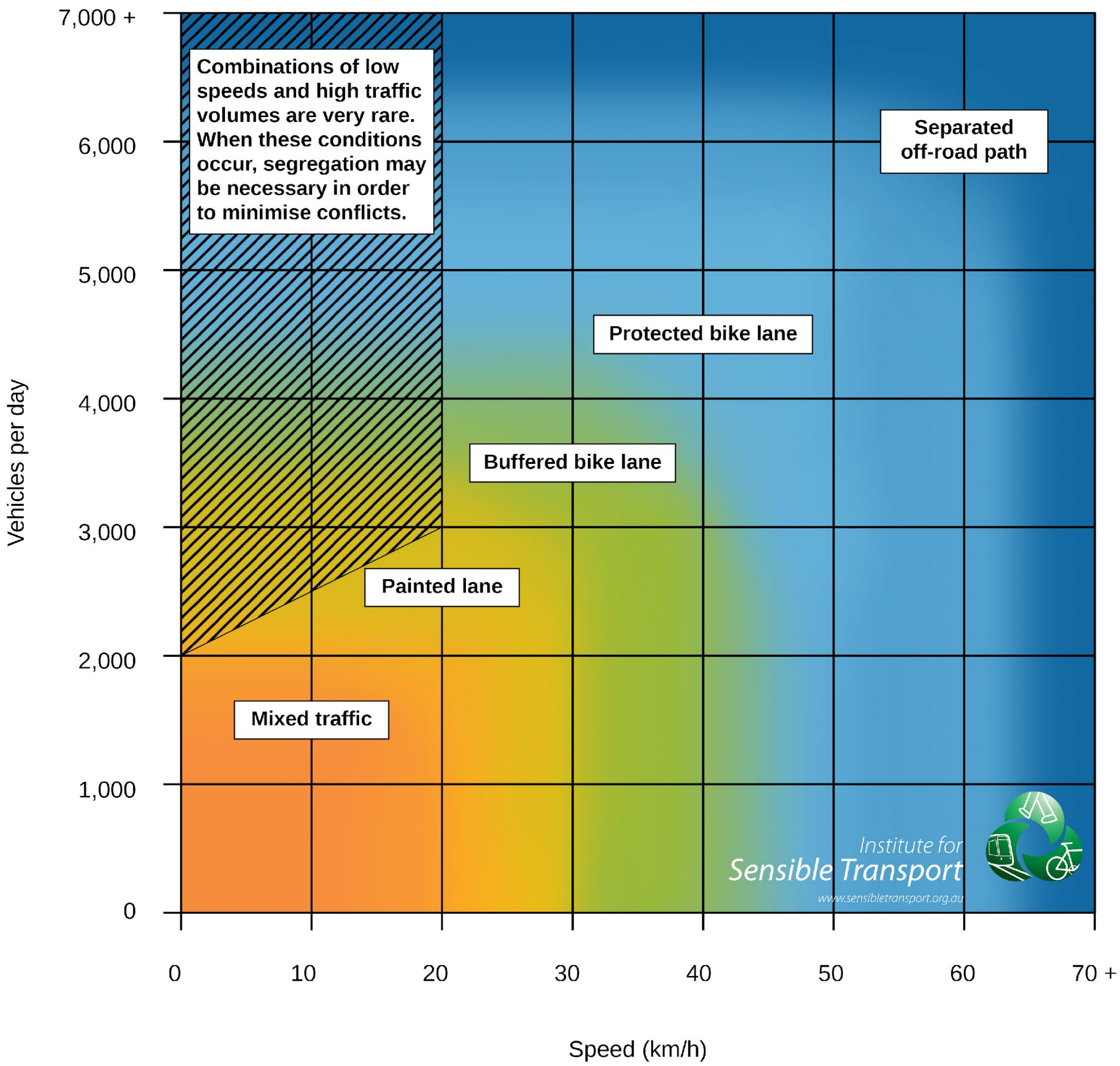
The following provides some example actions that encompass cycling network infrastructure interventions:

- Develop cycling networks that connect residential areas to attractions, including activity centres, employment centres, parks and beaches, and other high-demand attractions.
- Develop cycling networks that support public transport, such as railway stations (see also Section 7.5.1).
- Develop safe, protected, cycling networks around schools.

Appropriate infrastructure for different contexts

There are a variety of different types of bicycle infrastructure. Each has a role to play in creating a coherent network. Figure 7.4 offers a guide to infrastructure selection, based on the speed and volume of motorised traffic. When roads carry large volumes of fast-moving traffic, separated infrastructure is recommended. Quiet streets with low-speed limits may not require any dedicated cycling infrastructure other than some simple wayfinding signage and filtered permeability to discourage motor vehicles through traffic. A brief description of each of the main bicycle infrastructure typologies is provided below.

Figure 7.4: Bicycle infrastructure typology selection guide

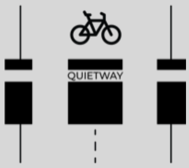
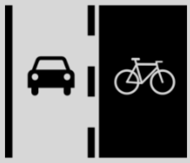


Source: Institute for Sensible Transport

Bicycle infrastructure typologies

There are a wide range of different bicycle infrastructure typologies, the use of which is context specific, and has different space and cost requirements. These are identified in Table 7.1 and discussed in detailed below.

Table 7.1: Bicycle infrastructure typologies

Sharrows	Quietways	Painted	Buffered	Pop-up separated	Separated
					
Cost					
Lower	Lower	Medium	Medium	Higher	Very high
Suitable areas					
Residential streets with low traffic and low cycling volumes and low traffic speeds.	Residential streets with low traffic volumes and speeds. Best when used with modal filters.	Lower volume collector roads with traffic speeds 40 km or below and low activity.	Medium volume collector roads with traffic speeds 40 km or below and moderate activity.	Commercial and retail areas with higher traffic volumes and higher levels of activity, and high-volume roads.	Commercial and retail areas with higher traffic volumes and higher levels of activity, and high-volume roads.
Also consider modal filters					
Mixed with traffic		**Dedicated lanes**		**Protected lane or right of way**	

Mixed traffic – Sharrows

Sharrows involve the placing of bicycle symbols with two chevrons above painted onto the road surface. Sharrows are designed to remind motorists that cyclists are allowed to use the road space, and motorists must share the space with them. They are only suitable in streets with low traffic volume and speed.

Filtered permeability, modal filters and quietways

Filtered permeability and quietways refer to a design strategy that limits the through-traffic of motor vehicles in certain areas, while allowing cyclists and pedestrians to use the same space with relative ease. This is a form of mixed-traffic cycling environment that can provide maximum benefits to all users. This is typically achieved using barriers, bollards or other street furniture to create a network of low-traffic or traffic-free streets that are more accessible and attractive to cyclists and pedestrians (see Figure 7.5). This approach can help to create a more pleasant and safer environment for active transport users.

Figure 7.5: Filtered permeability example (1)

Source: Institute for Sensible Transport

Filtered permeability design can also be used with other forms of bicycle infrastructure. Figure 7.6 provides an illustration of a filtered permeability design combined with a buffered painted bicycle lane (discussed below). This image, from Canning Street, Melbourne contains modal filters (visible in the mid-ground), preventing motor vehicles from using the street as a thoroughfare. Some designs also include retractable bollards, to enable emergency service vehicles to gain street access via the use of a transponder.

Figure 7.6: **Filtered permeability example (2)**

Source: Institute for Sensible Transport

Painted bicycle lanes

A painted bicycle lane is a designated space on the road, marked with paint, that is reserved for people on bikes. Painted bicycle lanes began to be installed on streets in Australasia in the early 1990s and helped to demarcate a space for riding. As highlighted earlier, research with potential users has found that painted bicycle lanes do not boost riding confidence levels to the degree that physically (vertically) protected bicycle lanes do (CDM Research and ASDF Research 2017). This was highlighted earlier, in Figure 3.4. Furthermore, females are generally more sensitive to the riding environment and more concerned about riding on roads without physical separation from motor vehicle traffic (Heesch et al. 2012).

Protected bike lanes

Protected bike lanes offer full separation from motor vehicle traffic. They are also known as *vertically protected bike lanes*. These include features that are implemented vertically along the road, such as bollards, traffic dividers, garden boxes etc. They can be located on road, as protected kerbside lanes, bi-directional on one side of the road, or completely separated from the road on an adjacent path. Only cyclists and other forms of micromobility may use protected bike lanes, which differentiates them from shared paths (which can be used by pedestrians).

The first protected bicycle lane in New Zealand was installed on Ilam Road in Christchurch, and completed in 2013. The project's primary goal was to increase pedestrians' safety along a key corridor to the University of Canterbury. Figure 7.7 provides a comparison of what Ilam Road looked like before and after installation of bicycle infrastructure.

Figure 7.7: Ilam Road before and after bicycle infrastructure was installed

Source: Waka Kotahi NZ Transport Agency (2013)

Pop-up bike lanes

Pop-up bicycle lanes are fast build separated bicycle infrastructure. During COVID-19, many state and local governments began to invest in pop up lanes, as trials. Their key advantage is the speed with which they can be rolled out, the significantly lower cost of installation, as well as their adaptability. Detailed case studies of pop-up bike lanes in Melbourne, Sydney, Paris and New Zealand are provided on pages 72 to 84 of this report.

Intersection treatments for cyclists

Intersections present a disproportionate level of risk to people on bicycles, even with bicycle lanes, compared to mid-block sections (Hull and O'Holleran 2014). In instances in which active transport users are the priority at intersections, the safety outcome is positive (CROW, 2016). Indeed, the Dutch *Design Manual for Bicycle Traffic* contains a section on intersection design to minimise risk, as do other leading design manuals, such as those produced by National Association of City Transportation Officials (NACTO).

Evidence base

This section provides an overview of the evidence for bicycle infrastructure's impact on increasing mode share, and safety. Bicycle lanes are one of the most effective means both to increase cycling participation and reduce real and perceived risk of collision (Fishman et al. 2012; Morrison et al. 2019). Not all types of bicycle infrastructure offer the same level of safety or ridership benefit. Research has found that *'sharrows'* are less effective than dedicated space (Wall et al. 2016), such as a protected bicycle lane. However, as highlighted in Figure 7.4, on streets with low traffic volumes and speeds, separation is not required.

Bicycle infrastructure's impact on attracting people to cycle

Figure 7.8 provides a snapshot of the different types of bicycle lane, with those on the right generally considered to offer more comfort to the user.

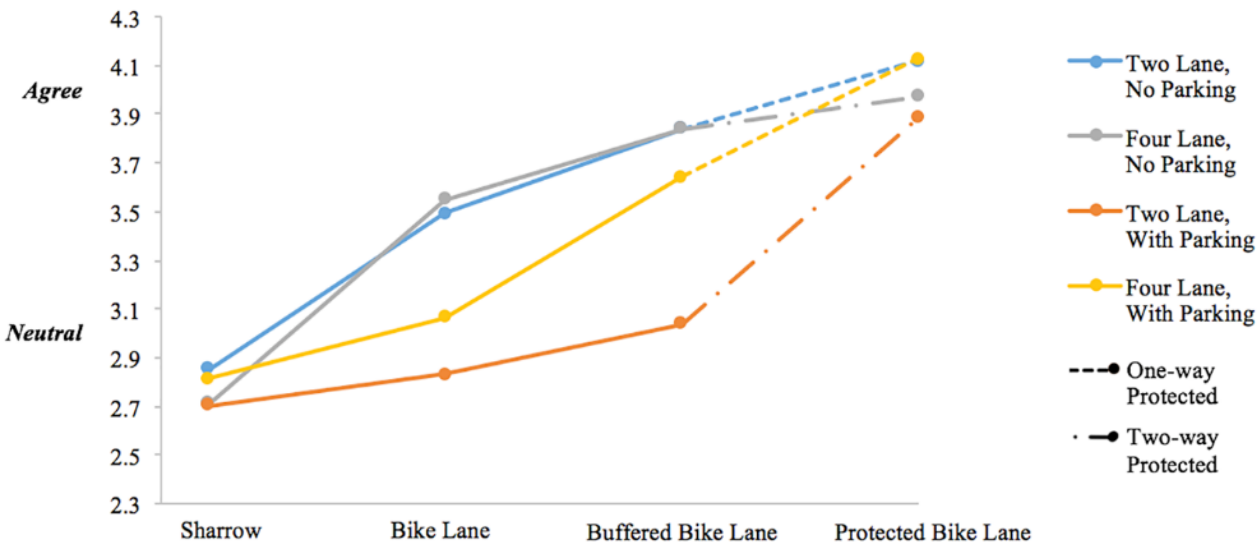
Figure 7.8: Different types of bicycle lanes

Source: City of Boston

Filtered permeability is among the most effective methods to grow active transport mode share (Kuss and Nicholas 2022). The introduction of filtered permeability and quietways emerged as among the most consistent themes from the subject matter expert interviews.

Participants in a study with over 1,000 individuals, in six communities with low rates of cycling (Alabama and Tennessee, US), were shown a series of images of different riding environments and asked to provide feedback (Clark et al. 2019). The different road typologies were very similar to road designs typical of Australasian cities and towns. These included riding on sharrows, painted bike lanes with and without kerbside parking, buffered lanes and protected lanes. Regression analysis modelling revealed a preference for bike infrastructure that is separated from motorised traffic. A scale of 1 being *strongly disagree* to 5 being *strongly agree* (to their inclination to use these facilities) was used. The results were presented in terms of *comfort*, *safety*, and *willingness to try*, and all broadly demonstrate the same pattern: the greater the level of protection, the more comfortable, safe and willing to try the participants say they would be. Figure 7.9 presents the results to the question of how *comfortable* respondents say they'd feel riding in the different environments presented. The results closely align with the findings of an Australian study that used a very similar methodology, the results of which were presented in Figure 2.4. Similarly, a Sydney-based study found that cycling becomes more attractive when low-stress facilities are offered (Standen 2017).

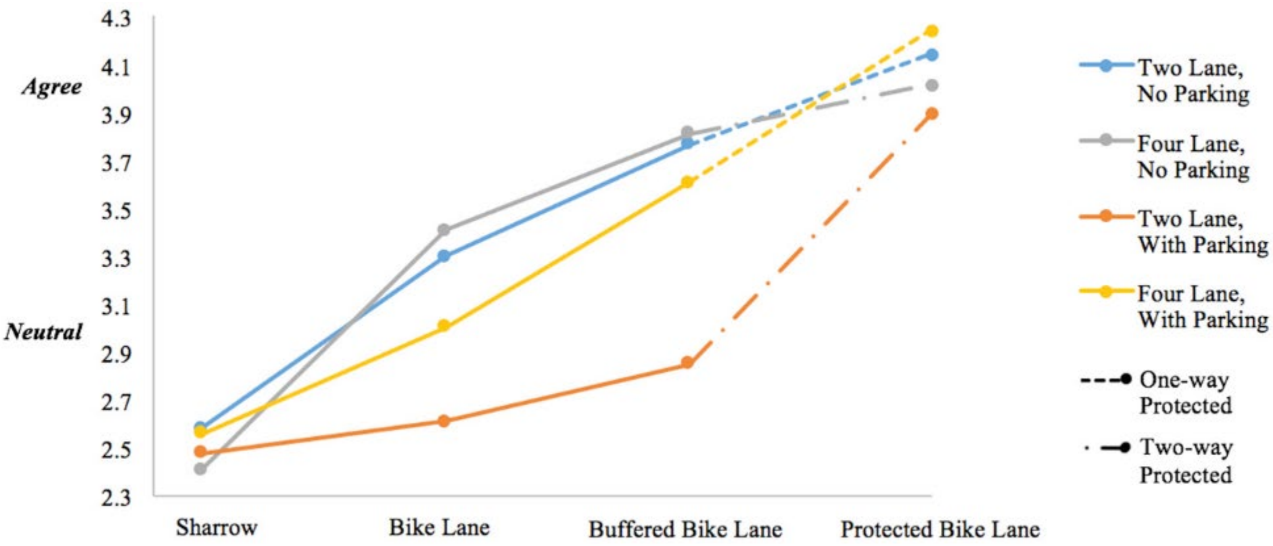
Figure 7.9: Comfort levels for different riding environments



Source: Clark et al. (2019)

Figure 7.10 presents the results for the perceived *safety* levels riding in different environments. The general, consistent trend is for people to feel safer on infrastructure with greater levels of separation from motor vehicles.

Figure 7.10: Perceived safety levels for different riding environments

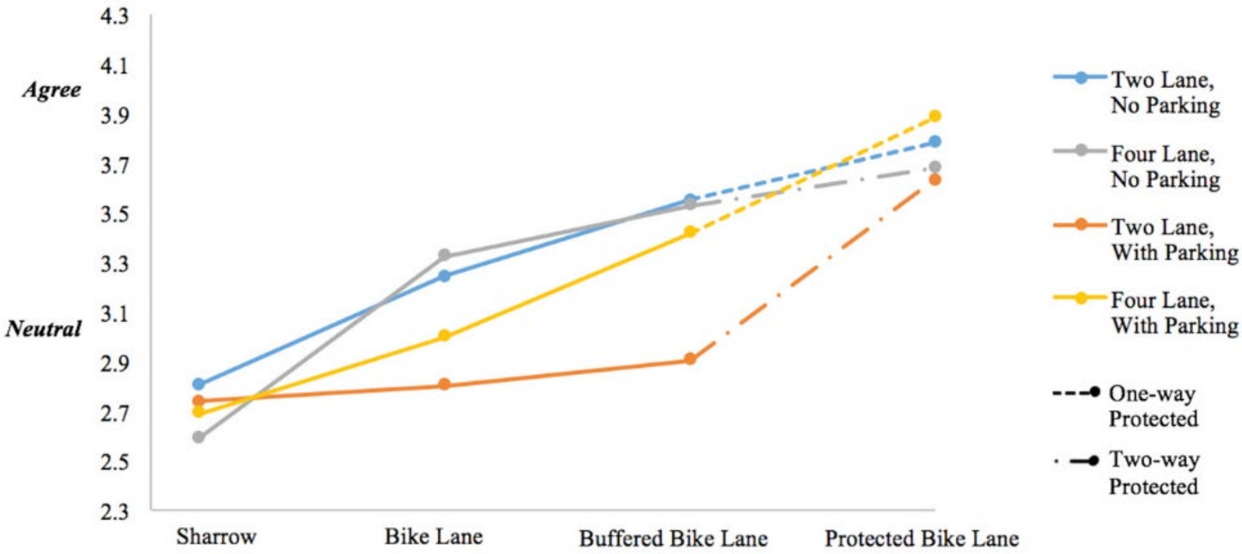


Source: Clark et al. (2019)

For busy streets, the evidence shows a consistent trend in which people feel safer on infrastructure with greater levels of separation from motor vehicles.

Finally, Figure 7.11 presents the results of how *willing to try* respondents say they would be when presented with the different riding environments. Again, the general pattern remains the same, with protected lanes having the highest levels of *willingness to try*. The results of this study are directly relevant to the objectives of the current project because they provide an indication, from car-dependent communities, of the degree to which various road designs can transfer trips from motor vehicles to bicycles. While there are other factors to consider, such as trip distance, topography and weather, it is clear that separation from motor vehicle traffic is an important requirement before a significant proportion of the (non-cycling) population will be willing to consider cycling.

Figure 7.11: Willingness to try for each type of riding environment



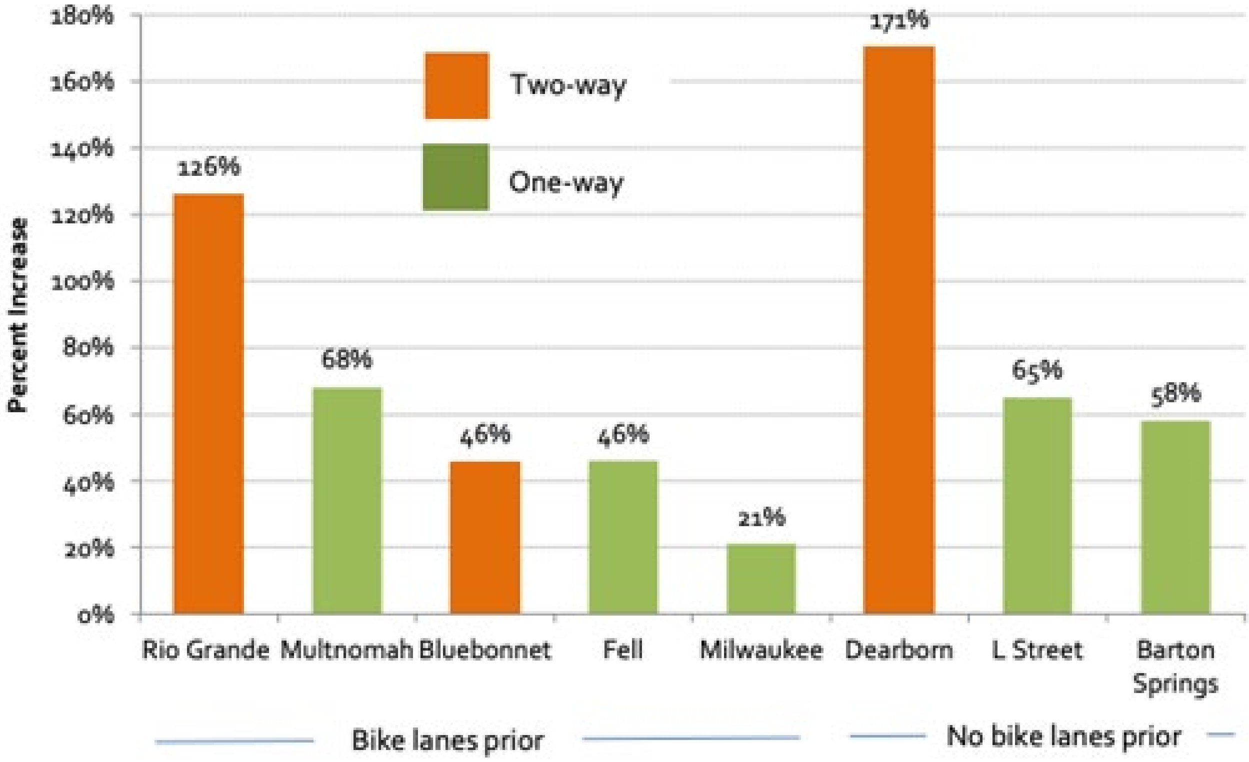
Source: Clark et al. (2019)

The presence of kerbside car parking was also shown to detract from people's perceived safety levels while cycling. Ultimately, the results of Clark et al.'s (2019) study are highly relevant to the objectives of this project and highlight that cycling mode share may not increase significantly without a greater provision of connected networks of bicycle infrastructure that satisfy people's desire for physical separation.

Research across five U.S. cities with protected bicycle lanes found cycling increased by between 21% to 171% following the installation of the lanes (results shown in Figure 7.12) (Monsere et al. 2014). Users were asked how they would have travelled had the protected bicycle lane not been built (results shown in Figure 7.13). These data were collected via direct intercept surveys with users of the protected bicycle lanes. Some of this increase is from *diverted* cyclists (i.e., they were cycling before, by diverting their route due to the higher level of service the protected infrastructure affords). Around 25% of respondents indicated they cycled more since the installation of the protected bicycle lanes, and this was more pronounced for women. Two-thirds of residents said they would be more inclined to ride if protected lanes were more prevalent.

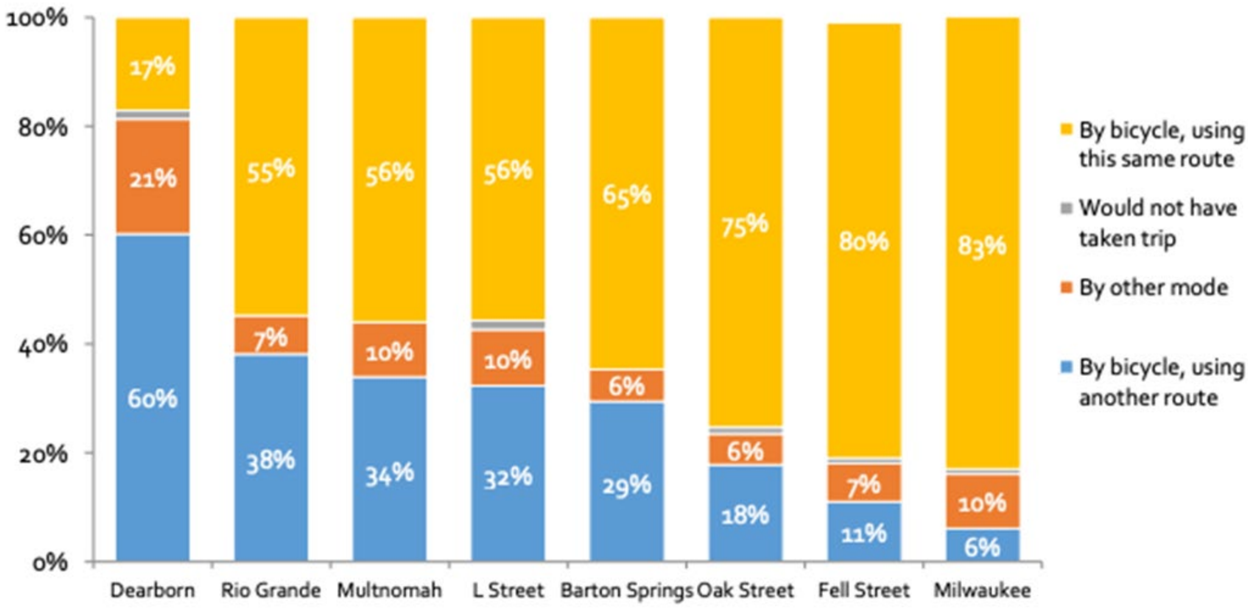
Two-thirds of residents said they would be more inclined to ride if protected lanes were more prevalent.

Figure 7.12: Changes in observed bicycle volumes



Source: Monsere et al. (2014)

Figure 7.13: Before the new facility was built, how would you have made this trip?



Source: Monsere et al. (2014)

Similarly, people living within 3 km of a new 2.4 km bi-directional protected cycleway that was built through Sydney's inner-city suburbs of Redfern and Waterloo were found to increase their cycling participation (Crane et al. 2017).

While all the projects evaluated involved bicycle lanes with vertical protection, there was a considerable degree of variation in the increase in cycling that occurred as a result of the protected bicycle lanes (Monsere et al. 2014). This highlights an important finding: the extent to which cycling increases depends on the context. How well the infrastructure joins up with the wider network, the land use mix and density of the surrounding suburbs, as well as the corridor's connection with key trip generators will all influence the change in cycling that can be expected due to the infrastructure. For these reasons, it is not possible to arrive at a generic metric of 'boost rate' associated with the installation of a protected bicycle lane.

Filtered permeability has also been found to be a critical element in increasing cycling mode share. All cities with high levels of cycling have filtered permeability (Savaria et al. 2021). One of the main reasons filtered permeability is effective at increasing cycling mode share and reducing motor vehicle mode share is because it can increase the relative value proposition cycling offers (Savaria et al. 2021). A city with a widespread network of streets that employ filtered permeability will be able to offer bicycle journeys that are both faster than the motor vehicle and safer, compared to if filtered permeability had not been employed. A cyclist in a city in Europe will, on average, have a freedom of movement that is 44% greater than a motorist, as a consequence of filtered permeability (Savaria et al. 2021). This has a direct impact on travel time competitiveness and cycling mode share.

Finally, it is important to highlight that in many cases, the space required for protected bicycle lanes will need to be taken from another mode. In many urban areas, there are competing demands on a finite street width. It is common for streets to use kerbside space for on-street parking. In many cases, the most practical place to install a protected bicycle lane is along the kerbside. The subject matter expert interviews highlighted that targeted interventions that reallocate on-road space from car parking to bike lanes were one of the most potent interventions used to stimulate cycling and reduce road traffic risk. Indeed, on-street car parking supply reductions is one of the most widely adopted interventions in cities with high levels of cycling.

Bicycle infrastructure's impact on safety

The risk of injury while cycling varies depending on the type of bicycle infrastructure. A comprehensive Canadian study compared 14 different infrastructure types (Teschke et al. 2012). Fully separated bicycle infrastructure was safest, with the adjusted odds ratio of 0.11 (i.e., about nine times safer), compared to a referent of a *street with parked cars and no bike infrastructure* (see Table 7.2 for full results).

Table 7.2: Route types and injury risk

Variable	No. Injury Sites/No. Control Sites	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Major street route, parked cars[a]			
No bike infrastructure	155/114	1.00 (Ref)	1.00 (Ref)
Shared lane	9/7	0.78 (0.25, 2.41)	0.71 (0.21, 2.45)
Bike lane	25/28	0.53 (0.26, 1.07)	0.69 (0.32, 1.48)
Major street route, no parked cars			
No bike infrastructure	112/118	0.65* (0.44, 0.97)	0.63* (0.41, 0.96)
Shared lane	13/12	0.66 (0.24, 1.82)	0.60 (0.21, 1.72)
Bike lane	35/46	0.47* (0.26, 0.83)	0.54 (0.29, 1.01)
Local street route			
No bike infrastructure	89/116	0.44* (0.28, 0.70)	0.51* (0.31, 0.84)
Designated bike route	52/57	0.53* (0.30, 0.94)	0.49* (0.26, 0.90)
Designated bike route with traffic calming	49/47	0.59 (0.32, 1.07)	0.66 (0.35, 1.26)
Off-street route			
Sidewalk or other pedestrian path	52/47	0.73 (0.42, 1.28)	0.87 (0.47, 1.58)
Multiuse path, paved	64/56	0.75 (0.42, 1.34)	0.79 (0.43, 1.48)
Multiuse path, unpaved	12/11	0.63 (0.21, 1.85)	0.73 (0.23, 2.28)
Bike path	21/21	0.54 (0.20, 1.45)	0.59 (0.20, 1.76)
Cycle track	2/10	0.12* (0.03, 0.60)	0.11* (0.02, 0.54)
Grade, degree			
0 (flat)	245/312	1.00 (Ref)	1.00 (Ref)
< 0 (downhill)	333/231	2.13* (1.61, 2.81)	2.32* (1.72, 3.13)
> 0 (uphill)	112/147	1.07 (0.76, 1.50)	1.13 (0.79, 1.63)
Streetcar or train tracks			
No	540/592	1.00 (Ref)	1.00 (Ref)
Yes	150/98	3.48* (2.14, 5.65)	3.04* (1.80, 5.11)
Construction			
No	605/644	1.00 (Ref)	1.00 (Ref)
Yes	85/46	2.05* (1.39, 3.04)	1.93* (1.27, 2.94)

Note. CI = confidence interval; OR = odds ratio. Analysis was performed via logistic regression, conditional on participant injury trip, for each variable separately and in a multiple logistic regression model.
[a]Parked cars on the cyclist's side of the street.
**P* <.05.

Source: Teschke et al. (2012)

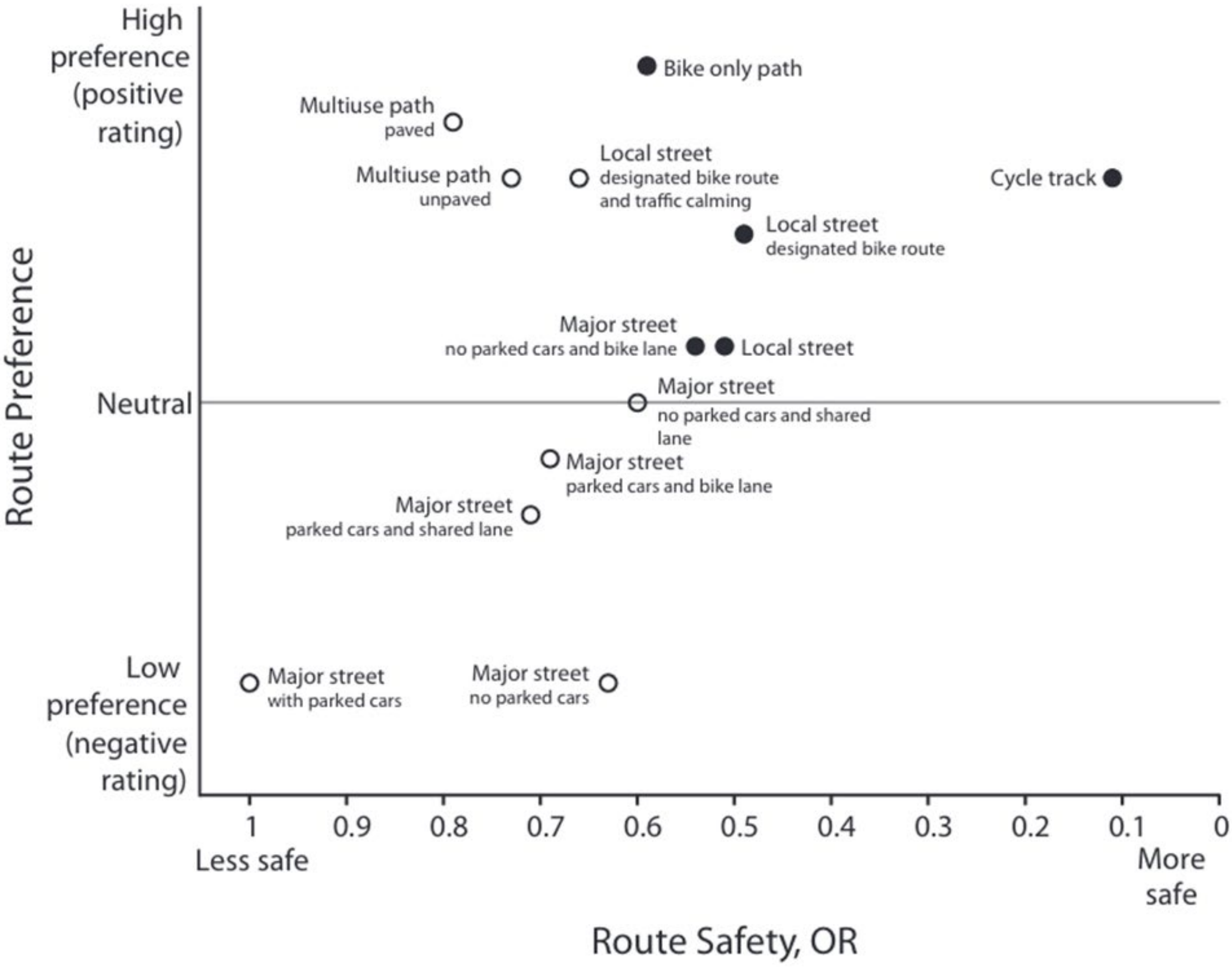
Quietways (low motor vehicle traffic, low volume streets) have been found to lower crash risk, compared to busy streets without bicycle infrastructure (Teschke et al. 2012). Using a modal filter on a small residential street has been found to prevent motor vehicle through traffic, resulting in a 90% reduction in car traffic and an increase in active travel volumes (39% increase in pedestrian volumes and 19% for cyclists) and user satisfaction (Aldred and Croft 2019).

The safety impact of painted bicycle lanes is lower than protected bicycle lanes (assuming the same number of motor vehicles use the street). Despite painted bicycle lanes failing to provide the levels of perceived and actual safety of protected bicycle lanes, they can improve safety when compared to riding in mixed traffic, which may lead to higher cycling levels (Ferrari et al. 2020; Garrett et al. 2012). It is important to highlight that while often preferred to having no bicycle infrastructure at all, there are also some safety issues associated with painted bicycle lanes that need to be considered. Firstly, conflicts with turning vehicles may arise. In some cases, painted bicycle lanes end just prior to an intersection. This can lead to left-turning vehicles colliding with a bicycle (Nicholls et al. 2017). To mitigate this risk, bicycle lanes should continue through the intersection, and painting the full width of the bicycle lane through the intersection can enhance compliance (Johnson et al. 2010) and reduce crash risk. The second issue impacting on the safety of painted bicycle lanes relates to ‘dooring’. This describes a collision in which a driver/occupant of a parked car opens the vehicle’s door, into the path of an oncoming cyclist. This can be a safety hazard, sometimes resulting in serious injury or fatality. It is particularly a risk on streets in which there is a high turnover of parked vehicles (e.g. shopping strips). To prevent dooring incidents, cycle lanes should be positioned away from parked cars, or have a buffer zone to provide a safety margin.

Comparing safety and route preference

There is a relationship between actual levels of safety and route preference. Figure 7.14 presents the results of research conducted in Vancouver and Toronto (Teschke et al. 2012), which combined injury data and route preference information. The road type that was least favoured, and least safe was a *major street with parked cars*. This is of particular relevance to the Australasian context as most major arterial roads have parking and lack protected bicycle infrastructure.

Figure 7.14: Comparing route safety and preference



Source. Route preference data from 2006 Metro Vancouver opinion survey.[24]

Note. OR = odds ratio. Closed circles represent route types with positive preference rating and adjusted injury OR < 0.6 (safest route types). Open circles represent route types with negative or neutral preference rating or adjusted injury OR ≥ 0.6. "Sidewalk or other pedestrian path" was not included because this route type was not queried in the preference survey. ORs for injury risk are plotted in reverse order.

Source: Teschke et al. (2012)

Case study – VicRoads Melbourne pop-up bike lanes program, 2020 – onwards

Following a surge of cyclists in 2020 from the COVID-19 pandemic, the Victorian government announced a $15.9 million investment to deliver improved cycling by rolling out 100 kilometres of pop-up bike lanes across inner Melbourne. VicRoads (2022) is responsible for delivering this initiative and has partnered with local councils to plan and roll out pop-up bike routes in the local government areas of Maribyrnong, Moonee Valley, Darebin, Yarra, and Port Phillip. Figure 7.15 provides an illustration of the first pop-up bike lane delivered as part of the VicRoads project, on Heidelberg Road in the inner north of Melbourne.

Figure 7.15: Pop up bike lanes, Melbourne

Source: VicRoads

The project aims to support safer, more accessible cycling to help relieve congestion on the transport network using a combination of temporary infrastructure including pop-up bike lanes on busy roads using bollards and line markings, improved signage and new markings along quieter streets, and improved connections between on-road and off-road bike networks.

Key routes and gaps in the network expected to be completed through this program include:

- City of Port Phillip – pop-up bike routes
- Darebin and Yarra Connectors/ St Georges Road Off-road Routes
- Footscray Pop-up Links
- Heidelberg Road Link
- Moonee Ponds – pop-up bike routes.

This temporary infrastructure will be installed for up to 12 to 18 months, during which community feedback and monitoring will help to determine whether they are converted to permanent routes, re-designed or removed.

As the project is ongoing, the total impact of the pop-up bike lanes cannot be fully assessed at the time of writing. However, community feedback and monitoring have delivered some positive results as well as highlighted areas for improvement.

The pop-up bike routes on the Heidelberg Road Link fixed a primary gap in the network connecting inner metropolitan northern suburbs to the Melbourne CBD. This link makes it safer and provides more direct connections for over 80,000 residents who live within close proximity of the corridor. It also provides improved bike connections to public transport for residents along the Hurstbridge metropolitan train line. Monitoring found average weekly riders increased steadily from approximately 5,000 to 6,000 riders per week following the installation of the pop-up bike lanes. Ridership growth on the Heidelberg Road Link was reported over two months. In addition, female ridership almost doubled, increasing from 16% to 30% of riders. Observations also indicated more children and families are cycling on roads with pop-up infrastructure.

> On the Heidelberg Road Link, female ridership increased from 16% to 30% of riders. Average weekly riders increased from approximately 5,000 to 6,000 riders per week.

In Port Phillip, Heidelberg and Footscray, there were several requests to make pop-up bike routes permanent with more separated bike lanes and increased visual amenities. There were also requests to continue to fill gaps in the network with improved access to destinations like schools, parks, and villages.

While users across the wider community commented feeling safer on roads, there are calls for further design treatments to improve bike rider visibility through green surface treatment, adjusting bollard placements and updated signage on the approach to pop-up bike lanes. Furthermore, users requested greater prioritisation for bike riders and pedestrians at intersections. Some residents and local businesses expressed concerns about increased traffic conflicts, parking changes and traffic congestion where pop-up bike lane infrastructure has altered turn lane conditions or has removed a car lane. A significant number of proposed designs and some implemented infrastructure was withdrawn due to opposition from some within the community.

Case study – Sydney Pop Up Cycleways, 2020 - 2021

In 2020, Transport for NSW (TfNSW) (2023) partnered with the City of Sydney to improve cycling access to the Sydney CBD by installing low-cost, temporary bike lanes as part of the NSW government response to COVID-19. The project aimed to give people increased transport choices and provide a safe alternative to driving or catching public transport. Figure 7.16 illustrates the pop-up design implemented in Pitt Street, Sydney.

TfNSW and the City of Sydney delivered approximately 7.6 kilometres of pop-up bike lanes using painted markings, divider barriers, flexible posts, and temporary kerbs on:

- Pyrmont Bridge Road
- Pitt Street
- Moore Park Road and Fitzroy Street
- Bridge Street, Railway Parade and Henderson Road
- Sydney Park Road
- Dunning Avenue.

Figure 7.16: Pitt Street cycleway

Source: City of Sydney

In addition to the installation of pop-up bicycle infrastructure, speed limits were also reduced, to support safer streets and encourage more people to ride.

Over the course of the trial period, the City of Sydney (n.d.) recorded more than 700,000 trips along the pop-up bike routes. The Pitt Street pop-up demonstrated strong patronage growth with approximately 6,000 trips per week, a 500% increase. Between August 2020 and March 2021, Pitt Street saw more cyclists than the Sydney Harbour Bridge, the city's most established cycling path. Before the pop-up bike lanes, around 89% of people riding a bicycle on Pitt Street were cycling on the footpath.

> The Pitt Street pop up demonstrated strong patronage growth with approximately 6,000 trips per week, a 500% increase.

Similarly, the pop-up bike route on Bridge Street, Railway Parade and Henderson Road saw the number of bike trips increase by more than 30%, with an average of 2,900 trips per week (Bicycle Network, 2021). Furthermore, a survey of pop-up bike lane users found that perceived safety has also improved, with over 90% of respondents reporting they feel safer riding on separated bike lanes.

> …a survey of pop-up bike lane users found perceived safety has also improved, with over 90% of respondents reporting they feel safer riding on separated bike lanes.

Road space changes—such as the removal of kerbside parking for pop-up bike lanes and parklets and the widening of footpaths—provided additional benefits and significantly enhanced the amenity for pedestrians and reduced crowding in high-foot traffic areas. Much of the material reviewed within the peer-reviewed literature, as well as the subject matter expert interviews, identified this type of approach as being amongst the most impactful in terms of increasing active transport mode share. This is because it effectively combines *encouragements* and *discouragements* to simultaneously make cycling safer and more attractive, while also restricting the ease with which people can travel by motor vehicle.

At the conclusion of the trial period in 2021, TfNSW (2023) announced that all except the pop-up bike lanes on Dunning Avenue and Moore Park Road will be made permanent.

Table 7.3 presents a concise overview of the official evaluations conducted on the Sydney pop-up bike lanes. The material is largely reproduced from the City of Sydney evaluation. These temporary cycleways have demonstrated notable success in enhancing safety measures and promoting greater female participation in cycling.

Table 7.3: Summary of official evaluation of Sydney pop up bike lanes

Project	Length (km)	Infrastructure typology	User satisfaction	Cost	Changes in ridership
Sydney Park Rd pop-up cycleway	500 metres	Bi-directional pop-up cycleway (3.2 metre wide bi-directional cycleway on northern side, 2 travel lanes Westbound and 1 travel lane Eastbound. 40 km/h posted speed limit.)	Previously, the majority of people (67%), rode their bikes on the shared path. However, according to a survey of individuals who used the temporary cycleway, their perceived safety has significantly improved. Specifically, 96% of those surveyed felt safe or very safe using the separated cycleway, and all respondents reported feeling safer than before. Most community feedback has been positive, although some negative feedback has focused on the reduced number of lanes and slower traffic. These changes were intended to create a safer environment for people to walk and ride their bikes, particularly in light of the high residential density and major green space served by the cycleway. An intercept survey found that 96% of respondents felt safe, and 100% felt safer than before. As a result of the cycleway, there has been a small increase in the percentage of women walking on the shared path and riding on the cycleway. The diversity split of bicycle riders ranges between 25% to 50% female. Additionally, the cycleway has provided increased space for people to walk on the shared path, which was previously dominated by bicycle riders (67% on shared path versus 33% on the road).	The pop-up cost 20% of traditional construction methods. Construction of the pop-up took four weeks, verses eight months for a permanent cycleway.	During the first three months of its operation, from July 2020 to November 2020, the number of bike trips increased by 10%, reaching over 1,300 weekly trips. However, in March 2021, the number of bike trips decreased to approximately 910 weekly trips. Although there has been a slight decrease in ridership over the 6-month period since the cycleway opened, it is important to note that the Sydney Park Road pop-up cycleway fills a gap in the cycleway network between the inner west and the Sydney CBD south. To enhance the attractiveness and coherence of the facility, it is recommended that further improvements be made, such as improving wayfinding and increasing the buffer between the pop-up cycleway and the adjacent travel lane. There was a 14% increase in ridership between the first and twelfth weeks, with an average weekly usage of approximately 1,030 trips. Evaluation can be difficult during a period in which many people continue to work from home.
Pitt St pop-up cycleway	800 metres	Bi-directional pop-up cycleway	According to a survey conducted among users of the pop-up cycleway, almost all (97%) respondents felt safer riding on the separated cycleway. Most of the feedback from the community has been positive and supportive of the cycleways, with people expressing satisfaction about feeling safer while cycling and the creation of more space for pedestrians (now that cyclists don't occupy the footpath). However, some negative feedback centred around the removal of on-street parking and loading areas.	The pop-up project was constructed and installed within two months and cost 8% of what a permanent project would cost. In comparison, a permanent project would take eight months to complete.	After the opening of the cycleway for two-way travel, there has been an increase of 50% in the number of weekly bike trips, averaging around 6,000 weekly trips. The users of the cycleway are diverse and consist of people who use it for commuting, delivery riders for food and parcels, and approximately 20% of the observed riders are women, which is higher than the average for Sydney.

Project	Length (km)	Infrastructure typology	User satisfaction	Cost	Changes in ridership
Moore Park Rd pop-up cycleway	1 kilometre	Bi-directional pop-up cycleway	A survey of the temporary cycleway revealed that their perceived sense of safety has increased significantly. Some 94% of respondents considered the pop-up cycleway to be safer than the previous condition. Additionally, 98% of the 100 respondents in an intercept survey reported feeling safe or very safe on Moore Park Road, with 90% indicating that it was safer than the previous road conditions. The City of Sydney received a total of 194 submissions regarding the project, with the majority of submissions from the local community (62%) expressing negative feedback. Out of the 160 submissions sent directly to the Lord Mayor or CEO, the majority (87%) were negative as well. People who provided negative feedback cited a lack of consultation, loss of parking, and reduced accessibility.	It cost only 2% of the traditional permanent project costs and took only two months to complete, while a permanent scheme typically takes around three years to be implemented.	After the initial week of its opening, the weekly number of bicycle trips has risen by 16%, reaching an average of more than 2,100 trips per week. Moreover, the proportion of female riders has increased and now ranges between 20-55% in comparison to male riders.
Henderson Rd pop-up cycleway	1.2 km: 600m on Henderson Rd (Mitchell Rd to Park St), 350m on Railway Pde (Park St to Erskineville Rd), and 240m on Bridge St (Erskineville Rd to Ashmore St).	Bi-directional pop-up cycleway	According to an intercept survey, 92% of the respondents reported feeling safe while using the pop-up cycleway, with 62% of them indicating that they feel very safe. Additionally, 90% of the survey respondents believed that the temporary cycleway is safer than the previous conditions, with 78% of them reporting that they felt much safer. A survey conducted among the users of the temporary cycleway revealed that their perceived sense of safety has also improved, with more than 90% of the respondents indicating that they feel safer riding on the separated cycleway. Currently, the proportion of women riding a bicycle varies from 20% to 45%.	20% of permanent project cost 6 weeks to construct and install compared to 8 months permanent project (20% of construction time).	Following its opening in July 2020, the pop-up cycleway has witnessed a 35% increase in the number of bike trips per week, reaching an average of 2,400 trips. Additionally, there has been a 10% increase in the proportion of women riding bikes.

Project	Length (km)	Infrastructure typology	User satisfaction	Cost	Changes in ridership
Fitzroy St pop-up cycleway	320 metres between Flinders Street and Bourke Street, Surry Hills.	Bi-directional separated pop-up cycleway (3.2 metre wide)	According to an intercept survey, 89% of the respondents (n=100) felt safe or very safe, with nine out of ten people considering it to be safer than the previous road conditions. Additionally, 85% of the respondents preferred riding on the pop-up cycleway instead of using the footpath. A phone survey conducted in the City of Sydney with 600 participants, including 200 local residents and 400 residents of surrounding LGAs, revealed that 71% of the respondents support creating more space for cycling and providing a separated cycleway. The survey found that the level of support for making more space for people to ride was high, particularly among City of Sydney residents. There were 80 submissions received by the Sydney Your Say regarding Fitzroy Street from the local community, with 57% of them being negative. Most of the negative feedback reported a lack of consultation, the closure of the bus stop, the motor vehicle traffic from Flinders Street, and the design of the cycleway connection to the Bourke Street cycleway.	Pop-up project cost 14% of permanent project cost, two months to construct and install compared to up to eight months for a permanent project.	The average weekly usage of the pop-up cycleway is 2,327, which is 7% more than the usage in the first week. According to a survey of 100 riders, 87% of them intend to ride at least weekly in the future, compared to 61% before the pop-up cycleway was introduced. Since the opening of the cycleway in August 2020, the average weekly usage has increased by 15% and is now over 2,500 trips per week. Furthermore, the proportion of women riding on the cycleway has increased and varies from 25% to 55% in the female to male gender split.
Dunning Avenue pop-up cycleway	1.4 kilometres	Pop-up cycleway	According to an intercept survey of 50 people, 66% of respondents said they felt safe or very safe on Dunning Ave, and 63% believed that it was safer than the previous road conditions. These figures are the lowest among all the pop-up cycleways. Furthermore, when asked about the width of the cycleway, 58% of riders thought it was not wide enough. In a random survey conducted in the City of Sydney local government area, 71% of participants supported the idea of making more space for cycling and providing a separated cycleway. In contrast, there were 260 submissions made by the local community to the Sydney Your Say, and 82% of these were negative about the Dunning Ave project. Additionally, eight submissions that were sent directly to the Lord Mayor or CEO were also negative. Issues raised in these submissions included the narrow width of the street, vehicle parking and movement on the street, and the perception that the cycleway was not necessary.	The pop-up cycleway was 48% of permanent project cost. Two months to construct compared to eight months for a permanent project.	The number of riders on Dunning Ave increased by 63% from the first week of operation in August 2020 to the end of the interim evaluation period in October 2020. However, ridership started from a low base, with the smallest number of riders in the first week of all the pop-ups, and the cycleway is located on the outskirts of the City's cycling network and connects to a relatively low-density area. In the week commencing 16 November 2020, there were around 1,000 trips. Currently, the average weekly usage is 710, representing a 23% increase in ridership since its first week of opening.

Project	Length (km)	Infrastructure typology	User satisfaction	Cost	Changes in ridership
(Pyrmont) Bridge Rd popup cycleway	1.2 kilometres	Pop-up cycleway	According to an intercept survey with 100 respondents, 86% said they felt safe or very safe on Pyrmont Bridge Rd, and 92% said it was safer than before. However, when asked about merging with cars on the pop-up cycleway, only 28% said they felt safe, while 44% said they felt unsafe. This is because riders and cars are sharing the road on the approach to intersections, and the speed differential is greater on uphill sections. In a phone survey of 600 people, 71% of respondents in the City of Sydney area supported making more space for cycling and providing a separated cycleway. Regarding feedback from the community, there were 150 submissions about Pyrmont Bridge Rd on Sydney Your Say, with 55% of comments being positive. However, all 20 submissions made directly to the Lord Mayor or CEO were negative. Some of the negative feedback concerned the removal of on-street parking, access issues for residents without rear access, and a lack of consultation or notification.	Pop-up project cost 10% of permanent project, two months to construct and install compared to up to 8-12 months for permanent.	There was a 22% increase in the number of riders from the first week of the pop-up cycleway's operation to the end of the interim evaluation period, which was in the week commencing on December 7th, 2020. According to a survey, 46% of the respondents said that they would not have ridden a bike if the cycleway did not exist. Since the pop-up cycleway's opening in September 2020, there has been a 32% increase in ridership, with an average of approximately 2,800 weekly trips. Women make up around 20-30% of riders at all times of day and night, which is a higher percentage than the results of the Cycling Participation survey, where the female percentage is 9% in Sydney and 10% in New South Wales.

Source: City of Sydney

Case Study – Paris Plan Velo

The French capital has not traditionally been a cycling-friendly city. However, during the last 25 years, Paris has promoted cycling through investing in the expansion of the city's bicycle network and other measures such as Vélib', the city's bike sharing program, and offering financial incentives for e-bikes and e-cargo bikes purchased between 2009 and 2022 (Buehler and Pucher 2022).

Cycling levels in Paris increased sharply during the COVID-10 pandemic, with cycling levels about 60% greater in 2020 and 2021, than in 2019. Compared to cyclists in 2019, cyclists during the COVID-19 pandemic were more likely to be former public transport passengers, women, people from Paris' suburbs, and people from lower-income groups (Buehler and Pucher 2022). New cyclists account for almost 60% of pop-up cycle lane users in Paris (MacMichael 2021).

Cycling levels were 60% greater in 2020 and 2021 than in 2019. Additionally, new cyclists account for almost two-thirds of pop-up bike lane users.

From 2015 to 2020, Paris continued toward its aim to become a bike-friendly city through Plan Velo, a €150 million cycling plan that delivered 47 kilometres of pop-up bike lanes across the city. The Ile-de-France region provided financial support, part-paying for the project (Région Île-de-France 2022). Plan Velo connected crucial gaps in Paris' growing bicycle network, delivering improved bicycle connections between the city's periphery ring and its inner core. Figure 7.17 illustrates the pop-up installed in inner-city Paris.

Figure 7.17: Pop-up bike lane, Rue de Rivoli

Source: Bloomberg

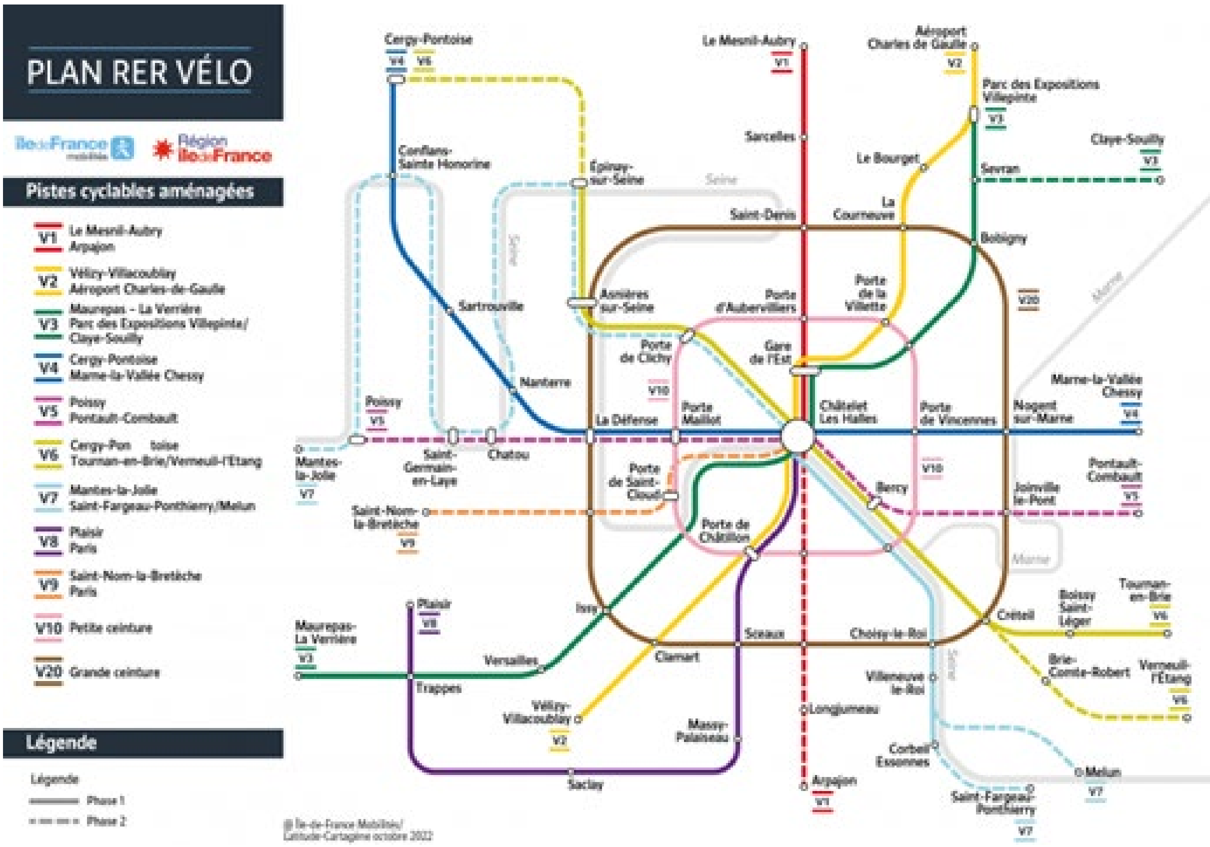
The Paris pop-up bike lanes were constructed using a combination of painted markings, plastic posts and staggered blocks that could be installed quickly without requiring heavy construction. Other measures implemented included reducing the speed limit to 30 km/h on most city streets (Buehler and Pucher 2022). The pop-up lanes increased connectivity within the bike network as the proportion of bike lanes connected to at least four other bike lanes increased from 23% pre-COVID to 58% (Alderman 2020). Of the pop-up lanes, 31 km were installed where no other bike lanes were previously present, whereas 16 km replaced existing painted lanes (Alderman 2020). Currently, Plan Velo's pop-up bike lanes make up approximately 9% of Paris' bike network. Several pop-up bike lanes are located on major transport corridors, such as the Rue de Rivoli and Rue Saint-Dominque and run adjacent to the RER metro rail lines. These pop-up routes provide direct connections to high-activity areas and increase intermodal efficiency.

> The proportion of bike lanes connected to at least four other bike lanes increased from 23% pre-COVID to 58%

A critically important element in the implementation of the Paris pop-up network was the road space reallocation that occurred to create room for the new protected lanes. Approximately half of the pop-up bike lanes installed replaced general traffic lanes, whilst one-third replaced on-street parking (Alderman 2020). As highlighted earlier, it is this combination of encouragements (pop-up bike lanes) and discouragements (removal of general traffic lanes and kerbside parking) that has been found to be most effective in boosting levels of active transport mode share (Kuss and Nicholas 2022). Figure 7.18 illustrates the future bicycle network connecting with the RER railway system.

> Approximately half of the pop-up bike lanes installed replaced general traffic lanes, whilst one-third replaced on-street parking.

Figure 7.18: Future RER-Velo network



Source: Région Île-de-France

Figure 7.19 is indicative of Paris' plan to expand the bicycle network between now and 2026, with the aim of becoming a '100% cyclable city'. With a €250 million budget, the next stage of Plan Velo aims to achieve several objectives. First, Plan Velo will increase separated bike lanes by 180 km and create enough lanes to allow bicycle journeys to be completed on separate paths. The expanded bicycle network will be designed to improve the level of service for people on bicycles while travelling through intersections, including connections across the peripheral beltway that feeds into the city. This is intended to make it safer for people entering the city from the suburbs. The second stage of Plan Velo will focus on increasing bicycle parking spots by more than threefold, from 60,000 currently to 180,000. The additional bicycle parking will be located on streets, and in private spaces such as parking structures or co-housing projects (Bennett 2021; O'Sullivan 2021). As bike parking will dramatically increase, car parking allocation will significantly decrease. Paris has commenced the process of removing more than 70% of the city's on-street parking spaces (Latz 2021). The removal of car parking is one of the most effective measures to reduce car mode share (Kuss and Nicholas 2022), and therefore increase the role of active travel.

Paris has commenced the process of removing more than 70% of the city's on-street parking spaces.

Figure 7.19: Paris' bicycle network by 2026

Source: Bloomberg

In addition to *Plan Velo*, the French government continues to encourage people to ride by introducing a €20 million program for people to subsidise bike repairs (Bicycle Network 2020).

Prior to the pop-up bike lanes, women made up 36% of cyclists in Paris. Following the implementation of the pop-ups, this has increased to 41% (MacMichael 2021). The impact of the Paris pop-ups on serving to close the gender gap in cycling aligns with existing research that has found a stronger preference from females for protected infrastructure. Some 62% of residents were found to be in favour of making the Paris pop-up lanes permanent (MacMichael 2021).

Case study – Innovating Streets for People, New Zealand

The Innovating Streets fund delivered a range of projects, often involving the use of fast-build, pop-up bike lanes. A comprehensive evaluation of the program was undertaken (Mackie Research and NZ Transport Agency 2021). The program was established prior to COVID-19, in 2018, and was set up to boost the cycling network, which is less than 10% complete (Mackie Research and NZ Transport Agency 2021). Projects were not exclusively focused on bicycle lanes and also included activation projects related to urban vibrancy. A total of NZ$29 million was made available, and a funding cap of NZ$1 million per project was applied. Some 78 projects received funding, including 11 cycleway projects and 11 low-traffic neighbourhoods.

Tactical urbanism was an underlying principle in many of the projects delivered as part of the Innovating Streets for People program. This approach 'acknowledges that tolerance for uncertainty is required' (Mackie Research and NZ Transport Agency 2021). This approach was praised by a New Zealand member of the subject matter expert interviews. They mentioned that having the demonstration serve as the consultation is critical to the success of the project. Members of the public are better able to judge whether they like the design once they have seen it. An illustration of the type of pop-up lanes installed as part of the project can be seen from Figure 7.20.

> Tolerance for uncertainty is required (Mackie Research and NZ Transport Agency, 2021).

Figure 7.20: Pop up bicycle lane, Waipa District Council

Source: Mackie Research and NZ Transport Agency (2021)

Evaluation data was provided for 44 projects. The project evaluation identified that 28 of the projects resulted in an increase in the number of people using active transport. While the report did not specify the change in pedestrian or cycling activity in a uniform metric, or mode shift, where figures were reported, they are provided in Table 7.4.

Table 7.4: Project impact

Project	Impact
Waipa District Council pop up cycleway	300+ people per day using pop up cycleway. A 58% increase in people riding to nearby primary school
Gore City Council street activation	35% - 53% reduction in heavy vehicle traffic
Wellington City Council	64% of Brooklyn Road cycleway users report an improvement in safety for everyone

Source: Mackie Research and NZ Transport Agency (2021)

The evaluation of the *Innovating Streets for People* program developed a synthesis of the key learnings, and these are reproduced as Table 7.5 and Table 7.6. Importantly this includes what *does not work*, and this can help avoid mistakes. This is particularly useful given that tactical urbanism approaches generally include a level of uncertainty.

Table 7.5: Innovating Streets for People - key insights (1)

	What works	What does not work
Project definition and context	Aligning the project with a planned permanent upgrade Engaging with the community about the need prior to applying for funding	An isolated project disconnected from a wider strategic plan Testing an idea on a community, without evidence of need or local relevance
The project team	A multidisciplinary team comprised of Council staff, consultants, communications support, and community champions A full-time project manager with community development skills	Outsourcing the entire project to consultants Managing the project on top of a regular workload
Collaboration & community partners	Embracing local talent and existing relationships Employing local businesses and community members to support the project	Asking a community group to be the face of the project and making decision without them in the room Not recognising the time community members dedicate to project as work
Communications	Community-led communications early on. Communications that articulated the larger objectives, expected benefits, next steps and stood firm on the need to 'see the trial' through and make decisions on evidence	Underestimating the required communication resources Project (and funding) timeframes that made it hard to communicate the 'why' and complexities of tactical urbanism

Source: Mackie Research and NZ Transport Agency (2021)

Table 7.6: **Innovating Streets for People - key insights (2)**

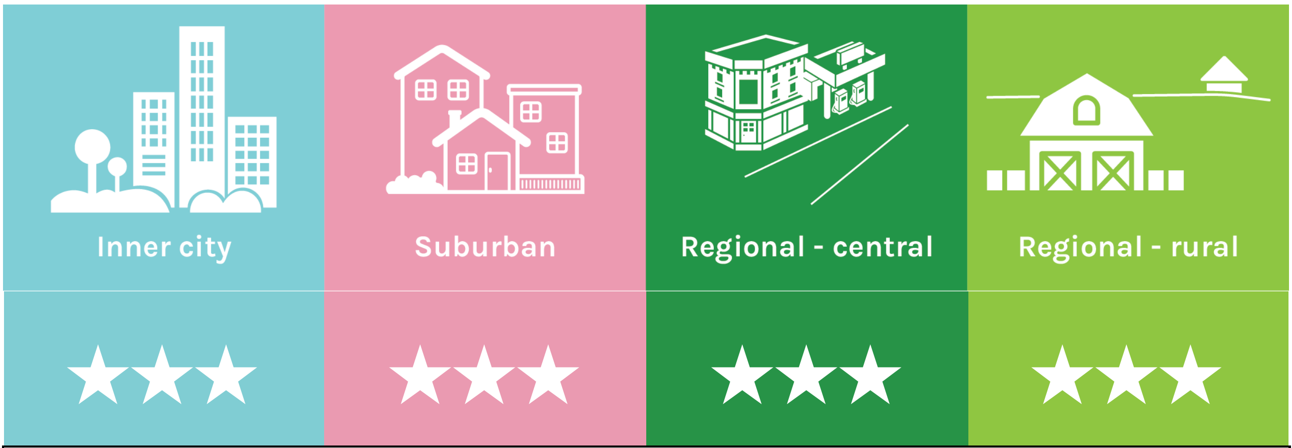
	What works	What does not work
Engagement and co-design	Direct, personal engagement, and onsite presence that is visible, accessible, and regular Clarity and transparency about the co-design process and next steps, followed by 'sticking' to the process (e.g. simplifying complexity, documentation of decisions)	Inconsistency between co-design messages/ intentions and the reality of constraints (e.g. timeframes, agility, tolerance for risk) Multiple changes to the planned co-design process in the face of public opposition or perceived political risks
Materials and installation	A 'look and feel' that aligns with the surrounding environment and fosters community acceptance Materials that are durable, practical, and don't look cheap	Having no clear purpose or function regarding materials/design, or a limited link to a permanent solution Timeframes and materials that create supply chain pressures and maintenance issues
Monitoring and evaluation for adaptation and retention	Shared understanding of success criteria Using a range of data collection techniques, and embedding them into communication and engagement plans	No agreed evaluation framework or shared understanding of success Vocal opponents having undue influence over decisions, despite evidence of successful outcomes or support from project beneficiaries

Source: Mackie Research and NZ Transport Agency (2021)

7.2.2 Bike parking at stations / destination

Providing an adequate supply of appropriate bicycle parking at railway stations and other key transport hubs is key to supporting multi-modal bike-train journeys. Similarly, providing bicycle parking at activity centres and other key destinations supports people to cycle. Bicycle parking should provide the right balance between security against theft and convenience for the user. This balance shifts based on numerous factors including the destination type, duration of parking, and user preferences. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.21. More information on the integration of active and public transport can be found in Section 7.5.1.

Figure 7.21: Bike parking at stations / destinations in prioritisation framework



Implementation time	Impact	Cost	Complexity
Months to Years	★★	★★★	★

Actions

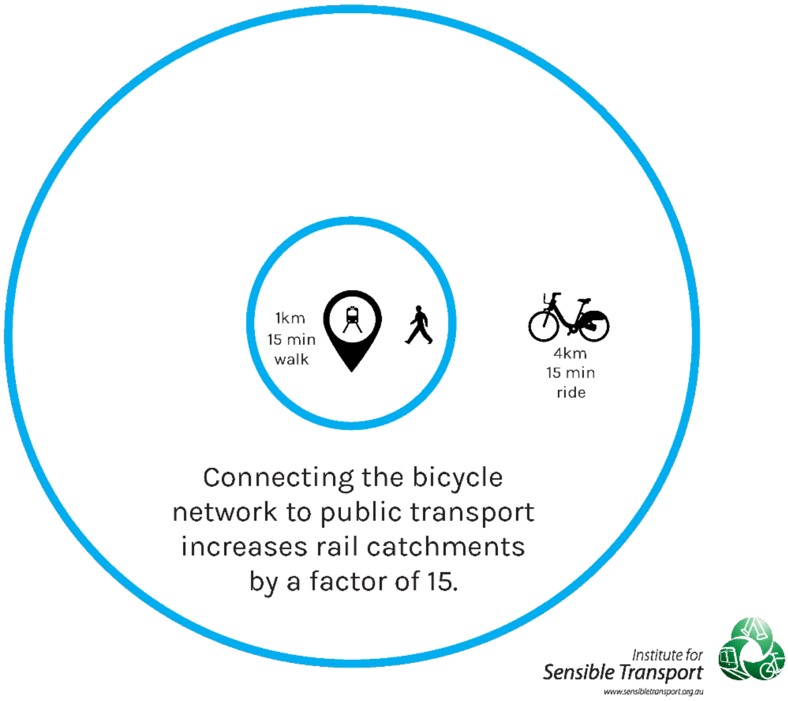
The following provides some example actions that support bike parking at stations and key destinations:

- provide secure bicycle parking at all stations for regular users (see also Section 7.5.1)
- provide open-access bicycle parking at all stations for irregular users (see also Section 7.5.1)
- provide open-access bicycle parking at all activity centres and key destinations
- monitor bicycle parking occupancy levels and increase supply where necessary.

Evidence base

Connecting railway stations with high-quality bicycle infrastructure can increase the catchment area of public transport by a factor of 15 (Hudson 1982). This relationship is illustrated in Figure 7.22.

Figure 7.22: Increasing the catchment area of public transport

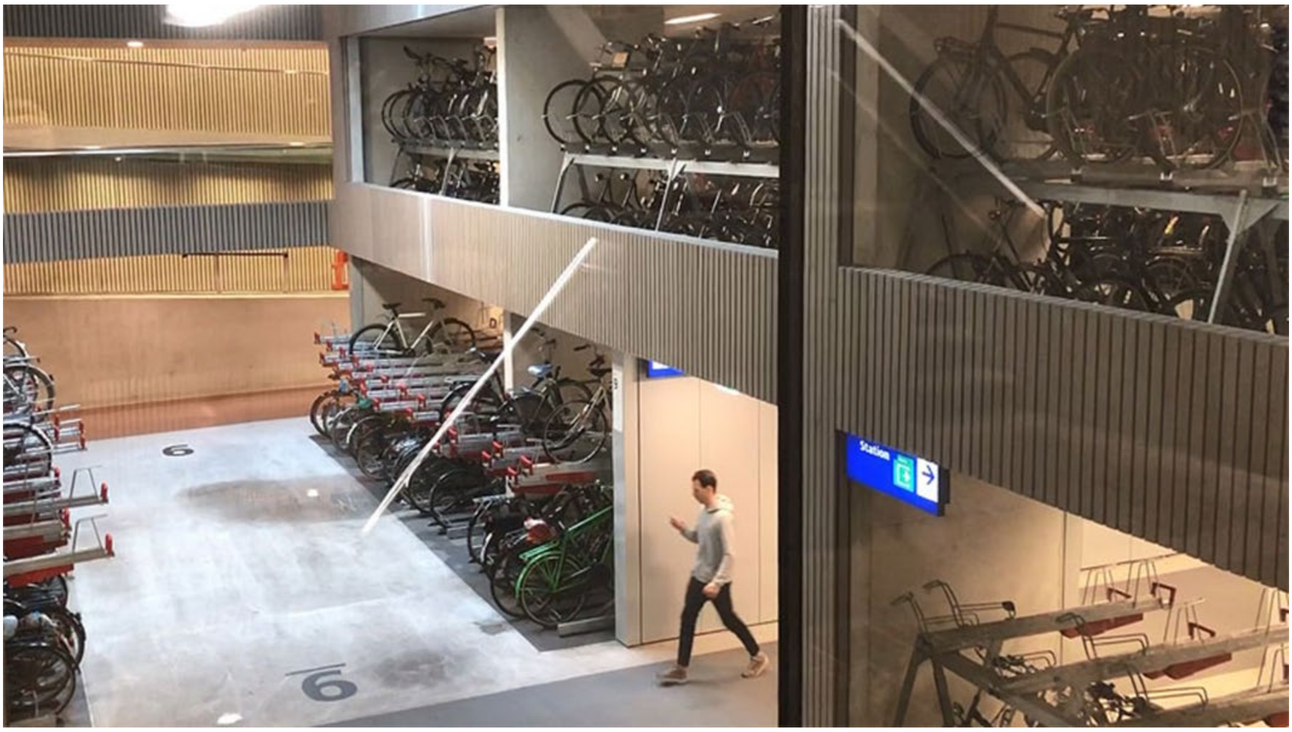


Source: Hudson, 1982, taken from Fishman, 2019

The country with the most well-developed relationship between cycling and public transport is the Netherlands. This is supported by a well-developed cycling network and the provision of ample secure bicycle parking at railway stations. Some 50% of train passengers arrive at the station by bike, and this can rise to as much as 70% in some locations (M van Hagen, personal communication 2018). Moreover, data from the national rail operator has found that passenger satisfaction levels are highest for those who have arrived by bicycle. This is thought to be related to the fact that the passenger has complete independence as to when they arrive, therefore minimising wait times (M van Hagen, personal communication 2018), as well as having the ability to more easily access hub stations that offer more travel choice/journey speed. A distinct category of “bicycle-train travellers” has emerged in the transport literature (Jonkeren et al. 2021). This has relevance to Australian cities, which can often have significant car parking issues at suburban stations, despite a large proportion of car trips to stations being short (i.e., less than 3 km), according to number plate analysis conducted by the author in conjunction with the Victorian Department of Transport and Planning.

Figure 7.23 shows the underground parking facility under Utrecht Central Railway Station in the Netherlands. The facility offers parking for over 32,000 bicycles, which can be parked for free, for the first 24 hours. The user scans their standard public transport pass to enter the facility and is provided with direct access to the station (located above the facility) which includes real-time information on train departure times.

Figure 7.23: World's largest bicycle parking facility, Utrecht



Source: Mark Wagenbuur, Bicycle Dutch

Perhaps more important than the bicycle parking itself is the network of protected bicycle lanes that connect to train stations in the Netherlands. Jonekeren et al. (2021) argue there are a variety of elements to understand when trying to encourage bicycle-train travel. Firstly, not all stations attract bicycle-train travellers. Bicycle-train travellers very often do not use their nearest station, rather they take advantage of cycling's increased catchment area to reach stations the Dutch National Railways consider as having 'hub' functions. According to their research, 80% of the time, 'hub' stations were chosen over the nearest station (Jonkeren et al. 2021). These stations offer the most diverse range of connections which usually results in the fewest train transfers to reach the travellers' destination. Such stations generally also have express and intercity services and higher train frequencies. The quality of bike parking at these 'hub' stations is also important. 'Hub' stations tend to offer better and safer bicycle parking (e.g., Figure 7.23). The increased ability to reach these 'hub' stations is likely another factor influencing the high satisfaction levels bicycle-train travellers exhibit compared to other train travellers.

The second point of Jonekeren et al. (2021) is that the catchment effect of cycling can occur 3 – 7 km at both ends of a train journey. Whilst it is vastly more frequent to cycle the "home-end" trip to the station, cycling also occurs at the "activity-end" of the journey. Most "activity-end" trips are taken on foot (average 51%), by another means of public transport (average 23%) or by bike (average 20%). Activity-end bike choices differed depending on the city. Some cities witnessed a high use (up to 65%) of folding bikes (e.g., see Figure 7.24), implying bicycle-train travellers brought their bikes with them. Cost-benefit analysis has revealed broader benefits than just the users, which exceed the cost of delivering the parking (Van Der Spek and Scheltema 2015). Of critical importance for this project, Dutch research found that 15% of people who combine public transport use with their bicycle had replaced trips previously completed by car (Jonkeren et al. 2021).

Dutch research found that 15% of people that combine public transport use with their bicycle had replaced trips previously completed by car.

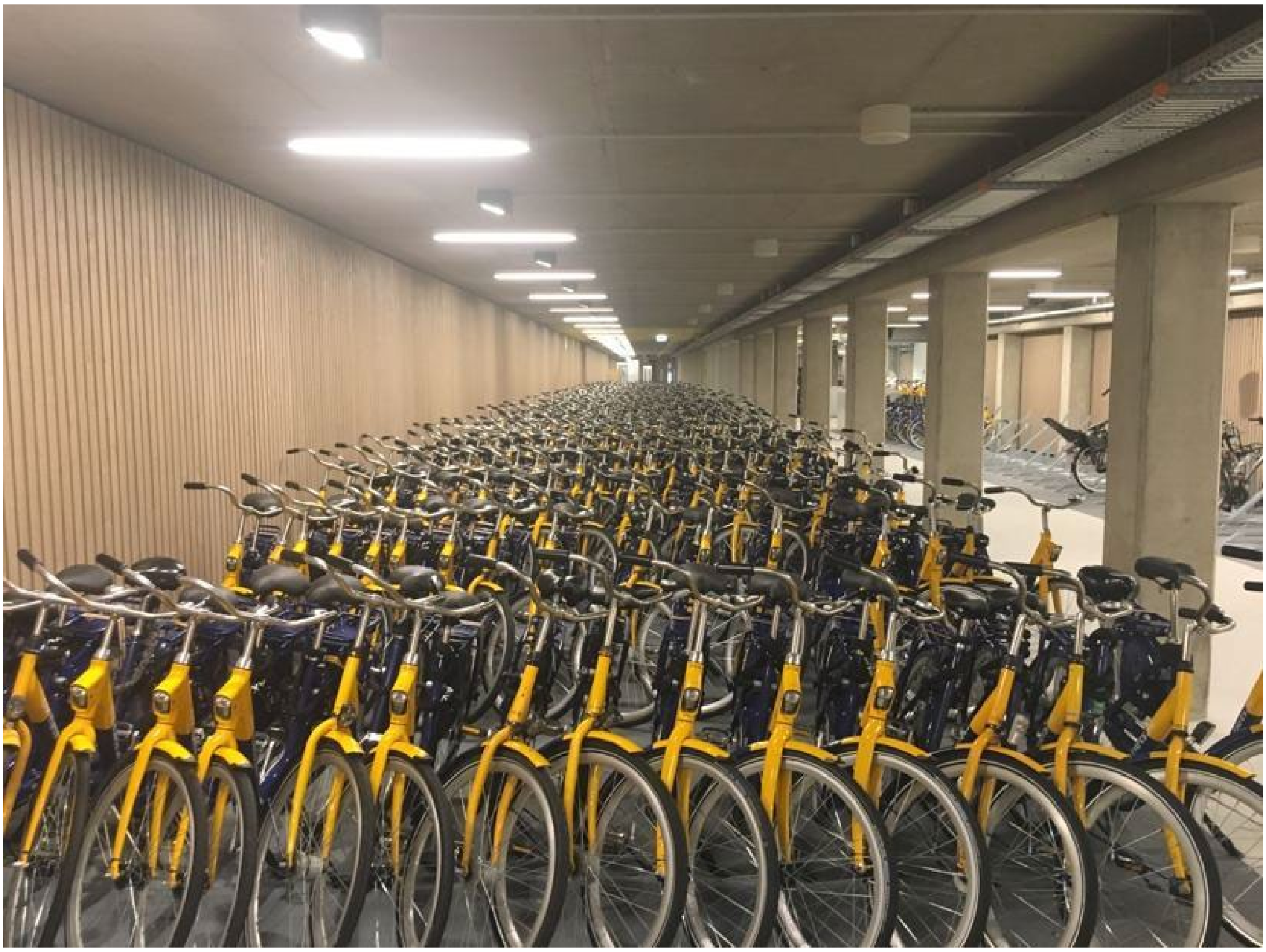
Figure 7.24: Fold-up bicycles are widely used to connect to both ends of a rail journey in the Netherlands

Source: Institute for Sensible Transport

The key theme from the Netherlands' experience is that railway stations, with frequent services and a range of onward connections, become preferred stations over the closest station. Whilst cycling infrastructure should be provided to facilitate safe travel within a 3 – 7 km radius from the station, there is a strong argument to develop public transport interchanges and to provide sizable amounts of conveniently located, safe, and secure bike parking at public transport interchanges.

Some Dutch cities have witnessed a high use of public transport bikes (known as OV Fiets, or public transport bikes) owned by the Dutch National Railways (up to 44%). Figure 7.25 depicts the national bike share service offered at train stations throughout the Netherlands. This system allows passengers to use their public transport pass to rent out bicycles to make onward journeys, therefore allowing train users to cycle at both ends of their journey. This demonstrates the role that shared mobility (discussed in Section 7.4) can have in complementing bicycle parking at stations.

Figure 7.25: Public transport (shared) bicycles provided as part of the Dutch rail service

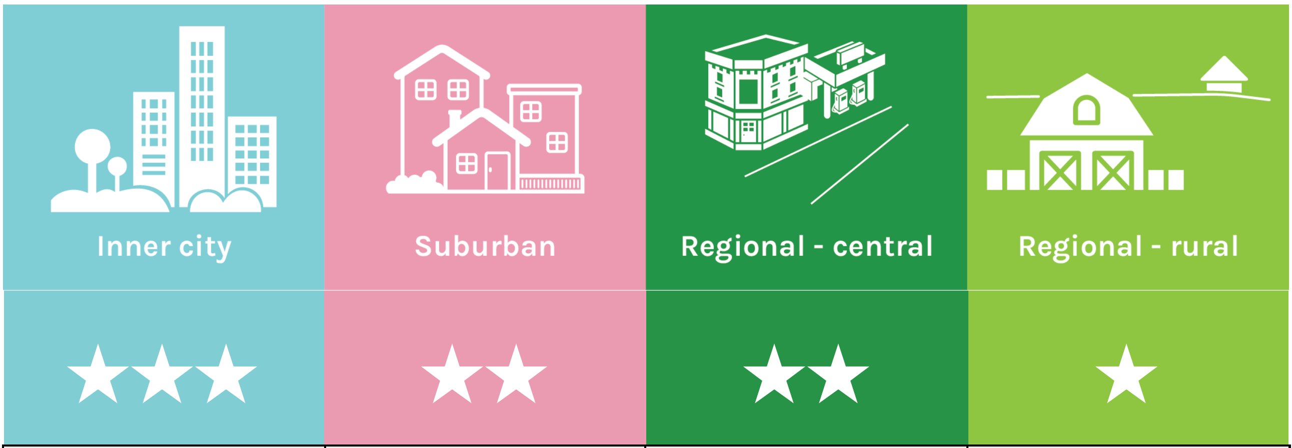


Source: Institute for Sensible Transport

7.2.3 In-building bike parking and end-of-trip facility

Providing in-building bike parking can be a crucial prerequisite for bicycle ownership and therefore use. As highlighted earlier, typical bicycle parking ratios in new residential developments are often inadequate to allow residents to own a bicycle (see Section 7.1). This is relevant for apartment developments in particular, as residents are unlikely to have the ability to easily store their bicycles within the apartment itself. Bicycle parking and end-of-trip facilities at workplaces can also be an important factor in people’s willingness to cycle to work. End-of-trip facilities typically include showers, change rooms, and clothing lockers. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.26.

Figure 7.26: In building bike parking and end of trip facilities in prioritisation framework



Implementation time	Impact	Cost	Complexity
Years	★★	★★★	★

Actions

The following provides some example actions that support in-building bike parking and end-of-trip facilities. See Section 7.1 for actions specifically related to residential bicycle parking.

- Require new office, commercial and industrial developments to include bicycle parking and end-of-trip facilities for employees and visitors.

Evidence

Just like car parking, bike parking can affect peoples' choice of mode. However, bike parking has some different considerations from car parking. In the public realm, bicycles can be informally parked, rather than only parked in designated areas or on designated equipment (for example, locked to parking signs, trees, or street furniture (Veillette et al. 2018). However, people can be concerned about the risk of theft or vandalism, especially when parking on the street, and this can deter some from cycling (Veillette et al. 2018). It should be noted that in Montreal, 50% of stolen bicycles are informally parked, indicating the perceived risk is likely to be real (Van Lierop et al. 2015). Different parking types are more suitable for different trip types. For those accessing local shops, parking in the public realm is best, however, for those parking bikes for longer periods of time, more secure facilities can encourage use.

In the UK, end-of-trip facilities at workplaces have been found to increase cycling to work from a base of 5.8% (Wardman et al. 2007). Where outdoor parking is provided, 6.3% will cycle to work, and this rises to 6.6% where indoor parking is also provided (Wardman et al. 2007). For commuters, showers can also be important, especially in hot climates. When showers are provided, the proportion of people cycling to work in the UK rises to 7.1%. Similar results have been found in Canada, where secure parking and showers have been found to influence peoples' decisions to cycle to work (Hunt and Abraham 2007). Likewise, people need to be able to park bicycles at their homes (Van Der Spek and Scheltema 2015). While some Australian planning schemes can require bike parking, studies indicate that this is often insufficient, with bicycle parking at residential dwellings typically at capacity, resulting in bicycles also being informally parked as a type of 'overflow' (De Gruyter et al. 2015). This is discussed in Section 7.1. Finally, it is important to highlight that good bicycle parking and end-of-trip facilities on their own are unlikely to significantly increase bicycle use. The high-quality bicycle infrastructure discussed in Section 7.2 is required before most people will be willing to consider cycling, regardless of the quality of the bike parking and end-of-trip facilities that may await them at their destination.

7.3 Walking infrastructure

Walking infrastructure refers to the physical facilities and design elements that support and encourage walking as a mode of active transport. It includes a wide range of features and improvements that aim to make walking a safer, more convenient, and enjoyable mode of transport.

7.3.1 Footpath

Perhaps the most obvious infrastructure requirement for walkability in a city with motor vehicles is footpaths. Footpaths provide a car-free area to enable people to walk from one destination to another. Wide, smooth footpaths, combined with shelter from rain and sun, street furniture and consistent, safe crossings are important for walkability. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.27.

Figure 7.27: Footpaths in the prioritisation framework

Implementation time	Impact	Cost	Complexity
Decades	★★★	★	★

Actions

The following provides some example actions that encompass footpath infrastructure interventions:

- ensuring built-up residential areas have footpaths on both sides of the street
- ensuring footpaths are wide enough to support pedestrian numbers (also linked with Section 7.3.3)
- ensuring lower-density residential areas have footpaths on at least one side of the street
- ensuring footpaths are provided that connect key destinations such as schools, parks, shopping centres, and local services
- ensuring railway stations, bus stops, tram stops and ferry wharves have footpaths (see also Section 7.5.1).

Evidence base

There is a close relationship between the provision of footpaths and walking levels (Brown et al. 2016). The proximity of a footpath to a larger number of residents leads to increased use, resulting in greater active transport mode share (Gunn et al. 2014). The same is true of school children, with those living in areas well served by footpaths found to be significantly more likely to be physically active (Carson et al. 2010).

Changes to the pedestrian environment on walkability in Lisbon, Portugal were investigated by Cambra and Moura (2020). Figure 7.28 highlights the before and after street environments that were included in the study. The space for widening the footpath generally came from areas previously used for car parking or traffic lanes (Cambra and Moura 2020). The number of pedestrians counted at each of the locations increased following the pedestrianisation project. These projects align with the encouragement and discouragement concept introduced earlier, where space dedicated to the motor vehicle is replaced with enhanced provision for people-focused places and active transport infrastructure.

Moreover, improving walkability in cities like Melbourne can boost the economy (SGS Economics and Planning, 2018). A study by SGS Economics and Planning showed that a 10% increase in walking connectivity could add $2.1 billion annually to Melbourne's Hoddle Grid economy.

A study with Western Australian residents looked at the association between footpath provision and walking (Gunn et al. 2014). The study was particularly interested in the cost-effectiveness of providing footpaths. In essence, this involves a comparison of the monetised benefits of increased walking with the cost of providing footpaths. They found it most cost-effective to install footpaths in streets lacking any footpaths. This is particularly important for middle and outer suburban areas of Australia, as well as regional townships, which often lack footpaths on either side of the street. In areas with high levels of pedestrian demand, footpaths should be installed on both sides of the street (Gunn et al. 2014). It is important to recognise the effect that density has on the cost-effectiveness of providing footpaths (Gunn et al. 2014). The higher the surrounding density, the higher the cost-effectiveness. While the provision of footpaths is important, as highlighted in Section 7.1, land use planning that builds in a diversity of destinations is essential for creating neighbourhoods with high levels of walkability.

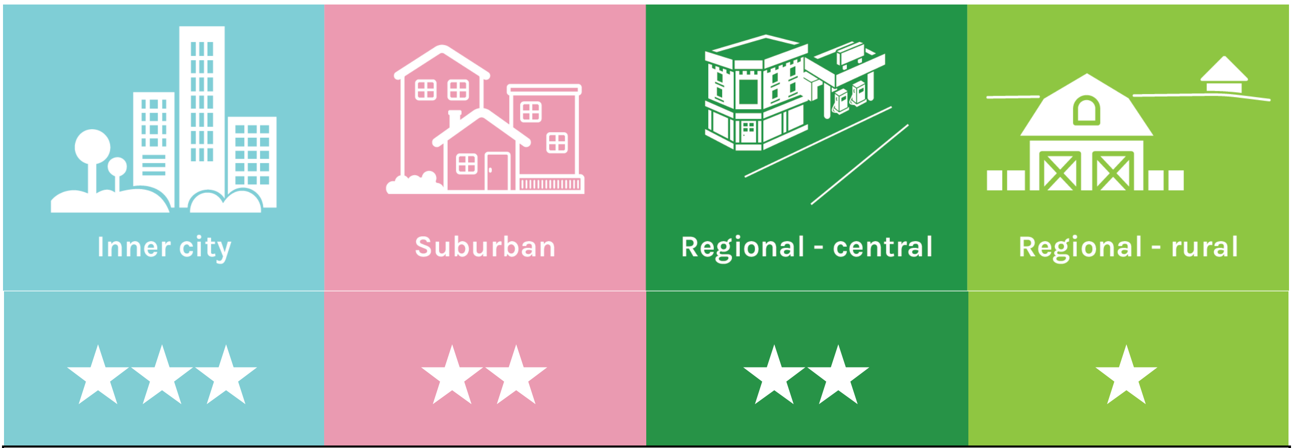
Figure 7.28: Before and after walkability changes, Lisbon

Source: Cambra and Moura (2020)

7.3.2 Crossings

The quality of the pedestrian crossing environment has an important impact on walkability and safety. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.29.

Figure 7.29: Crossings in the prioritisation framework



Implementation time	Impact	Cost	Complexity
Decades	★★★	★★	★

Actions

The following provides some example actions that encompass crossing infrastructure interventions:

- provide safe crossing points at busy intersections and key locations (such as shopping strips, schools, parks, and other attractions)
- conduct regular audits of crossings, and implement safety improvements where necessary
- ensure all crossings meet DDA requirements, with pram ramps, tactile surfaces, and appropriate width/grade.

Evidence base

Crossing points are a source of conflict between pedestrians and other road users. It is therefore important to use some strategies to reduce vehicles' speed and increase safety and access for pedestrians. A disproportionate number of collisions involving vulnerable road users occur at intersections, and therefore the design of crossings is central to walkability. In addition to safety considerations, pedestrians are highly sensitive to detours, and good pedestrian design minimises deviations (Global Designing Cities Initiative 2016). The following factors are important to walkability at crossings:

- Pram ramps: Footpaths that fail to provide pram ramps limit walkability, especially for those using walking aids or other devices that require a smooth, gentle gradient.
- Motor vehicle volume: Crossings with high motor vehicle volumes, especially multiple traffic lanes can impact negatively on pedestrian outcomes.
- Motor vehicle speed: High traffic speed reduces safety outcomes. Slip lanes and wide-angle corners allow vehicles to negotiate an intersection at speed, reducing pedestrian friendliness (Road Safety Toolkit, 2021).
- Intersection complexity: When traffic moves in multiple directions, the ability of a pedestrian to safely cross is reduced.
- At controlled (traffic light) intersections, pedestrian wait times are short and include a leading pedestrian interval, to enable a pedestrian to become more visible to drivers in turning motor vehicles.
- Crossing density is at least every 100m in dense areas and every 200m in other areas.

Crossings can improve the walking experience in a neighbourhood. Streetlights, benches, kerb cuts, the presence of footpaths, and buffers between streets and footpaths have a significant effect on active transport in most age groups (Sallis et al. 2015). The quality of crossings has a significant impact on active transport use for older adults. In another study, Witten and Field (2020) found that when crossings prioritise motorised vehicle movements, safety concerns for young children prevent independent active transport behaviour. Conversely, when crossings have been designed to enhance the pedestrian experience, this results in a greater willingness to walk to destinations.

Where single-interval crossing is not possible, the use of pedestrian refuges provides pedestrians with an opportunity to wait to make the second leg of their crossing. For detailed design information on different crossing types and when to use each type see Global Designing Cities Initiative, 2016.

7.3.3 Placemaking

Placemaking involves the creation of public spaces that enliven the area as a destination, and often result in improvements to the environment for active transport, especially walking. The Movement and Place frameworks adopted across Australasia are an acknowledgement that an overemphasis on the traffic function can be detrimental to the vibrancy of place and reduce the quality of the destination. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.30.

Figure 7.30: Placemaking in the prioritisation framework

Implementation time	Impact	Cost	Complexity
Years	★★	★★	★

Actions

The following provides some example actions that encompass placemaking interventions:

- In activity centres and areas of high (or desired) pedestrian activity undertake placemaking initiatives such as:
  - footpath widening
  - footpath trading
  - urban greening
  - public art, playgrounds and water features
  - installation of parklets

- reduced speed limits
- closing streets to motorised traffic and introducing turning bans to lower vehicle volumes.

Evidence base

Urban liveability and social and economic connections are enhanced when cities provide a people-focused public realm. When people walk in an area, it can bring a sense of life and activity to the space, making it a more desirable place. This in turn can lead to more walking in the area (Auchincloss et al. 2019; Benton et al. 2021; Cambra and Moura 2020). Overall, people's walking experience as a mode of transport can be improved by placemaking and the creation of vibrant and liveable communities. By providing a safe and enjoyable walking environment, street designers and planners can encourage more people to walk. It is rare for placemaking projects to evaluate the overall impact of the project on car use and active travel. This is made more difficult given that placemaking can often take place over many years or even decades, complicating any estimated change in travel behaviour on the placemaking project itself.

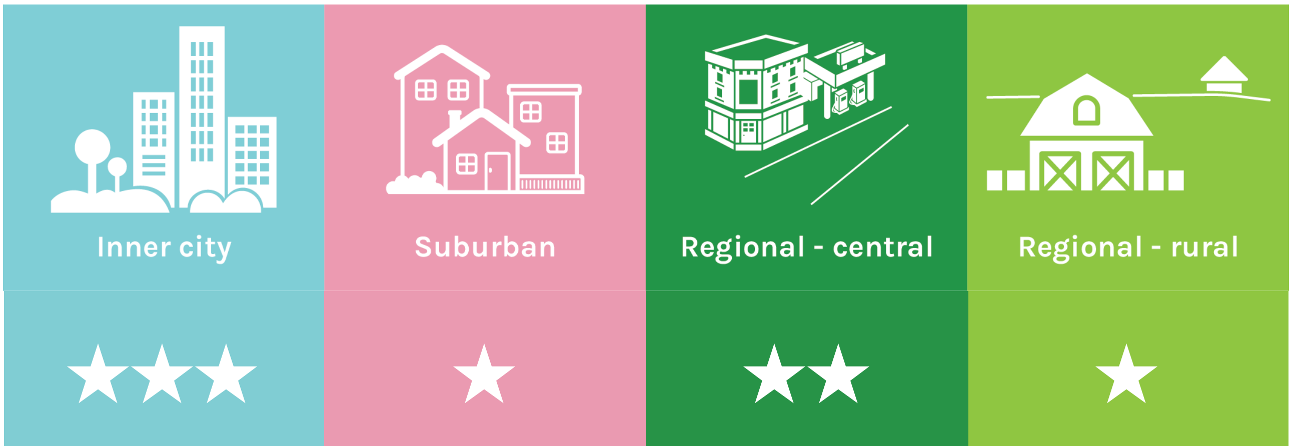
7.4 Shared micro-mobility

Shared micro-mobility refers to the use of small-footprint, lightweight vehicles that are shared among multiple users for short-distance trips. This includes modes such as bike-sharing, scooter-sharing, and other similar systems. Integrating shared micro-mobility into the active transport prioritisation framework requires coordination among local governments, transport authorities, and private operators. By offering convenient, eco-friendly, and cost-effective mobility solutions, shared micro-mobility contributes to the broader goal of making cities more liveable, sustainable, and accessible for all residents and increasing the mode share of active transport.

7.4.1 Bike share

Bike sharing provides access to bicycles for short-term use. Bike-share programs can offer a convenient way to make short trips in urban areas. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.31.

Figure 7.31: Bike share in prioritisation framework



Implementation time	Impact	Cost	Complexity
Months to years	★★★	★★★	★★

Action

The following provides some example actions for bike share interventions:

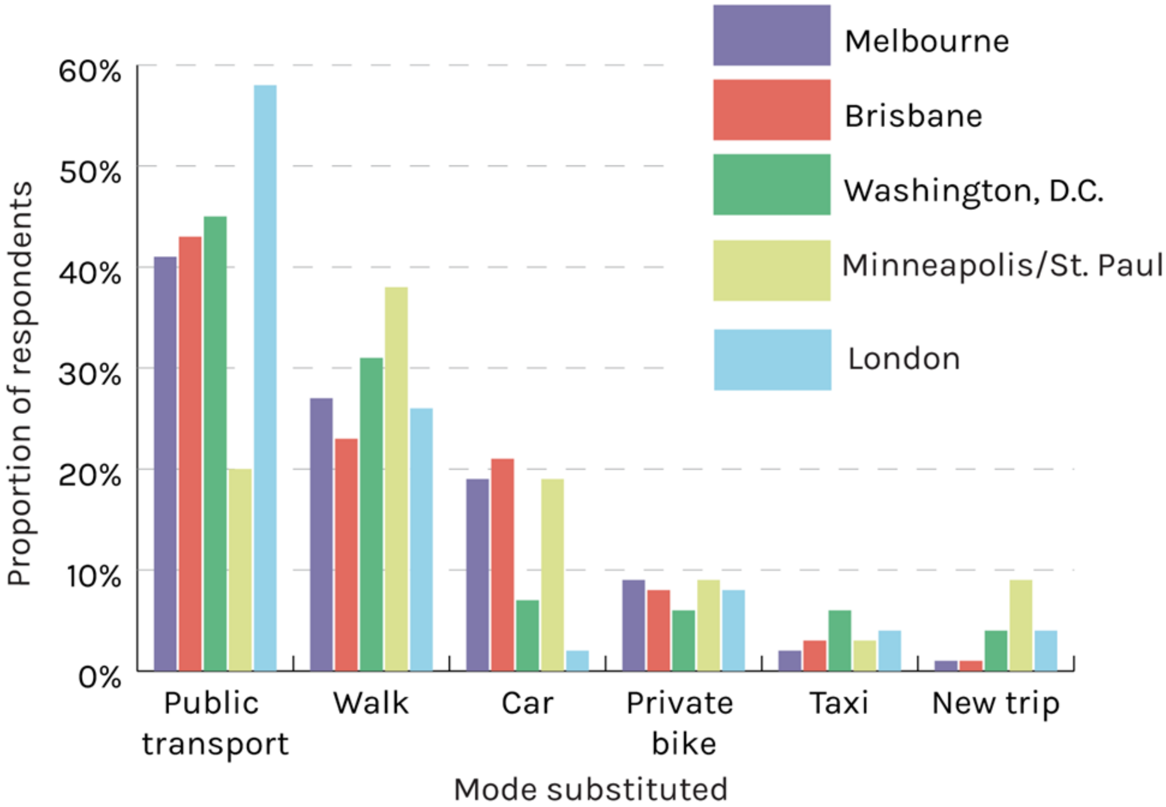
- Develop a Micro-mobility Strategy that outlines an agency's ambition for bike share programs. This could include:
  - prioritised network of micro-mobility lanes
  - prioritised parking locations in high-demand areas
  - identifications of "No go zones" in which it is unsafe to mix bike share and pedestrian traffic
  - policies around user fees design to encourage high levels of use
  - analysis of optimal catchment size and density of bikes.
- Engage with the commercial bike share sector to explore the potential deployment of bike share options.
- Develop the bike infrastructure network. Studies have found that bike share success is related to the level of investment governments make in the bicycle infrastructure network, as well as vehicle speed reduction in streets without the capacity to have separated infrastructure.

Evidence base

Many of the most heavily promoted benefits of bike share (e.g., congestion reduction, climate change mitigation) are contingent on bike share being used as a replacement for motor vehicle travel (Fishman, Washington and Haworth 2014). Indeed, there is little to be gained from a climate change or health perspective when one uses bike share to replace a trip previously completed by foot or private bike.

An increasingly common question directed towards bike share users is 'For your last bike share trip, what mode would you have used if bike share was not available?'. The answer to this question is crucial to developing an understanding of the impact bike share has on active transport. A consistent theme has emerged when examining responses to this question: most of the trips are replacing trips formerly made by public transport and walking (Fishman, Washington and Haworth 2014). Therefore, transferring trips from public transport to cycling can free up more seats for passengers on crowded public transport which can make public transport more comfortable for those who need it. The results for a selected number of bike-share cities are provided in Figure 7.32.

Figure 7.32: Mode being substituted by bike share in selected cities



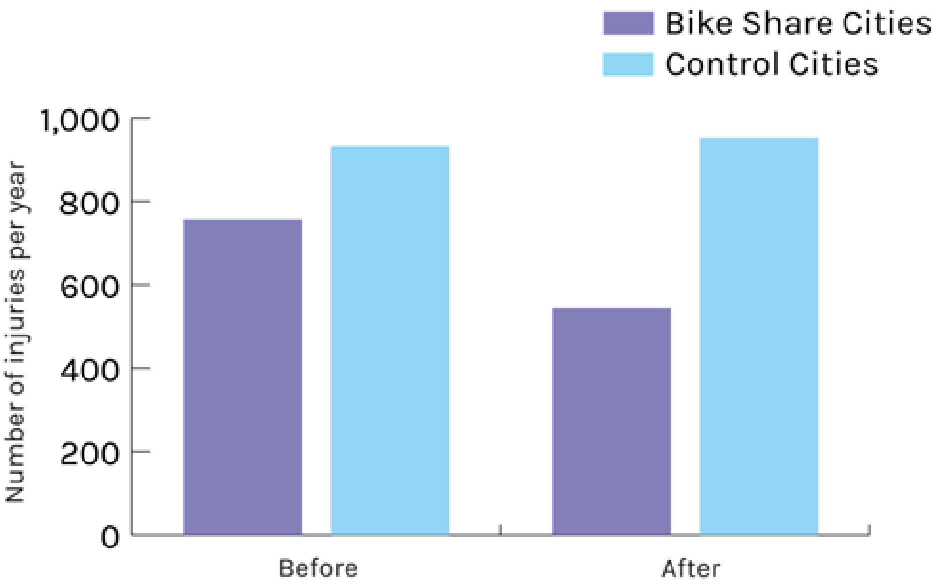
Source: Fishman (2019)

Several studies have attempted to quantify the health impacts of bike share, with some focused on one outcome variable, such as changes to physical activity levels, while others attempt to capture a larger range of outcomes. Among the most comprehensive examinations of the health impacts of bike share was published in the British Medical Journal by Woodcock et al. (2014) and focused on the London bike share program. The researchers focused on three issues: physical activity, crashes and exposure to air pollution. This study used trip data to model the health impacts of the program via comparison to a scenario in which the program did not exist. Physical activity was found to increase considerably at the population level. The associated benefits were shown to differ by gender and age, with men's major benefit coming from reductions in ischaemic heart disease, whereas women were more likely to benefit in terms of reductions in depression.

In relation to crashes, the results of the Woodcock et al. (2014) study suggest that on balance, the program delivers more benefit than harm, although the effects are not uniform for all age groups or genders. Interestingly, the researchers found that more benefits would be gained if users were older, as older people have fewer healthy life years to lose (if involved in a crash). When the researchers applied the general crash risk for all cycling in central London, they found a negative health impact for women, due to the greater fatality rate among female cyclists in London (Woodcock et al. 2014). However, since the data was collected, Transport for London has made major upgrades to their cycling network (Transport for London 2017), and this is likely to reduce the crash risk and thus further tip the balance of safety benefits in favour of bike share's existence. In terms of air pollution, the study found little impact on air pollution exposure to the riders themselves (Woodcock et al. 2014).

Bike share safety has attracted a lot of attention within the mainstream media (Fishman and Schepers 2016). Prior to the introduction of bike share in cities such as New York, some analysts had forecast a rise in the number of bicycle crashes. This section will examine the impact bike share programs have on cycling safety. Bike share safety research straddles the sustainable transport and population health/safety fields. A somewhat volatile debate was sparked by an article published in the American Journal of Public Health (see Graves et al. 2014) that assessed hospital injury data from five U.S. cities with bike share programs and five without. The analysis occurred during a 24-month period before bike share implementation and also for a 12-month period post-implementation. The non-bike share cities essentially acted as a control. What the researchers found, but failed to include in their discussion, was the dramatic reduction in the total number of hospital-recorded injuries in the bike-share cities, post-implementation. Figure 7.33 uses data collected by Graves et al. (2014) to illustrate the reduction in recorded injuries in bike-share cities compared to a slight increase in control cities (no bike-share).

Figure 7.33: Injuries (all types), bike share cities and non-bike share cities (control)



Source: Graves et al. (2014)

The conclusions by Graves et al. (2014), which have been criticised by other scholars (e.g. see Teschke and Winters (2014) and Goodman and Woodcock (2014)), were for bike share operators to provide helmets, despite a clear reduction in the number of head injuries for bike share cities. The data reported by Graves et al. (2014) are especially significant when considering that the overall amount of cycling increases after the introduction of a bike-share program. This is consistent with the Safety in Numbers phenomenon (e.g. see Elvik 2009), in which a rise in the amount of cycling does not lead to a proportional rise in the number of injuries.

In comparing crash levels on bike share systems, and regular bikes (in the same cities), Fishman and Schepers (2016) found that bike share riders in London and Paris are less likely to sustain fatal, severe or slight injuries. One explanation for the higher levels of safety for bike share use might be that their speeds are substantially lower than for other cyclists. Bike share speeds are generally in the same range as the Netherlands. A slower speed increases the time available for cyclists to react to avoid crashes that may have occurred at higher velocities. It is also possible that motorists perceive bike share users to be less experienced and/or tourists and therefore display a greater level of caution, as revealed in qualitative research on perceptions of bike share (Fishman 2019). The notion that drivers behave differently depending on the appearance of the cyclist has been established by Walker (2007) who found that drivers overtook closer to helmeted cyclists. The upright position of bike share bikes may improve cyclists' visual observation of the road environment, potentially helping to avoid crashes. Finally, most bike share systems occupy the inner area of cities, which typically have better bicycle infrastructure than outer suburbs. As highlighted in Section 7.2, protected bike infrastructure is known to reduce crash risk between cyclists and motor vehicle drivers (Teschke et al. 2012).

As identified earlier, the benefits associated with bike share are directly proportional to the degree to which they substitute for trips formally done by car. Results from a survey of non-bike share users from Brisbane (see Fishman et al. 2014), suggest that this may be best achieved via policy changes that seek to increase the competitive advantage of bike share over the convenience of car use, and improve perceptions of rider safety, through the development of a network of protected bicycle lanes and paths. The encouragements and discouragements analogy, introduced earlier in this report, can be used in the planning of a bike share program. Creating a system that seeks to restrict car use and provide a high-quality environment for cycling can serve to grow the number of bike-share trips and reduce car mode share (Fishman, Washington and Haworth 2014). For this to occur, marketing efforts attracting car drivers will be necessary, as well as increasing the value proposition of bike share relative to car use. An example of the encouragements and discouragements approach would be a complementary policy of an increase in the cost and decrease in the supply of inner-city car parking. Whilst recognising the potential divisiveness of this issue, it is clear that the most successful bike-share cities are all in places where car use is expensive and difficult. These changes (i.e. enhanced convenience and safety of cycling relative to short car trips) will of course not just enhance bike share's performance, but will also enhance overall sustainable mobility choices in cities (Buehler and Pucher 2021).

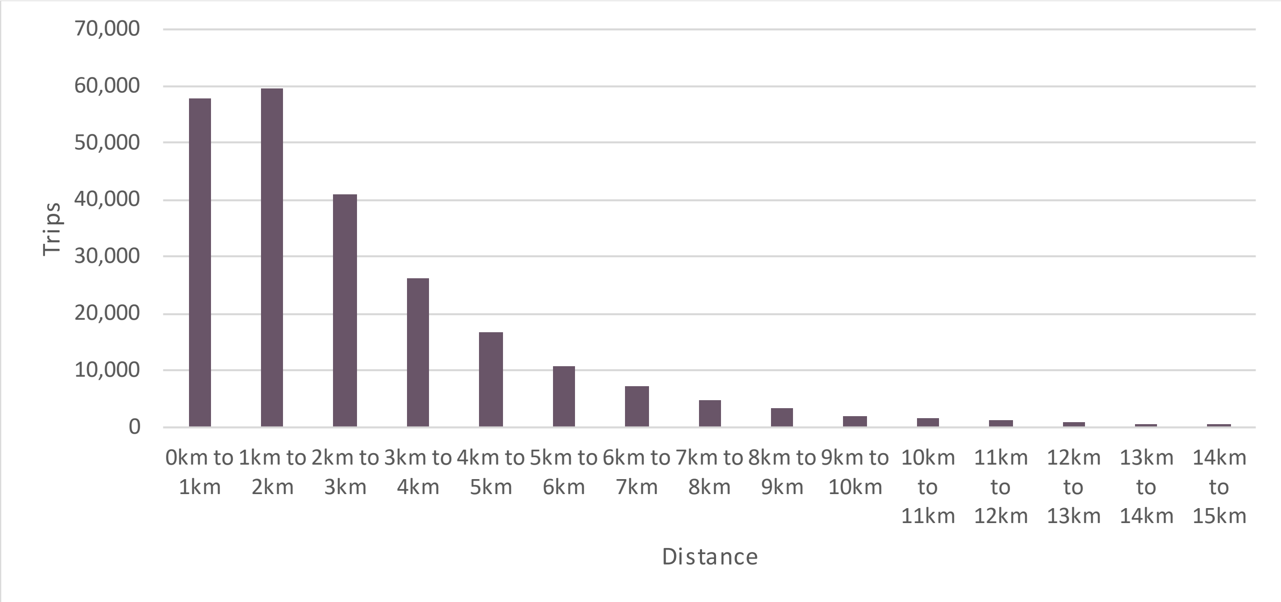
The LIME e-bike share program is a dockless system run by a private operator within the inner city of Melbourne. The program began in February 2020. The bikes were withdrawn due to COVID-19 prior to a relaunch in September 2020. The bikes can be accessed via an App. The number of bikes in the system has varied, from a peak of 685 in September 2021 before declining to a low of 203 bikes in May 2022. The cap on bikes in the system is set at 800, via a Memorandum of Understanding (MOU) between Lime and the participating councils.

LIME has plans to expand operations to surrounding local government areas. A review/evaluation of the program was undertaken in 2022, and revealed the following:

- In the busiest month, a LIME bike is used for approximately 24 minutes per day (i.e. 2 rides of 12 minutes each, on average).
- Most trips are short; almost all trips are less than two kilometres and are completed within 10 minutes.
- Weekends are the busiest days. Based on usage data, it is likely that LIME is not used as much for commuting as some other bike-share programs. Trip profile by time of day aligns with social/recreational trips when compared to travel diary surveys (VISTA).
- Most people who have used LIME have done less than 10 trips.
- A small minority (2.5%) of users account for about one-third of trips.
- The pricing structure and small catchment (relative to the size of Melbourne) contribute to short, infrequent trip patterns.
- The introduction of e-scooters does not appear to have influenced e-bike trip numbers.
- COVID-19 restrictions in 2021 did not reduce LIME use.

Figure 7.34 indicates trip distance, with the majority being under 2 km. This is partly a reflection of the cost, as well as the small size of the catchment.

Figure 7.34: Trip distance, LIME



LIME has conducted surveys on their users, to gain a better understanding of how the e-bike share system is being used. They also include questions on what users would like to see in the future. These surveys have found:

- most trips (44%) were for recreation, with one-third commuting, and 23% to shops or restaurants
- most enjoyed their experience using LIME bikes
- damaged bikes and missing helmets were key frustrations
- the pricing structure restricted long trips and more frequent use of the bikes
- more bikes and an expanded operating boundary, particularly to the inner north, would bolster usability further.

Of particular relevance to the prioritisation of active modes, users were asked what would encourage greater levels of use, with the key findings being:

- integration with public transport ticketing, with one ticket/App enabling integrated use
- safer streets and more protected bicycle lanes
- lower bike share fees and monthly passes.

Finally, the review recommended the following to enhance the degree to which the bike share program acted as a viable replacement for motor vehicle trips:

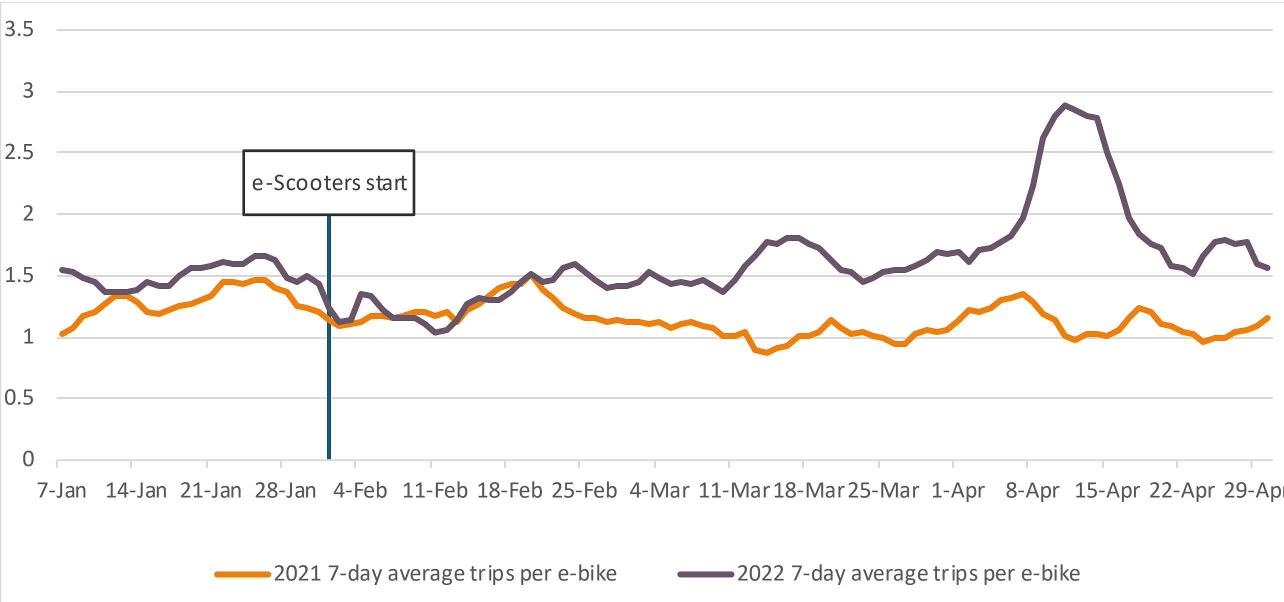
- Grow the network of safe cycling routes.
- Increase the catchment of e-bike share, to cover Melbourne's inner and some middle-ring suburbs, as identified in the map below.
- Increasing the density of bikes within the catchment, to be consistent with best practice and provide a more usable system for everyday transport.
- Lower the cost of use, to enable regular, everyday use at a competitive price and integrate access with public transport ticketing.

By comparing the seven-day average of trips taken for the first four months of 2021 and 2022, shown in Figure 7.35, this report can determine whether the introduction of shared e-scooters influenced e-bike use. The e-scooters were available from 1 February 2022. The two lines in both figures relate to e-bike only.

The results show that the introduction of e-scooters does not appear to influence e-bike trip numbers. However, this report can see an increase in trips per bike by 0.5 trips per bike from mid-February 2022 compared to the same time period in 2021. This could be influenced by a decrease in the number of total bikes available. This insight is interesting as it appears to indicate that the decrease in bikes available on the street have not reduced overall trip numbers.

The spike in trips seen in the graph over mid-April are during the F1 Grand Prix at Albert Park.

Figure 7.35: Seven day average of trips by e-bike



This section provides a high-level evaluation of the benefits of the trial LIME e-bike on transport outcomes. Across the trial, there are 283,621 recorded bike trips. Of those, 235,306 have a distance associated with that trip. Using only those trips with a distance recorded, a total of 650,496 km have been travelled. As highlighted earlier, previous research indicates that around 19% and 21% of docking station-based bike share users in Melbourne and Brisbane respectively would have used a car had bike share not been available (see Figure 7.39). Based on these rates of mode substitution, it is possible that the scheme has avoided around 47,000 car trips and around 130,000 vehicle kilometres travelled.

To understand what this could mean from a greenhouse gas emissions perspective, a subset of data from 2021 has been analysed (providing an annualised figure). In 2021 there were 203,727 trips, with a combined distance of 482,656 km travelled. The results of this process are shown in Table 7.7.

It is estimated that LIME e-bike use in 2021 avoided 11.4 tonnes of CO2-e emissions.

Table 7.7: Estimated car substitution and GHG benefits of LIME e-bike share program

Bike share outcome metrics	2021
LIME e-bike trips	203,727
Total LIME e-bike distance (km)	482,656
Estimated mode substitution from car	20%
Car trips avoided	40,745

Bike share outcome metrics	2021
Car km avoided	96,531
Average emissions (g CO2-e) per car km	118

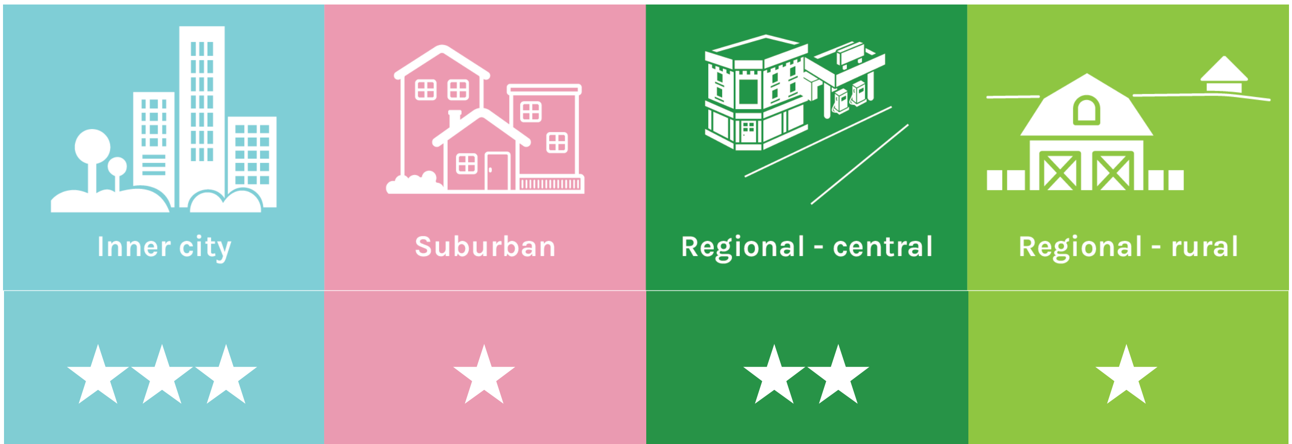
However, if the assumption that most of these journeys would otherwise be taken in ride-sourcing services (e.g. Uber) or taxis is correct, there are further potential benefits. Firstly, reduced demand for ride-sourcing services is likely to reduce the total number of vehicles in activity centres (e.g., drivers will have less opportunity for a fare, so will avoid the area), thus reducing congestion and overall traffic volumes. Secondly, there is a potential multiplier, as ride-sourcing services and taxis have significant numbers of ‘empty miles’, where they are seeking a fare.

7.4.2 E-scooter share

E-scooters have the potential to impact active transport mode share in several ways. On one hand, e-scooters could potentially increase active transport mode share by offering a convenient and affordable alternative to driving for short trips. On the other hand, e-scooters could have a negative impact on active transport mode share if they replace walking or cycling rather than complement these modes (Bicycle Network 2022).

Moreover, the impact of shared e-scooters and private e-scooters on active transport mode share may be different. The restricted catchment of shared schemes, plus the pay-per-minute model may skew usage patterns towards shorter trips. This may result in shared e-scooters replacing walking to a higher degree than private e-scooters. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.36.

Figure 7.36: E-scooter share in prioritisation framework



Implementation time	Impact	Cost	Complexity
Months to years	★	★★★	★★

Action

The following provides some example actions that encompass e-scooter share interventions:

- Develop a Micro-mobility Strategy that outlines an agency’s ambition for e-scooter share programs. This could include:
  - prioritised network of micro-mobility lanes

- prioritised parking locations in high demand area
- identifications of “No go zones” in which it is unsafe to mix e-scooter share and pedestrian traffic
- policies around user fees design to encourage high levels of use
- analysis of optimal catchment size and density of e-scooters.

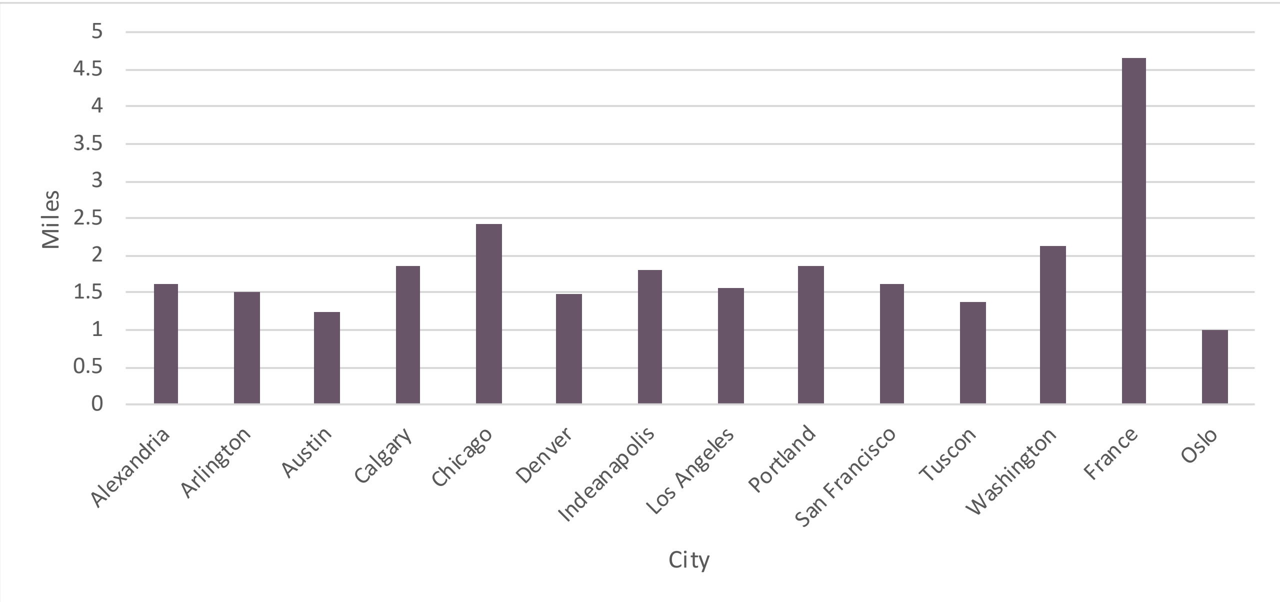
- Engage with the commercial e-scooter share sector to explore the potential deployment of shared e-scooter options.

Evidence base

E-scooter share programs have increased rapidly over the last five years. In many cases, more trips (on a per-device basis) are generated with e-scooters than with e-bike share. This section examines the available evidence on the impact e-scooter share programs have on active travel mode share.

Shared e-scooters are typically available in areas with high levels of pedestrian and bicycle activity, which may encourage more people to substitute walking or cycling for e-scooters. The average trip distance for e-scooters ranges from 1 to 4.7 km (Figure 7.37) with an average of 1.85 km, while the duration of the trips varies from 7.6 to 20 minutes (Figure 7.38) with an average of 13.1 minutes (Badia and Jenelius 2023). The differences between the length and duration of trips are due to variations in commercial speeds, which average around 8 km/h (this may include stopping time). In terms of trip purpose, ‘leisure’ is the most common reason for using an e-scooter (Badia and Jenelius 2023). The research found that in at least 50% of cases, users of shared e-scooters replace other forms of sustainable transport such as walking, cycling, and public transport (Badia and Jenelius 2023), as shown in Figure 7.39. Additionally, e-scooters are often used for recreational purposes rather than transport, which may not have a significant impact on active transport mode share (Figure 7.40).

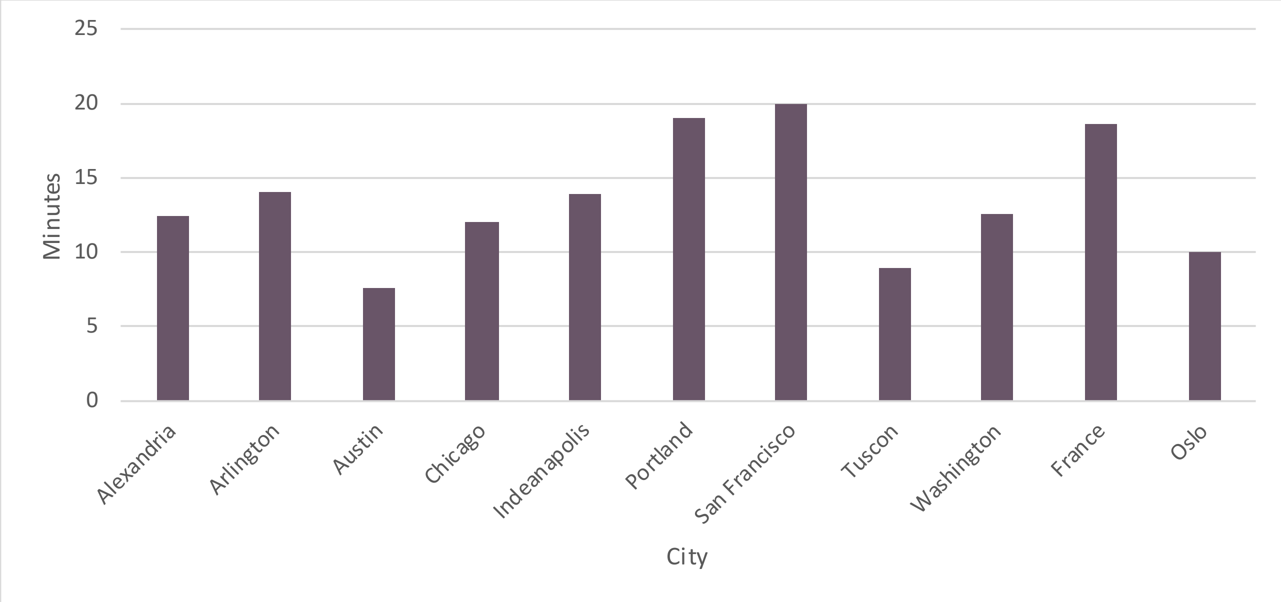
Figure 7.37: Trip distance



Source: Badia and Jenelius (2023)

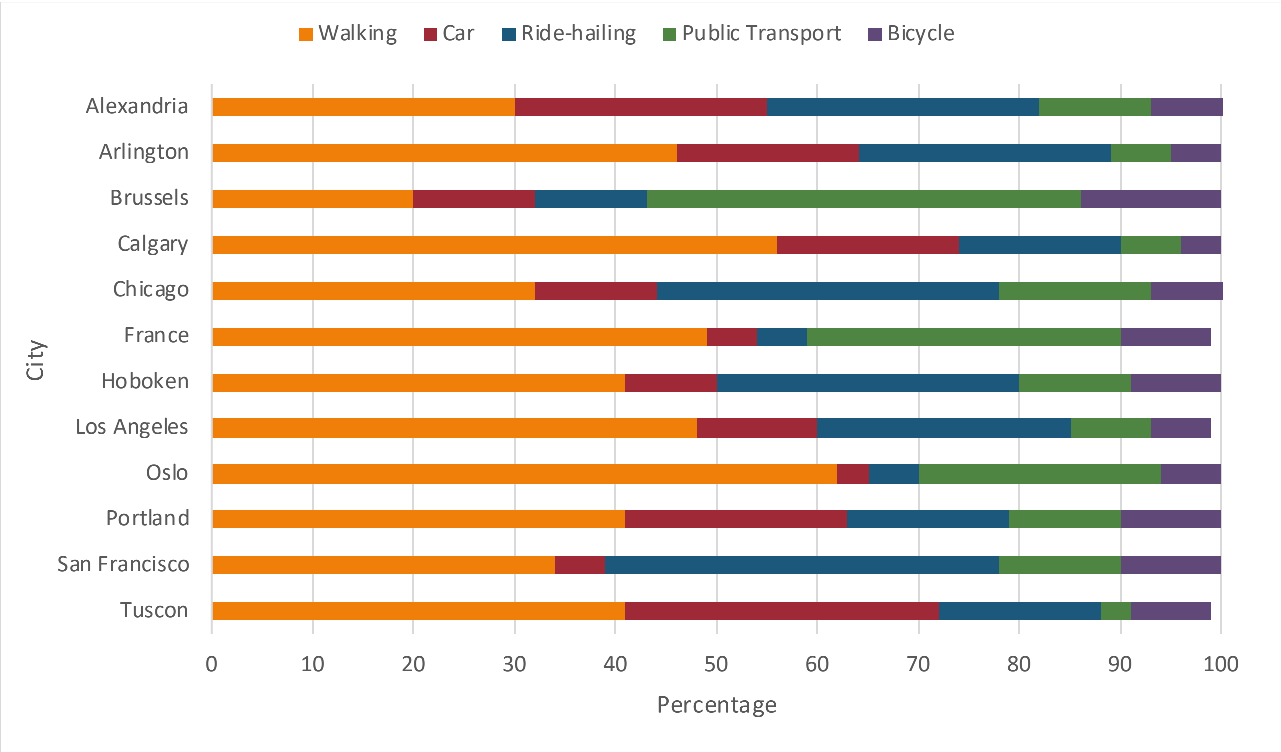
In at least 50% of cases, users of shared e-scooters replace other forms of sustainable transport such as walking, cycling, and public transport

Figure 7.38: Trip duration



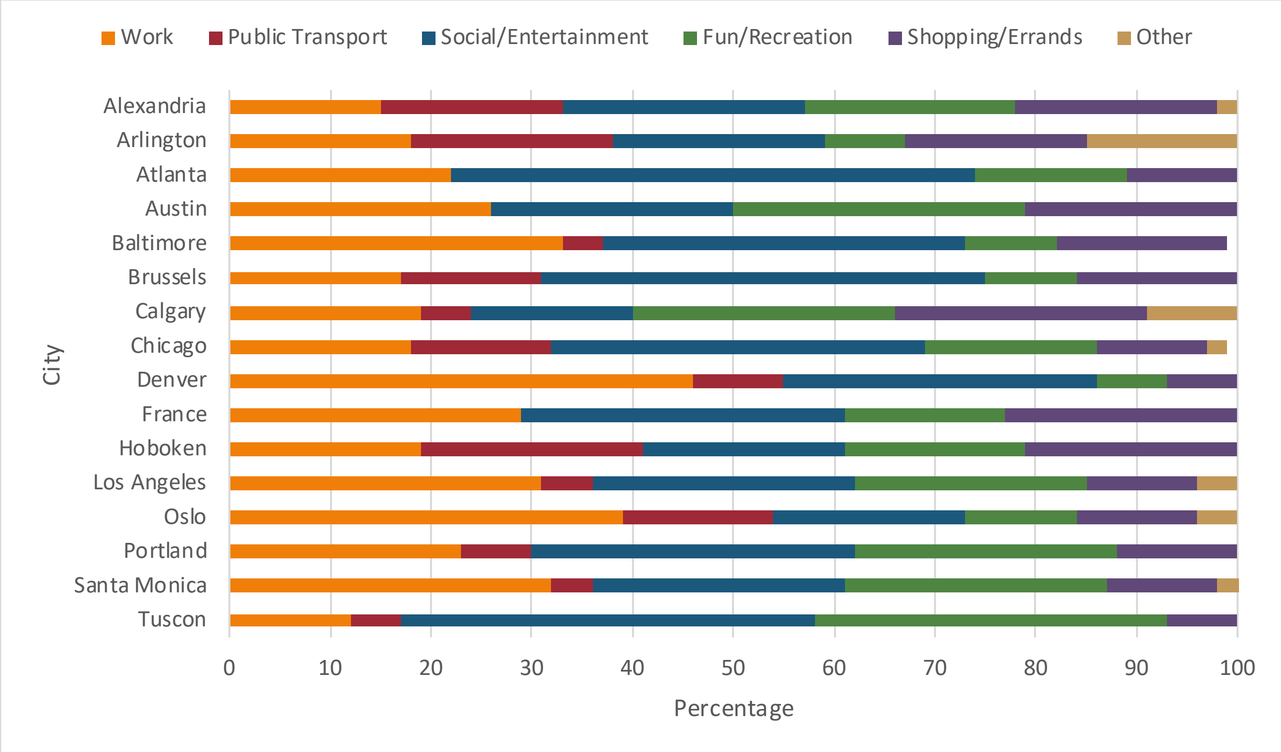
Source: Badia and Jenelius (2023)

Figure 7.39: Degree of displacement of transport modes by shared e-scooter



Source: Badia and Jenelius (2023)

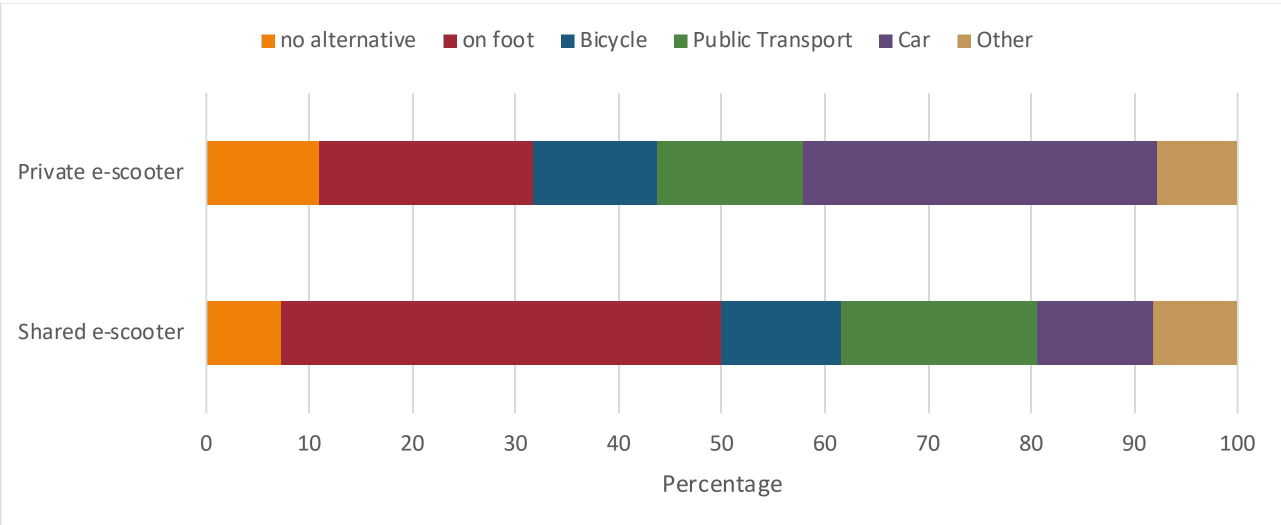
Figure 7.40: Purpose of trips made by shared e-scooter



Source: Badia and Jenelius (2023)

Private e-scooters, on the other hand, may have a mixed impact on active transport mode share. While they may be used for short trips that would otherwise be made by car or other motorised modes of transport, they may also be used for longer trips that would have been made by walking or biking (Figure 7.41). Moreover, they may be used more frequently in comparison to shared e-scooters (Oostendorp and Hardinghaus 2022).

Figure 7.41: Mode replaced by e-scooters



Source: Oostendorp and Hardinghaus (2022)

Sanders et al. (2022) investigated the impact of shared e-scooter use on physician activity. They utilised a pattern known as a five-week, "A-B-A" design, in which an intervention was implemented with a small group (8 participants) of frequent e-scooter users in Phoenix, Arizona, during the summer of 2019. The A-B-A design consisted of three phases. During the first "A" phase (Phase 1), which lasted for two weeks, the participants' behaviour was observed as they went about their normal routine, which included riding e-scooters at least three times per week. At the end of Phase 1, the participants were instructed to refrain from using e-scooters for the following two-week period (Phase 2: "B" intervention/treatment phase). After Phase 2, the participants were informed that they could resume using e-scooters, and the second "A" phase (Phase 3), which lasted for one week, was used as a return-to-baseline condition. The purpose of the A-B-A design was to compare the overall physical activity output between the two types of phases in order to determine whether there were significant effects that could be extrapolated over time. Their findings showed that bicycling and walking trips were significantly more physically active compared to e-scooting or driving trips. Based on self-reported trip data, when e-scooters were allowed (Phases 1 and 3), the use of e-scooters replaced walking, bicycling, and/or e-biking trips more often than car trips. However, during the period in which participants were not allowed to use e-scooters (Phase 2), a 9% increase in car usage was reported.

> …bicycling and walking trips were significantly more physically active compared to e-scooting or driving trips.

Data principally from North America with some studies from Europe, Australia, and New Zealand indicate that using shared e-scooters is more likely to replace trips made by private cars or by walking/cycling, rather than trips made by public transport (K Wang et al. 2023). This is supported by three European studies conducted in France and Norway, where around one-third of the participants reported using shared e-scooters to replace public transport trips. This percentage is higher than what has been observed in North American cities, which could be due to public transport trips in the United States generally being longer compared to shared e-scooter trips. Moreover, the percentage of people using public transport in most United States cities is relatively low. These findings are presented in Table 7.8.

Table 7.8: Reported modes replaced by the use of shared e-scooters

Study area	Driving alone	Taxi	Public Transport	Walk	Micro-mobility
Tempe city		25%		57%	8%
Tuscan	24%	14%	3%	36%	8%
Los Angeles	11%	22%	9%	48%	5%
Oakland	14%	25%	9%	42%	12%
San Francisco	9%	51%	34%	61%	20%
Santa Monica		49%	4%	39%	7%
Denver	10%	22%	7%	43%	14%
Tampa	21%	27%	1%	38%	6%
Atlanta		42%	2%	48%	4%
Bloomington	25%	16%	7%	54%	
Chicago	11%	32%	14%	30%	8%
Portland	19%	15%	10%	37%	5%
Calgary	21%	12%	6%	56%	5%
Toronto		44%	53%	57%	36%
Paris	4%	6%	37%	35%	7%
Munich		24%	59%	80%	59%
Thessaloniki		17%	33%	44%	7%
Oslo	3%	5%	23%	60%	6%
Zurich		10%	24%	52%	14%
Auckland		21%	7%	53%	6%
Christchurch	14%	9%	5%	52%	6%

Source: Wang et al. (2023)

Overall, the impact of shared and private e-scooters on active transport mode share depends on a variety of factors, including usage patterns, availability, and local infrastructure. There is still ongoing research on the impact of e-scooters on active transport mode share, and the results have been mixed. Some studies have found that e-scooters have the potential to increase active transport mode share, while others have found that they may have a negative impact. Factors such as the availability of bike lanes, the price of e-scooter rentals, and the overall culture of active transport in a given area may all play a role in determining the impact of e-scooters on active transport mode share. Further research is needed to fully understand the impact of e-scooters on active transport mode share and to identify ways to maximise their potential to promote active transport.

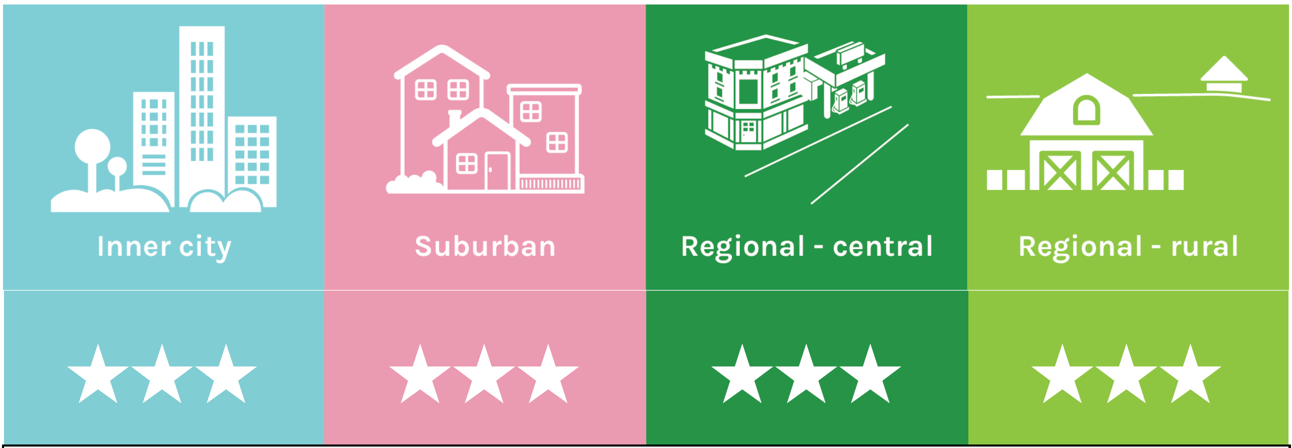
7.5 Policies and strategies

It is difficult to overstate the magnitude of the challenge in growing active transport mode share. The evidence reviewed as part of this project demonstrates that a wide range of interventions are required, sustained over several decades. To increase active transport mode share successfully, these interventions must include measures that incentivise walking and cycling, and disincentivise car use that has the potential to be shifted to active travel. Policies and strategies are an important component of this suite of interventions. These can include a wide change of interventions, from integrating active and public transport, to implementing road user pricing and incentivising the adoption of e-bikes.

7.5.1 Public transport integration with walking and cycling

The integration of public and active transport increases the attractiveness of each. Walking is already the primary mode of transport used to connect to public transport. Cycling is a less common method of accessing public transport in Australasia. The experience in best practice countries, such as the Netherlands, in which some 50% of rail trips start or finish with a bicycle journey, suggests there may be potential to grow this combination. Integrating active and public transport can serve to enhance the convenience of sustainable mobility by improving the door-to-door travel experience. A well-integrated public transport system can help reduce the journey time between people's origin and destination, making active travel a more feasible and attractive option. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.42.

Figure 7.42: Public transport integration with walking and cycling in prioritisation framework



Implementation time	Impact	Cost	Complexity
Years	★★	★★	★★

Actions

The following provides some example actions in which the integration of public transport and cycling is enhanced:

- installing bike racks on buses
- consider the accommodation of bikes when designing train carriages
- developing well-defined footpaths and crosswalks (as outlined in Sections 7.3.1 and 7.3.2)
- plan bicycle networks to provide radial connections to public transport hubs, to increase the catchment area
- provide bicycle parking at stations (as outlined in 7.2.2).

Evidence base

As highlighted earlier, walking is the most common method of accessing public transport in Australia. People who use public transport often walk more than those who do not. In a study conducted in southeast Queensland, Burke and Brown (2007) found that people spend on average 8.2 minutes walking, covering a distance of 670 meters for trips to/from public transport. This finding offers insights into the distances considered acceptable for Australians to access public transport by foot. It is also possible that should the walking environment become more attractive, people may be willing to extend their acceptable walking distance to access public transport. The area around public transport nodes (e.g. railway stations) should be prioritised for pedestrian-friendly design, using the interventions discussed in Section 7.3. A radius of 1.2 km from a railway station is an appropriate walking catchment.

The integration of cycling networks and public transport interchanges can serve to support the use of both bicycles and public transport (Austroads 2020) and can help to make up for the weaknesses inherent in each mode (Buehler and Pucher 2021). It is well established that integrating cycling networks with public transport can significantly increase the public transport catchment by up to a factor of 15, compared to walking (Hudson and Levy 1982). A common theme to emerge from the subject matter expert interviews was the importance the group attributed to the integration of active and public transport to grow active transport mode share.

Integrating cycling with public transport can help make up for the weaknesses inherent to both modes and reduce door-to-door travel time.

A key motivation for combining cycling with public transport is a reduction in door-to-door trip time (Leferink 2017). The factors influencing people's willingness to integrate cycling with train use are (Leferink 2017):

- access and egress distance
- the presence of quality cycle routes to the station
- the relative competitiveness with other modes (e.g. how easy it is to drive and park?)
- quality information provision and ticketing that integrates the use of bicycles, including bike share bikes.

The United States offers a similar level of land use and transport patterns to Australasia, and it is therefore useful to examine United States-based research on the integration of cycling with train use. Cervero et al. (2013) examined changes in the use of cycling as an access mode to the Bay Area Rapid Transit (BART) system in San Francisco and factors associated with the growth in bicycle/train use. Since 1990, the combination of cycling and BART use has grown three-fold. Ashby Station located just south of Downtown Berkeley, recorded among the highest bike mode share of any station in the United States, with some 10% of train travellers arriving by bicycle. There was a 79% increase in the distance cycle/train users travel between 1998 and 2008, increasing from 1 km to 1.8 km. It is therefore useful to look at the factors that may be influencing the high rate of bike/train travel. The authors identify that investment in high-quality bicycle infrastructure enabled more people to see cycling as an option. This influenced a sharp increase in the average distance passengers were cycling to access the station. In essence, the increase in bicycle infrastructure led to an increase in the viable catchment, resulting in longer trip distances to the railway station.

The linear kilometres of bicycle infrastructure surrounding Ashby Station increased from 6.2 km to 19.7 km (217%) between 1998 and 2008, while bike access to the station increased from 7.4% to 11.7%, over the same period. The linear kilometres of bicycle infrastructure surrounding another station, Fruitvale, increased from 4 km to 8.1 km (352%) between 1998 and 2008, while bike access to the station increased from 4.3% to 9.7%, over the same period. In comparison, Balboa Station, with less change in bike access, saw an increase of only 1.2% in cycling access over the same period. Separately, the research on the BART system also found a direct relationship between the increase in bike parking and the increased use of passengers arriving by bicycle.

"If bicycles are to play a significant mobility role for accessing rail stations…safe, secure, and well-designed bicycle infrastructure will be needed".

Cervero et al. (2013)

In addition to the increase in bicycle infrastructure, Ashby BART station also received upgrades that made it easier to navigate by bike, including a system of ramps, eliminating the need to carry bikes up or down stairs. In addition, a large number of secure bicycle parking spaces were provided. The researchers also identify that in 1998, car parking was offered at no cost, and by 2008, a fee of $US1 was imposed. The researchers go on to say that this may have acted as a disincentive to use the car. The provision of free car parking at train stations was identified as a factor that inhibits active travel as a mode of access to railway stations (Cervero et al. 2013).

The integration of cycling and public transport is rare in Australia, both from an individual perspective and in relation to strategic bicycle network planning at a government level. Historically, bicycle networks have not been developed to support access to train stations, and it is more typical for bike infrastructure to run parallel to a rail corridor rather than offer radial connections from the station to its surrounding catchment. Table 7.9 shows the number of people who responded in the 2016 Census as having used a bike and a form of public transport to travel to work. These numbers constitute a small minority of overall public transport patronage, with only around one in every 270 Sydney public transport commuters integrating cycle use, rising to one in around 116 for Melbourne and around one in 100 for Brisbane and Adelaide. This should be viewed in contrast to the Netherlands, where quality cycling networks provide connections to railway stations, and one in two rail users integrate cycle use.

Table 7.9: Bike and Public Transport Use for Journey to Work, Australian Capital Cities 2016

Capital City	Train, bicycle	Bus, bicycle	Ferry, bicycle	Tram, bicycle	Any PT, Bicycle
Greater Sydney	1,367 (0.4%)	417 (0.3%)	248 (2.8%)	25 (0.8%)	2,055 (0.4%)
Greater Melbourne	2,102 (0.9%)	120 (0.4%)	24 (3.1%)	509 (0.9%)	2,764 (0.8%)
Greater Brisbane	494 (0.8%)	262 (0.4%)	91 (2.4%)	N/A	856 (0.7%)
Greater Adelaide	134 (1%)	154 (0.5%)	N/A	26 (0.6%)	317 (0.6%)
Greater Perth	549 (1%)	143 (0.4%)	14 (3.8%)	N/A	703 (0.7%)
Greater Hobart	N/A	7 (0.1%)	N/A	N/A)	6 (0.1%)
Greater Darwin	N/A	67 (1.2%)	N/A	N/A	67 (1.2%)
Canberra (ACT)	6 (1.9%)	169 (1.2%)	N/A	N/A	171 (1.2%)
All Capital Cities	4,659 (0.6%)	1,331 (0.4%)	379 (2.7%)	566 (0.9%)	6,935 (0.6%)

Source: Census, Australian Bureau of Statistics (2022)

Note 1: Percentage is total for that mode – E.g., 0.55% of Sydney train commuters arrived at the station by bicycle

Note 2: N/A indicates that city did not have that public transport mode in 2016

To date, cities in Australia have not historically applied a strategic approach to the creation of bicycle networks that connect with railway stations. Where this has occurred, it has been through the inclusion of bike parking, including secure, weather-protected bike parking (see also Section 7.2.2). The most prominent example of this is Victoria's Parkiteer system which provides secure bike parking at over 100 Metropolitan and Regional railway stations. Customer research found that around a quarter of Parkiteer users previously drove to the station and theft prevention was their main reason for joining. It is also notable that in Melbourne, passengers are always permitted to bring a bike on board the train, while only folding bikes are permitted on trams and buses. In Sydney, passengers are always permitted to bring bikes on board trains and light rail vehicles, while only folding bikes are permitted on buses. Other capital cities in Australia have more restrictive policies, often forbidding non-folding bikes to be taken on board a train during peak hours.

Canberra has a long-standing policy of providing bicycle racks on buses and Victoria is continuing to expand the number of bus routes that provide racks capable of carrying two bicycles. More than 9 in 10 Canberra buses have a bicycle rack, and while it is likely this increases the number of people who cycle, little evaluation data is available. Despite this limitation, Census data does reveal that 1.2% of bus commutes in Canberra include a bike, compared to 0.4% for all Capital Cities, as shown in Table 7-9. In proportionate terms, three times as many people use the bike-bus combination in Canberra than people in other cities.

Three times as many people use the bike-bus combination in Canberra than people in other cities.

Figure 7.43 provides an illustration of a typical bus in Canberra, with the bicycle rack on the front of the bus. This type of configuration is widespread in North American cities. It is important to recognise that while the racks are frequently empty, this does not mean they are ineffective. The racks may serve to provide piece of mind to people on bicycles, knowing that if hills, rain, darkness or mechanical issues arise, they have the option of travelling on a bus with their bike.

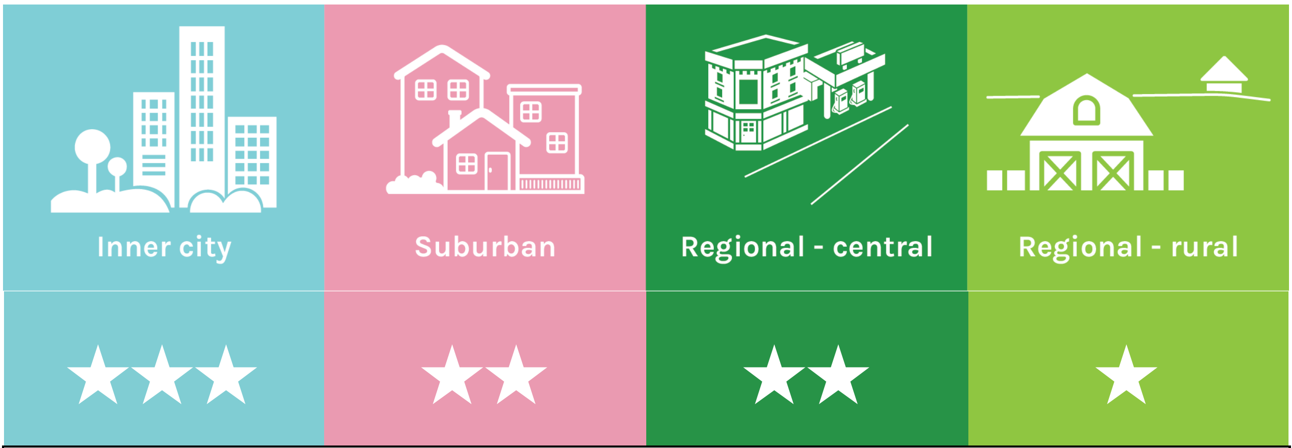
Figure 7.43: Bike racks on buses, Canberra

Source: Canberra Times

7.5.2 Road-user pricing

Road pricing is a policy instrument that can be used to reduce traffic congestion, improve air quality and raise revenue for transport investments (DeRobertis, 2016). Road pricing acts as a disincentive to driving, which can result in a greater uptake of other transport modes, including walking and cycling, where these options are available. The goal is ultimately to reduce the overall amount of driving and increase the efficiency of the overall transport network. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.44.

Figure 7.44: Road-user pricing in prioritisation framework



Implementation time	Impact	Cost	Complexity
Years	★★★	★★★	★

Actions

The following provides some example actions that relate to road user pricing:

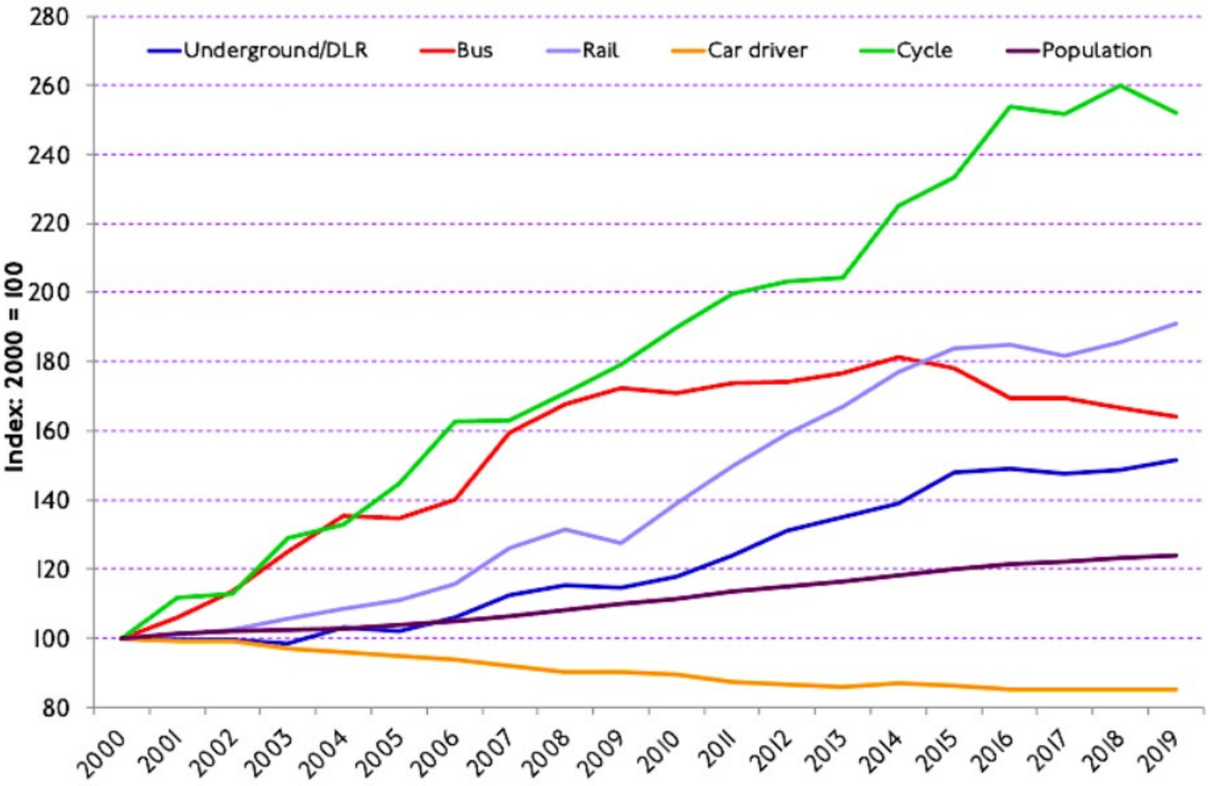
- cordon-based congestion pricing (e.g., London)
- distance-based road user charge (i.e., price per kilometre)
- employ variable pricing based on time and location.

Evidence base

Road user pricing can reduce car use by making driving more expensive and other options more attractive by comparison (Andersson and Nässén 2016). Initiatives that increased the cost of car use in cities were commonly identified by the subject matter experts as one of the most powerful actions to boost active transport mode share. The effects of road pricing on active transport mode share depend on the specific characteristics of the pricing scheme and the surrounding transport infrastructure and culture. For example, road pricing in Milan, Italy has been found to increase the mode share of cycling by at least 5% (Cornago et al. 2019).

Perhaps the most prominent example of road user charging can be seen in London. In February 2003, London introduced a Congestion Charge in which drivers pay a fee for entering the congestion charging zone (Metz 2018). This fee has been incrementally increased over time, and as of mid-2023 costs drivers the equivalent of $A29 to travel by car within the zone. The congestion charge has been effective in reducing car usage. Metz (2018) found that the congestion charge reduced car use by around 30%. Data released by Transport for London shows the change in use of different modes of transport over the two decades from 2000 to 2019, shown in Figure 7.45. A steady decline in car use is evident, even as population growth increased (also shown in Figure 7.45). The work by Kuss and Nicholas (2022) found that schemes such as the London Congestion Charge are among the most effective mechanisms for reducing car use and increasing sustainable transport use, including walking and cycling.

Figure 7.45: Change in transport mode use, London



Source: Transport for London

Sweden has implemented congestion charges in Stockholm and Gothenburg. Drivers are charged a fee for using certain roads during peak hours (Andersson and Nässén 2016; Eliasson 2014; Metz 2018). The Stockholm congestion charge system which was introduced in 2006, charges motorists a fee to drive into and out of the city centre during peak hours (Eliasson 2014; Metz 2018). The fee varies depending on the time of day and the location, with higher fees during the busiest times and in the most congested areas (Metz 2018). At the time of implementation, the Stockholm road user price reduced motor vehicle volumes by around 20% (Börjesson and Kristoffersson 2015). As the reduction in vehicle volumes has a non-linear effect on congestion, the 20% reduction in vehicle volumes led to an up to 50% reduction in congestion (Metz 2018). Cycling was found to increase following the introduction of the congestion scheme in Stockholm (Börjesson and Kristoffersson 2015).

As the reduction in vehicle volumes has a non-linear effect on congestion, the 20% reduction in vehicle volumes led to a up to 50% reduction in congestion.

Gothenburg introduced a cordon-based congestion charging scheme in 2013. Congestion pricing has reduced traffic across the cordon by 12%, during the hours during which a fee applies (Börjesson and Kristoffersson, 2015). Alongside a reduction in traffic, there has been an increase in public transport usage for commuting of 24% (Börjesson and Kristoffersson 2015). A pre-post analysis of commuting behaviour after introducing congestion pricing found that car commuting decreased by 6% and public transport increased by 3.2% (Andersson and Nässén 2016). Interestingly, women were found to be twice as likely to change behaviour as a result of the congestion charging (Andersson and Nässén 2016). It is uncertain to what level cycling increased following the introduction of the Gothenburg congestion charge. This may be due to unusually cold weather in the early Spring of 2013 when the data was collected (Börjesson and Kristoffersson 2015).

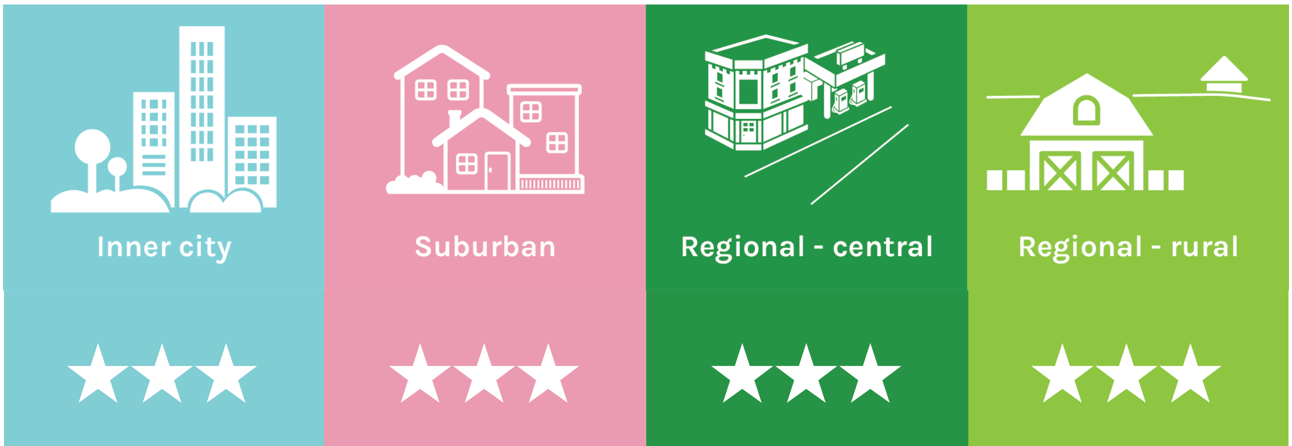
Singapore implemented congestion pricing through an electronic road pricing (ERP) system (Metz 2018). The system was first introduced in 1998 to manage traffic congestion during peak hours in the city centre and has since been expanded to cover other parts of the island. The fee varies depending on the location and time of day, with higher fees during peak hours and in more congested areas. Charges are assessed quarterly by measuring average speeds: if speeds fall below a threshold, charges are increased to reduce the volume of traffic, whereas if speeds are above the threshold, charges are reduced. Charges also vary by vehicle class, time of day and location (Metz 2018). The road user pricing system has caused a reduction in traffic volumes in the central business district by about 10–15% (Metz 2018). The number of bus trips has increased (Agarwal and Koo 2016), but there is a paucity of evidence related to changes in active transport, other than walking to/from public transport.

Edwina (2018) argues that an area-wide congestion charging approach, which differentiates based on time and place, is the most efficient method of road pricing. This supports the approaches taken in the above cities. Further, Edwina (2018) suggests that congestion charging in Stockholm and London has shown that the public accepts road pricing following implementation.

7.5.3 E-bike incentive

Financial incentives have become an effective option to further encourage e-bike use. Subsidising micro-mobility purchases can be an effective strategy to induce mode shift. E-bikes provide a wide range of benefits, including reduced infrastructure costs, consumer savings, increased public health and safety, and reduced sprawl (Litman 2022). A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.46.

Figure 7.46: E-bike incentive in prioritisation framework



Implementation time	Impact	Cost	Complexity
Months to years	★★	★	★★★

Actions

The following provides some example actions that relate to e-bike incentives:

- introducing trade-in programs for people buying e-bikes
- e-bike subsidy programs to help people buy e-bikes
- employer subsidies to employees to buy e-bikes
- offering e-bike leasing programs

- creating a free loan program, to enable people to *'try before they buy'*.

Evidence base

A number of European studies have found e-bikes to have a strong impact on reducing car use (Cairns et al. 2017). In general, most studies find that between 40% - 50% of e-bike trips replace a journey that would have otherwise been completed by car (Cairns et al. 2017). The degree to which e-bikes replace car trips can increase for the commute trip. In Australian research, 60% of respondents to an online survey cited replacing some car trips as a main motivation for e-bike purchases (Johnson and Rose 2013). The following offers a concise summary of the evidence related to e-bike subsidy schemes.

A bill has been introduced to the US Senate for a refundable tax credit on the purchase of a new e-bike called the Electric Bicycle Incentive Kickstart for the Environment (or E-Bike Act) (Fishman and Davies 2021). Under the proposed Act, a refundable tax credit worth 30% of a new e-bike's price would be available, for a maximum of $US1,500 ($A2,040). An e-bike costing more than this amount can still be eligible for the scheme, but the rebate is limited to the maximum amount. The E-Bike Act is means tested.

> *"The electrification of transportation is not just about cars, it's about every way to get around."*
>
> US Senator Schatz

Over the last two decades, the UK has funded a Cycle to Work scheme in which employees receive discounted bikes and equipment through their employer, as a lease-to-own model (Fishman and Davies 2021). More recently, the UK Government has been developing a program designed to make it easier for people to give e-bikes a try. The planned program would work by enabling local councils to purchase e-bikes, which are then offered on a low-cost loan basis to residents. The proposed program to fund e-bikes comes after a £2 billion funding initiative was announced to construct walking and cycling infrastructure.

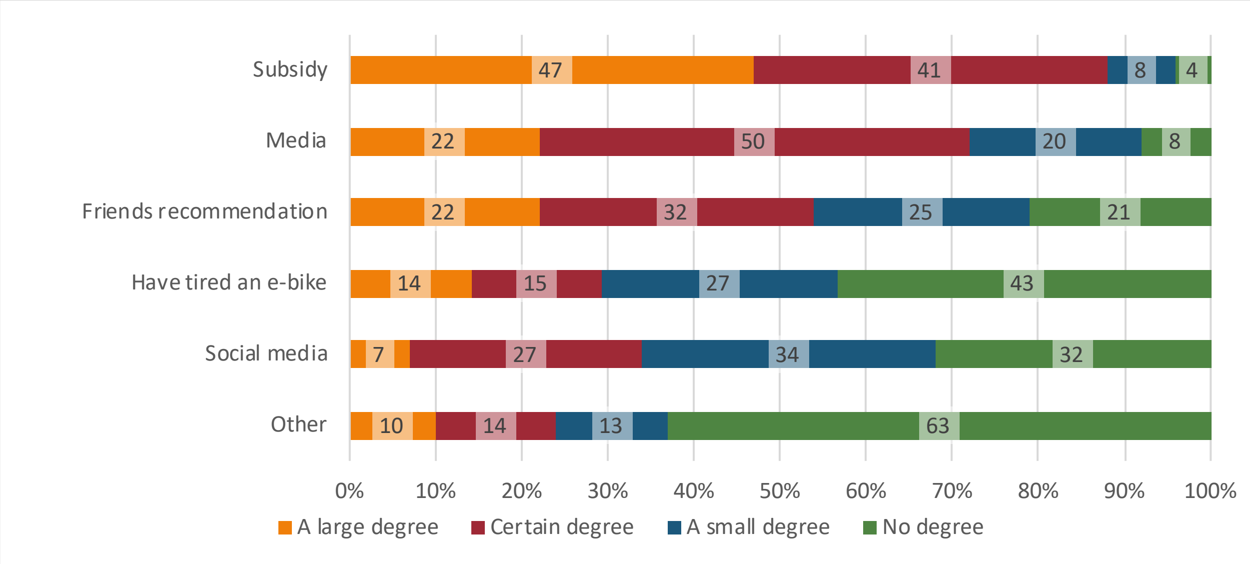
> The UK government has committed £2 billion for walking and cycling projects.

In 2018, the Swedish government launched a subsidy for e-bikes, providing a 25% rebate, up to a maximum sales price of SEK 10,000 (~$A1,555.50) (Fishman and Davies 2021). Given that all high-quality e-bikes meet the maximum subsidy rate, what this means in effect is that the Swedish government provides its citizens with a rebate of $A390 for the purchase of an e-bike. This subsidy has been found to significantly increase the number of people in Sweden who purchased an e-bike (Söderberg f.k.a. Andersson et al. 2021). When the Swedish subsidy period closed, the following year, the proportion of e-bikes sold (as compared to conventional bikes) went down 4%, from 20% to 16% (Söderberg f.k.a. Andersson et al. 2021).

Norway is well known as the leader in electric car adoption, with around 8 in 10 new cars sold in 2020 being battery electric (Fishman and Davies 2021). What is less well-known is that the Norwegian capital, Oslo, has had an e-bike subsidy program operating since 2016 (Fyhri et al. 2016). Residents of Oslo were able to apply for a 25% rebate on the cost of an e-bike, up to a maximum rebate of €500. For example, an Oslo resident could purchase an e-bike costing $3,000 and they would be eligible to receive a rebate of $750, meaning the out-of-pocket cost of the bike is $2,250. More recently, Oslo provided a special subsidy program to encourage the uptake of e-cargo bikes. A summary of the factors that influence e-bike purchases in Oslo is offered below.

Oslo's e-bike subsidy program was examined for its impact on e-bike purchases and found to have a strong influence on people's willingness to buy an e-bike (Fyhri et al. 2016). The Norwegian researchers used both the questionnaire data, and actual travel behaviour data recorded using an App. Figure 7.47 provides an indication of the influence of different factors in the purchasing of an e-bike, using the responses from 830 people who had recently become e-bike owners. It shows that overwhelmingly it was the subsidy from the City of Oslo that influenced the purchasing decision. Media and peer recommendation was also found to be an important factor – both of which may have been influenced to some degree by the subsidy program itself which attracted a lot of media attention when it was announced.

Figure 7.47: Factors influencing decision to purchase an e-bike (%)



Source: Fyhri et al. 2016

The Netherlands is well-known for having the highest levels of cycling globally, with ~27% of all trips taking place on two wheels (Fishman and Davies 2021). In addition to spending ~€30 ($A45) per head of population annually on bicycle infrastructure, the Dutch also have a financial incentive for those riding for work. Under the scheme, people riding to work can claim €0.19 from their employer for each kilometre they ride to/from the office.

The Dutch government, in addition to spending around $A45 per resident on cycling infrastructure, also pays people to ride to work.

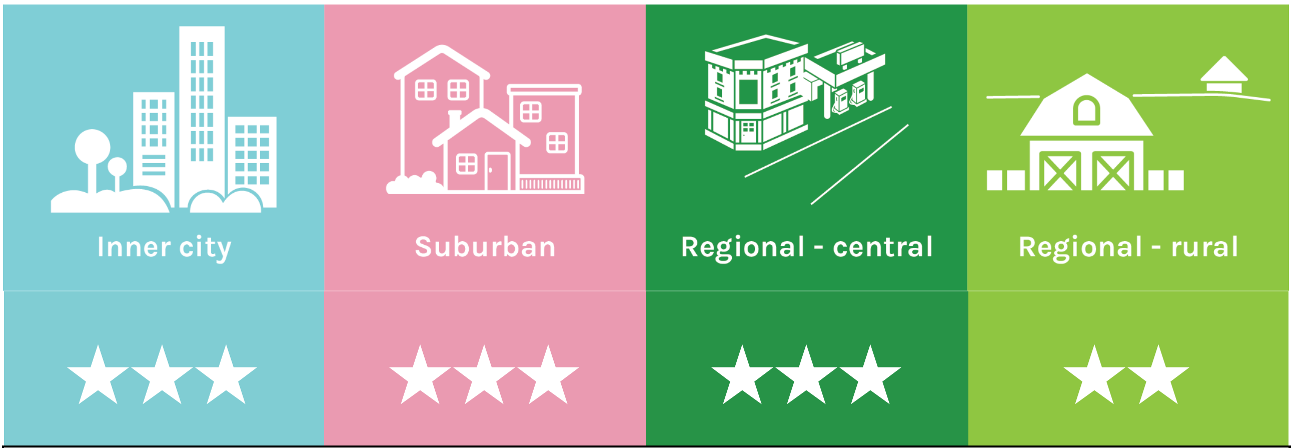
7.6 Education

Education interventions are designed to encourage individuals to shift from using motorised vehicles to more sustainable and active modes of transport. These interventions play a role in raising awareness, leveraging behavioural insights, improving people's skills for active transport such as bike training, and increasing community engagement.

7.6.1 Travel behaviour change programs

An individual's travel behaviour is influenced by their community, social and cultural factors, and the availability of various transport choices (Cheshmehzangi and Thomas 2016). Previous research indicated that behaviour change/individualised marketing had the potential to increase the time spent walking by up to one hour per day (Ogilvie et al. 2007). Interventions used a combination of methods, such as mass media campaigns, community events, modest environmental improvements, walking groups, and written materials. It is critical to highlight that the success of travel behaviour change programs is dependent on having an environment that is supportive of people's decision to walk or cycle. If the transport network is hostile to active travel, behaviour change programs will have limited impact. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.48.

Figure 7.48: Travel behaviour change programs in prioritisation framework



Implementation time	Impact	Cost	Complexity
Months to years	★★★	★★	★★★

Actions

- Social marketing programs to increase awareness of active transport options (e.g. TravelSmart).
- Local area wayfinding programs to inform the community of safer walking and cycling routes.
- Developing frameworks that can be used to identify areas that may be suitable for travel behaviour change interventions.
- School-based programs to increase active transport mode share to school (e.g. Ride/Walk to School Programs).

Evidence base

Understanding how individuals respond to different messages is an important issue in travel behaviour change programs. Notthoff and Carstensen (2014) used two studies to investigate whether approaches aimed at promoting walking could be enhanced by considering older adults' preferences for positive information. In Study One, they measured the effectiveness of positive, negative, and neutral messages in encouraging walking (using pedometers). In the positive framing condition, participants were informed about the potential positive outcomes resulting from walking (e.g., 'Walking can have important cardiovascular health benefits'). In the negative framing condition, participants were informed about the potential negative effects resulting from not walking (e.g., 'Not walking enough can lead to an increased risk for cardiovascular disease'). In the control condition, participants received neutral information about walking (e.g., 'Walking is an aerobic activity'). When older adults were informed about the benefits of walking, they walked a thousand steps more than those who were informed about the negative consequences of not walking, while younger adults were unaffected. In Study Two, older adults were assessed over a 28-day period for changes in walking in response to positively or negatively framed messages. Once again, positive messages promoted walking more effectively than negative messages.

When older adults were informed about the benefits of walking, they walked a thousand steps more than those who were informed about the negative consequences of not walking

Taken together, these findings suggest that tailored, multi-faceted interventions that incorporate positive messaging may be effective in promoting walking/ active transport, particularly among sedentary populations and older adults.

The Active Living by Design (Active Seattle) project based in Seattle, US was a project that aimed to make Seattle a more walkable city through social marketing and education. The project identified that lower-income adults were more likely to be sedentary and prioritised five neighbourhoods in Seattle with high concentrations of vulnerable populations historically underrepresented (Deehr and Shumann 2009). Walking was encouraged by indicating walk times to popular destinations, stairs, signalised crossings, elevation changes, bike routes, bus routes, and walking routes on maps. Figure 7.49 shows the activities introduced as a part of Active Seattle.

Figure 7.49: Active Seattle

Source: Deehr and Shumann (2009)

Deehr and Shumann (2009) evaluated Active Seattle and found it to be successful in promoting a change in the city’s culture. For example, the results from an informal survey showed that 35% of participants got more physical activity after the project. The survey also revealed that over 50% of participants walked to the grocery store more frequently. Likewise, at Bailey Gatzert Elementary in the Central District neighbourhood, a pilot program yielded a 24% increase in the number of students who walked to school and facilitated a policy change to improve and expand the city's definition of school zone boundaries. As a result of Active Seattle, walking maps became a community organising tool.

TravelSmart is a voluntary (opt-in) travel behaviour change (VTBC) program that was common in Australia, particularly in the decade from 2000. TravelSmart programs were implemented in schools, workplaces and communities. These programs provided targeted information for those expressing a willingness to make smarter use of the car via greater use of sustainable transport options. Stopher et al. (2010) carried out an evaluation of TravelSmart, finding a 5% reduction in car use for participants while non-participants reported 4% increase in car use. Moreover, a 5% increase in walking and a 1.6% reduction in cycling was reported by participants. These conversion rates will be highly dependent on the surrounding land use mix and riding environment. In situations with very low density and segregated land use, it should be expected that conversion from car use to walking will be less likely than for denser, more diverse land use.

Australian households can use VTBC for guidance, advice, and assistance in reducing their dependence on private cars (Taylor 2007). Taylor (2007) investigated the effect of VTBC in three Australian cities, Adelaide, Perth, and Brisbane. Based on her research, in Adelaide there was a 10% reduction in vehicle kilometres travelled (VKT). The outcomes from the first Adelaide trials indicated that there could be a consistent 15% reduction in VKT. This study involved about 900 households. The program offered an opportunity for everyone who lived, worked, studied, shopped, and played in the neighbourhood to change their behaviour. In another study, Stopher et al. (2010) measured the effect of the TravelSmart campaign over the 2-year survey period. The program led to a decrease in VKT by participant households (Stopher et al. 2010). The results suggest that participant households decreased their average daily travel distances by 15 km, while non-participant households increased VKT by 5 km.

In Perth, three programs were implemented: IndiMark, TravelSmart, and Your Move. The IndiMark program was implemented in the local government area of South Perth and involved about 400 households. The TravelSmart program was a larger-scale initiative that was implemented city-wide in South Perth and involved 15,300 households. Of these households, around 40% actively participated in the program by seeking advice about how to change their travel habits, while a further 15% were identified as existing ‘regular users’ of walking, cycling, and public transport. The IndiMark program aimed to increase the use of environmentally friendly modes of transport and decrease the amount of car travel. The program began with a travel survey to assess current behaviour and motivation to change, followed by individualised marketing for survey participants and an evaluation survey to measure the extent of behaviour change. The evaluation survey found a 10% reduction in car driver trips and a 14% reduction in VKT. This reduction in VKT saw the use of public transport increase by 21%, cycling by 91%, walking by 16%, and car passenger trips by 9%. A follow-up evaluation conducted 12 months later found sustained changes and additional reductions in VKT. The Travel Smart program also aimed to change the travel behaviour of all households in South Perth. Approximately 40% of households participated in the program which led to sustained reductions in car use and increases in walking, cycling, and public transport use (Taylor 2007). “Your Move" is a Department of Transport program encouraging active transport and reducing car trips. It provides resources and support for individuals, schools, and workplaces. The program evolved from earlier initiatives over two decades, focusing on behaviour change through personalised coaching and community engagement. It began in 2013/14 in the City of Cockburn and successfully achieved targets. Similar programs were launched in Wanneroo, Bassendean, and Stirling, all aiming to reduce congestion and promote public transport, physical activity, and community bonds (Department of Transport n.d.).

In Brisbane, a pilot study in the Grange district of inner northern Brisbane using the IndiMark technique was conducted. The study aimed to validate the results obtained from previous trials in Perth. The study surveyed a random sample of 1,080 households, of which half were controlled and the other half participated in the trial. Of the 455 households invited to participate, 294 households actively participated. The study found a 10% reduction in private vehicle trips, a 33% increase in public transport trips, and a 6% increase in cycling trips. These results differed in magnitude from those found in the earlier study due to differences in topography and public transport supply in the two study areas. The decrease in car usage was consistent with the earlier studies, and it should be noted that the use of environmentally friendly modes decreased slightly among the control group during the trial (Taylor 2007).

In Melbourne, a VTBC program that targeted incoming first-year students at the Clayton Campus of Monash University, was evaluated at the start of the 2004 and 2005 academic years (Rose 2008). An analysis of before and after travel surveys showed a significant reduction in single-occupant commuting and an increase in public transport usage. Some 6.4% of participants used environmentally friendly modes of transport after the campaign. Nearly one in four students who participated in the TravelSmart initiative indicated it had influenced them to think about using, trying, or regularly using alternatives to solo driving to campus. The information provided about public transport services was the most valued element of the program.

Overall, although the evaluation of TravelSmart programs is patchy, there is generally a 5% - 15% reduction in car use, with the average being closer to the lower end of this range.

The City of Sydney has committed to making cycling an equal first-choice transport mode along with walking and using public transport, with a goal of increasing the number of bicycle trips by residents to 10%. In addition to the physical infrastructure upgrades, the City of Sydney is also creating educational and social initiatives to encourage bike riding, such as creating an environment where cyclists feel safe and comfortable riding and promoting awareness and respect between cyclists, pedestrians, and other road users.

The City of Sydney is using a variety of complex and multi-faceted strategies and programs to encourage people to ride bicycles. One example is the Streetshare project from 2010, which recommended 12 different programs. These programs cover various areas, including advocacy through initiatives like the RMS, Community Leadership program, Friends of Sustainable Sydney, Big Picture Campaign, and employer program. There are also programs aimed at increasing awareness and education, such as the Coexistence campaign and village roadshows.

One of the training programs is the 'Cycling in the City' training course, which teaches responsible riding to residents and workers. The course has been running since June 2009 and consists of theory and practical sections. Around 400 people complete the course per year. In addition, there are other courses such as Rusty Riders, bicycle maintenance, modified Cycling in the City, schools' courses and balance bike clinics. In the period from December 2017 to March 2018, a total of 14 people completed the Rusty Riders course, 112 attended bicycle maintenance courses, 23 staff completed the modified Cycling in the City course, 176 school children attended the school's course, and 1,215 young children attended the balance bike clinics.

The 'Cycling in the City' training course consists of a four-and-a-half-hour course designed to teach low-risk, responsible riding, including introductory theory and rules sections, practical off-street and on-street drills, and is run every weekend by Bike Wise. To determine the effectiveness of the program, respondents were asked a series of questions about their biking habits before and after taking the course. The results indicate that 71% of participants reported riding more often after completing the course. This is due to increased confidence in riding in traffic and a better understanding of the road rules and bike routes. The number of people riding regularly (at least once a week) nearly tripled from 26% to 69%. The proportion of respondents who rode to work regularly more than tripled from 9% to 30% after completing the course. Additionally, more than three-quarters of all respondents stated that they were either "very confident" or "quite confident" performing different functions related to bike riding. Respondents felt least confident riding in traffic and riding through narrow spaces. Regarding bike riding knowledge, 91% of respondents reported "excellent" or "good" knowledge of road rules and cyclists' responsibilities, while 87% knew where to access cycling-related information, and 82% could identify a safe and quiet route. However, 43% stated that they were not confident in how to do a weekly bike check ('Cycling in the City' Post-Course Survey Results, Summer, 2018).

City of Sydney conducted research aimed at understanding how to communicate about infrastructure and promotional programs related to cycling to non-riders. A two-stage research process was used, consisting of two focus group discussions and a pilot questionnaire and choice modelling task. The researchers used a sample of respondents who commute three or more days a week and tested the questionnaire among them. The choice modelling component used photographs of cycle paths and banner ads, and respondents were asked whether they would choose to ride a bike or not. Half of the respondents were shown a video, and half were not. The research aimed to differentiate between attitudinal and behavioural responses through attitudinal scales. The study found that the availability of separated cycleways has the biggest impact on whether residents choose to commute by bike. Over 60% of residents surveyed indicated they would commute by bike at least once a week if they had access to a separate cycleway for the entire of their trip. The impact of separated cycleways is non-linear, and the likelihood of a resident commuting by bike increases exponentially with the proportion of their commuting trip made possible on a separated bike path.

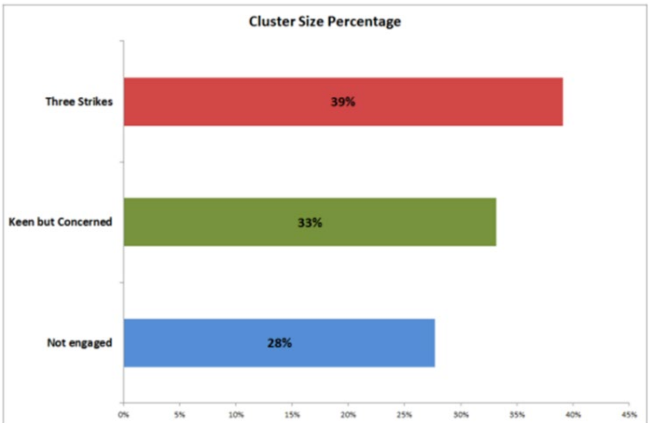
> The availability of separated cycleways has the biggest impact on whether residents choose to commute by bike.

The study also revealed three key attitudinal clusters:

- three strikes
- keen but concerned
- not engaged.

The group known as 'three strikes' don't see any advantages in cycling to their destinations, and they consider it to be unsafe, challenging, and inconvenient due to physical limitations or hilly terrain. It is unlikely that they can be persuaded to switch to cycling. For program efficiency, it is suggested they not be included in future activities. They are akin to the 'No way, no how' group identified by other researchers and practitioners. The group known as 'Keen but concerned' are more open to the idea of cycling as a means of commuting, as they acknowledge its benefits in terms of health, cost, time, and flexibility, as well as the positive impact on the environment. While safety is a concern, they are less likely to find cycling difficult compared to the 'Three strikes' segment. The 'Not engaged' group is notable because they don't see many advantages in cycling, but they don't consider it a challenging task, nor do they have safety concerns. This group is less likely than the other two segments to perceive cycling as a risky activity. Future demand for bike commuting is likely to come from the 'Keen but concerned' cluster, which represents 33% (Figure 7.50) of residents surveyed. This group has safety concerns regarding bike commuting but is much more likely than the other groups to see the benefits of commuting by bike, both for themselves and the environment. They are significantly less likely to find the prospect of commuting by bike difficult and are the most responsive to the presence of separated cycleways.

Figure 7.50: Attitudinal cluster distribution



Source: City of Sydney (2012)

The impact on commuter choice behaviour of promotional campaigns by the City of Sydney was very limited, and the recall of campaigns promoting the benefits of commuting by bike was low. The data suggests that promoting the existence of separated cycleways along key commuting corridors is likely to be a much more effective driver of behaviour change in the short term. Effective access to separated cycleways is still perceived to be limited, and only 13% of the surveyed residents believe they have a cycleway nearby, that is separated and would take them directly or broadly where they need to go. The study suggests that the priority activities, in order of likely effectiveness (impact on changing behaviour relative to cost), are (City of Sydney 2012):

1. raising awareness of existing cycleways amongst nearby residents
2. continue the building of separated cycleways, particularly focusing on eliminating interrupted sections of existing cycleways
3. focusing marketing messaging on separated cycleways. Investment in general promotional activities and building additional end-of-trip facilities should be deprioritised relative to the above.

7.7 Special events and marketing

Special events and marketing can promote active modes of transport, raising awareness, and encouraging their use. Incorporating special events and marketing into active transport prioritisation frameworks helps create a comprehensive approach that combines infrastructure improvements with behaviour change efforts.

7.7.1 Ride 2 Work Day / Walk to Work Day / Walk in to Work Out

These events are usually scheduled on particular days with the primary goal of increasing public knowledge and understanding about the advantages of incorporating walking and cycling into daily commuting routines. They are designed to spotlight the benefits of these sustainable modes of transport, such as improved health, reduced environmental impact, and decreased traffic congestion. A summary of this intervention in the prioritisation framework and its suitability in different geographical contexts is presented in Figure 7.51.

Figure 7.51: Ride 2 Work Day / Walk to Work Day / Walk in to Work out in prioritisation framework

Implementation time	Impact	Cost	Complexity
Months	★★	★★★	★★★

Actions

- Plan and implement a workplace-based program to promote cycling.
- Plan and implement a workplace-based program to promote walking.
- Evaluate the effectiveness of programs designed to promote walking and cycling at workplaces.
- Explore and implement measures that permanently enhance opportunities to walk and cycle to work.

Evidence base

Each year, Victoria hosts 'Ride 2 Work Day', which attracts thousands of participants and encourages riding to and from work. A single follow-up survey five months after the event showed that about one in five were riding to work for the first time. Moreover, more than one in four (27%) of those who rode to work for the first time as part of the event were still riding to work five months after the event. Over 80% of first-timers indicated that the event had a positive impact on their readiness to ride to work. Some 57% indicated that it influenced their decision to ride. The authors found the event had a greater impact on influencing behaviour change for female riders (Rose and Marfurt 2007).

A more generalised travel behaviour change campaign in Sydney focused on staff at an inner-city hospital. This resulted in a 20% reduction in driving to work (Wen et al. 2005). The campaign aimed to raise awareness of reducing private car use and increasing consideration of alternatives like walking, cycling, and public transport. The specific campaign materials included e-mail newsletters, and messages on payslips and flyers as intervention tools. The results suggest that targeted education interventions can be effective in reducing the proportion of employees who drive to work.

In Glasgow, Scotland, a self-help intervention (the 'Walk in to Work Out' pack), designed to increase active travel to work was carried out via written interactive materials (Mutrie et al. 2002). The evaluation found positive results for walking but not for cycling (Mutrie et al. 2002). Participants in this study included 295 employees who walked or cycled to work irregularly or thought about doing so in 2001. After six months, the intervention group was almost twice as likely to increase walking to work as the control group. In contrast, cycling did not increase despite the intervention. The results were not influenced by distance travelled to work, gender, or age. At 12 months after receiving the intervention pack at baseline, 25% of the intervention group was regularly active in commuting. As a result of this assessment, the authors concluded that the 'Walk in to Work Out' pack was successful at increasing walking, but not cycling. The findings of this study suggest that for cycling to become a popular option, the environment in which cycling takes place needs to be more supportive. This aligns with the findings reported earlier from the City of Sydney.

> For cycling to become popular as a workplace intervention, the wider environment must become more supportive.

When educational campaigns produce positive results, it is not always possible to assess which aspect of the campaign produced the best results. Bike Now was an intervention that implemented actions in the context of a workplace to encourage people to take up (and continue) cycling to work for a 12-month period in different parts of New Zealand. Some of the actions included:

- bike mentoring/buddying
- establishing 'bike buses'
- providing cycle skills training
- creating secure parking at the workplace
- providing a 'cycle fleet' for travel during work hours.

The results show that Bike Now's presence at work increased awareness of cycling, and some members of the self-selected sample started cycling to work, but none of the initiatives alone stood out as contributing to this success (O'Fallon 2010). In the assessment survey, 32% of the 675 respondents said they rode their bikes to work more often than they did before the intervention (one year earlier). Some 150 (69%) of those who rode their bicycle more frequently reported that they were cycling over an hour more per week, and the rest were cycling up to one hour more per week. Nearly half (49%) said they had replaced driving with cycling. Among 1,553 respondents, 20.3% stated they bicycled more often than they had before the intervention for reasons other than travelling to work.

> When educational campaigns produce positive results, it is not always possible to assess which aspect of the campaign produced the best results.

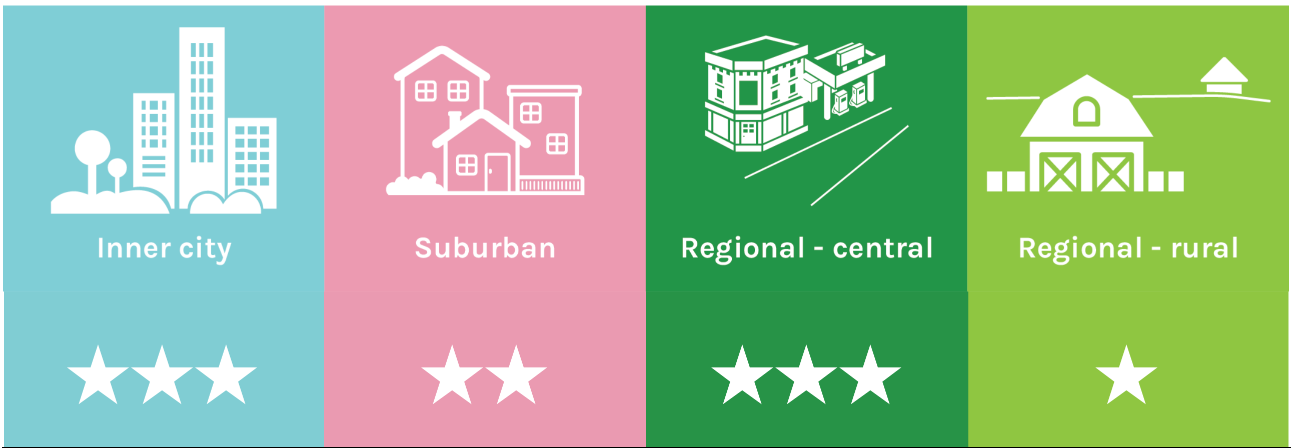
Not all media campaigns conducted in workplaces lead to favourable outcomes. For instance, a study assessing the behavioural change resulting from Australia's Walk to Work Day (WTWD) media campaign, found no statistically significant effect on mode shift (Merom et al. 2005). Using written materials, such as newspaper advertisements and community service announcements through the major free-to-air television channels and radio stations, and behavioural interventions, WTWD promoted walking, reducing car use, and increasing public transport among urban-dwelling working adults. The study used pre- and post-campaign telephone surveys of a cohort of adults aged 18 to 65 years (n=1,100, 55% response rate), randomly sampled from Australian major metropolitan areas. In New South Wales, researchers found a decrease of 3.1% in car trips and a decrease of 6.3% in trips only made by public transport. Moreover, there was a statistically significant increase of 9% in trips that combined walking and public transport. Nonetheless, other metropolitan areas experienced an increase in 'car only' trips (not significant) and a significant decrease in 'walking/cycling and public transport' trips. The mixed results show that not all populations react in a similar manner to the same interventions.

In conclusion, workplace interventions and media campaigns can be effective in promoting active travel to and from work, but their success depends on various factors such as the target population, the type of intervention, and the wider environment. The studies reviewed demonstrate that different approaches can produce positive results, such as increasing the number of employees who ride or walk to work, reducing the number of car trips, and increasing physical activity levels. However, not all campaigns and interventions are equally effective, and it is important to evaluate their impact and assess which aspects contribute to their success. Therefore, future workplace interventions and media campaigns should be tailored to specific populations and consider the social, cultural, and environmental factors that influence travel behaviour.

7.7.2 Ciclovias

Ciclovías are special events run in different cities and have become common in the Americas. Main streets across a city are open to active modes of transport and limited access is given to motor vehicles, for a period of several hours. This typically occurs on a Sunday, or in some cases, Saturday as well. Almost all Ciclovías programs are in Latin American countries. A summary of this intervention in the prioritisation framework and its suitability in different geographical context is presented in Figure 7.52.

Figure 7.52: Ciclovías in prioritisation framework



Implementation time	Impact	Cost	Complexity
Months	★★★	★	★★

Action

- Establish regular car-free days on selected streets or in selected areas to support walking and cycling.

Evidence base

Ciclovías programs began in Latin American countries, with Figure 7.53 showing the countries in this region that have Ciclovías programs. The Ciclovia program and *Cicloruta* (cycleways) network in Bogota, Colombia are approaches aimed at increasing access to physical activity and promoting active transport (Figure 7.54). These programs provide a more enjoyable way for people to walk and cycle through their city's streets and can also improve the social capital in an urban area. Torres (2012) analysed data from surveys of participants in Bogota's Ciclovía program (97 km of streets closed to motorised vehicles) and Cicloruta network (300 km of bicycle paths) and found that 59.5% of Ciclovia participants met physical activity recommendations in leisure time, while 70.5% of Cicloruta participants met recommendations through cycling for transport.

Those who frequently participate in Ciclovías have higher amounts of regular physical activity including vigorous physical activity. For Cicloruta, regular users had a much higher chance of meeting physical activity recommendations through cycling. Those who participated in Ciclovia over the last 12 months had a greater chance of meeting recommendations through cycling. Both programs have the potential to promote physical activity and provide mobility alternatives while enhancing social environments and safety perceptions (Sarmiento et al. 2017).

An assessment of 67 Ciclovías between 2014 and 2015 found that routes usually connect low-, middle- and high-income neighbourhoods. This leads to higher participation of minority populations. The most frequently offered complementary activity in Ciclovías was physical activity classes, and 80.0% of the programs included strategies to promote cycling (Sarmiento et al. 2017).

Figure 7.53: Latin American countries with Ciclovías

Source: Sarmiento, et al. (2017)

Figure 7.54: Ciclovía in Bogotá

Source: IDB (n.d.)

8. Initiatives Not Included

Several initiatives received a score too low to be included in the prioritised list of actions. These are briefly identified below. It should be noted that while these actions did not meet the threshold score, this is not to suggest they are inappropriate in certain situations. Very often, these initiatives may be suitable for denser, central city areas, but less so for suburban or regional environments. Some of them are likely to be effective in increasing active transport mode share, but may be highly complex politically or very costly.

8.1 Infrastructure

8.1.1 Pedestrianisation / car-free

Pedestrianisation/car-free initiatives refer to the process of transforming streets or areas that were previously open to motor vehicles into car-free spaces. It involves restricting the access of motor vehicles in favour of creating a pedestrian-friendly environment for walking, socialising, shopping, and various recreational activities. Although this intervention has a medium impact, it was not included in the prioritisation framework due to its high complexity, involving significant political capital, and its associated costs.

8.1.2 Super Blocks

Super Blocks are an urban planning concept involving the strategic use of modal filters to influence traffic flow and placemaking outcomes. An example is Barcelona, where this approach has led to reduced car use, improved air quality, and increased space for recreational activities. Although this intervention has high impact, it was not included in the prioritisation framework due to its high complexity, involving significant political considerations, and its associated costs. Policies and strategies

8.1.3 Motor vehicle speed reduction

Reducing motor vehicle speeds is a key strategy in road safety and urban planning that targets safer outcomes, especially for pedestrians and cyclists. High speeds increase crash severity and accident risks. Speed reduction involves physical road adjustments such as narrower lanes, tree planting for visual narrowing, tactile paving to subconsciously slow drivers, tighter curve radii, vertical deflections like speed bumps, and raised pedestrian crossings. This intervention did not score higher than the threshold due to its moderate cost and complexity, combined with a relatively low expected impact on mode share.

8.1.4 Car parking cost - on-street parking cost

Higher fees or limited availability for on-street parking can encourage people to look for alternative modes of transport like walking or cycling. This can decrease car usage and ownership rates, promoting more sustainable forms of travel. Increasing on-street parking costs can be part of a strategy to manage parking demand and allocate road space to walking and cycling infrastructure. The decision to exclude this intervention from the prioritisation framework is attributed to its lower relative impact, as well as considerable political complexity.

8.1.5 Car parking cost – off-street taxes and levies

These interventions often involve implementing strategies that influence the availability and cost of parking spaces. For instance, Sydney's Parking Space Levy (PSL) imposes fees on off-street parking spaces, with the revenue directed towards improving public transport. The omission of this intervention from the prioritisation framework is founded on its modest impact and cost while having moderate complexity.

8.1.6 Cycling incentives – e-bike trial

The e-bike trial intervention is focused on providing individuals with the opportunity to experience e-bikes firsthand. In such trials, participants are given access to e-bikes for a certain period, allowing them to test its benefits. The decision to exclude this intervention from the prioritisation framework is based on its limited impact, cost, and complexity. Limited research is available.

8.1.7 Parking cash-out scheme

The parking cash-out scheme is a strategy where employers offer financial incentives to employees who decide not to use workplace car parking. Instead of receiving free or subsidised parking, employees can choose to receive a cash payment or subsidy. This approach encourages employees to use alternative modes of transport such as walking, cycling, or public transport. The choice to not include this intervention within the prioritisation framework is derived from its restricted impact, cost, and level of complexity.

8.1.8 Free public transport

As its name suggests, this initiative involves removing fees at the point of accessing public transport. The choice to not include this intervention within the prioritised list of initiatives is related to its lower impact, high cost and complexity.

8.1.9 Car share

Car sharing reduces private car ownership, leading to fewer cars on the road, less congestion, and potentially more space for pedestrian and cycling infrastructure. The decision to exclude this intervention from the prioritisation framework is based on its limited impact, cost, and moderate level of complexity.

8.2 Special events and marketing

8.2.1 PARK(ing) Day

PARK(ing) Day, taking place on the 15th of September, aims to transform parking spaces into temporary public parks and communal areas, fostering creativity and reimagining urban spaces. The decision to omit this intervention from the prioritisation framework is founded on its limited impact.

8.2.2 Digital platforms and gamification

Utilising digital platforms and gamification as tools for behaviour change is an emerging area. The decision to exclude this intervention from the prioritisation framework is based primarily on limited evidence of its impact.

9. Recommendations for Austroads Guides

The purpose of this report is to support transport agencies and local governments seeking to increase active transport mode share. This report has provided an overview and prioritisation of interventions capable of boosting the proportion of trips by walking and cycling. It is recommended other Austroads Guides be amended to incorporate the shortlisted actions included in Section 7.

This report has demonstrated that achieving mode shifts towards walking and cycling is a complex and challenging task. The actions included in this report cannot be seen in isolation, but rather as a combined suite of actions that work to complement one another. This means that interventions should be broader than the provision of active transport infrastructure (e.g., bike lanes) alone, towards a holistic approach that includes a diversity of infrastructure and non-infrastructure interventions. These should include interventions that encourage walking and cycling, as well as those that discourage excessive car use.

Future updates to Austroads Guides can support increases in active transport mode share. This can be accomplished by including a diversity of actions, such as those included in this report. As highlighted in this report, cities that have had the most success in boosting active transport levels have also implemented measures that intensify land-use, to reduce trip distance and thereby increase the number destinations that are walkable and cyclable.

It is recommended that future updates to all Austroads Guides consult the actions prioritised in this report and consider consistency with the prioritisation results. This will help to ensure a harmonised approach to guidance documents, with an increased focus on mode shift towards active travel. As such, particular attention should be given to the actions identified in the sections below.

9.1 Transit orientated development and pedestrian orientated development

This report has found that land use planning and mode choice are intrinsically linked. This means that any attempt to increase active transport mode share must consider the build environment, and how this may need to change to support mode shift. Austroads Guides have typically paid greater attention to infrastructure and management of infrastructure than the broader built environment. However, Transit Oriented Development is discussed in the *Austroads Guide to Traffic Management, Part 7: Activity Centre Transport Management*, Section 3.3.3. This is the scope for expansion and inclusion of pedestrian-oriented development. It is recommended that transit-orientated development and pedestrian-orientated development be included in other Austroads Guides to provide practitioners with a deeper theoretical and empirical basis to support decision-making. In particular, transit-orientated development and pedestrian-orientated development should be discussed in greater detail in:

- **Guide to Traffic Management**
  - **Part 2: Traffic Theory Concepts** – Recommended discussion on mode choice, and the role of land use in mode choice.
  - **Part 7: Activity Centre Transport Management**
    - **Section 3.2.2** – Recommendation to include discussion on Transit Orientated Development and Pedestrian Orientated Development from an urban design perspective.
    - **Section 3.3.2** – Recommendation to include discussion on Transit Orientated Development and Pedestrian Orientated Development from a planning perspective.
    - **Section 3.3.3** – Currently discusses Transit Orientated Development but not Pedestrian Orientated Development, and it is recommended that additional discussion regarding design, mode choice, and potential mode shares be included.

- **Section 4.2** – Recommended discussion on Transit Orientated Development and Pedestrian Orientated Development and how this may affect trip generation and mode choice.
- **Section 4.3** – Recommended discussion on Transit Orientated Development and Pedestrian Orientated Development from a travel demand or mode choice perspective.

9.2 Cycling infrastructure – bike modal filter

Bike modal filters, which allow bikes to pass through but prevent motor vehicles through traffic are a low-cost and effective method of providing safer cycling routes. Bike modal filters are both design features and management features, and as such should be discussed in both the *Austroads Guide to Road Design* and *Austroads Guide to Traffic Management*. While the components of a modal filter are discussed in the *Austroads Guide to Traffic Management* parts 8 and 10, they are not specifically mentioned as an intervention.

In particular, bike modal filters should be discussed in greater detail in:

- **Guide to Road Design**
  - **Part 3: Geometric Design**
    - **Section 4.9** – Recommended to include the additional treatment of bike modal filter, with discussion about appropriate implementation in contexts where cycling is desired but through traffic volumes pose a comfort or safety risk and is not desired.
  - **Part 6A: Paths for Walking and Cycling**
    - **Section 7.5.3** – Recommendation to include discussion that these design response are also appropriate for bike modal filters.
- **Guide to Traffic Management**
  - **Part 7: Activity Centre Transport Management**
    - **Section 4.6** – Recommendation to include discussion modal filters, particularly in 4.6.1.
  - **Part 8: Local Street Management**
    - **Section 8.5.11** – Contains an image of a bike modal filters, and it is recommended that additionally discussion be included.
    - **Section 9.12** – Recommendation to include discussion about the role of bicycle infrastructure in providing protection as well as the role of bike modal filters in reducing traffic volumes, both of which can increase comfort and safety, particularly in 9.12.1.
  - **Part 10: Transport Control – Types of Devices** – Recommendation to include discussion of bollards and road closures as devices to create a bike modal filter, potentially in sections 5.6, 8 or 9.

9.3 Cycling infrastructure – bike parking at stations / destinations

Parking is a critical component of any vehicular transport system. For people to be able to ride bicycles to destinations, they need to be able to securely park them at said destinations. Bicycle parking is discussed in the *Austroads Guide to Traffic Management Part 11: Parking Management Techniques*, with section 8.15.5 discussing off-street and 9.9.5 discussing on-street. There is also discussion about the location of bicycle parking facilities in Commentary 9 of the *Austroads Guide to Traffic Management Part 11: Parking Management Techniques*. These sections provide a base level of information but should be expanded to better reflect current best practice, including design, placement, and what types of parking are most suitable in which contexts.

In particular, bike parking at stations and destinations should be discussed in greater detail in:

- **Guide to Road Design**
  - **Part 6A: Paths for Walking and Cycling** – Recommendation to include discussion about the role of bike parking at destinations.
- **Guide to Traffic Management**
  - **Part 2: Traffic Theory Concepts** – Recommendation to include discussion about parking and mode choice, with a focus on bike parking at destinations as a facilitator of cycling.
  - **Part 7: Activity Centre Transport Management**
    - **Section 4.10** – Recommendation to expand the discussion on the role of on- and off-street parking in supporting cycling.
  - **Part 8: Local Street Management**
    - **Section 8.5.11** – Recommendation to include discussion about the role of bike parking at destinations.
  - **Part 11: Parking Management Techniques**
    - **Section 8.15.5** – Recommendation to include discussion about the role of bike parking at destinations.
    - **Section 9.9.5** – Recommendation to include discussion about the role of bike parking at destinations.
    - **Commentary 9** – Recommendation for greater discussion about the need for a diversity of bike parking options at destinations and for different contexts. Also recommended discussion about other forms of end-of-trip facilities at public transport stations.

9.4 Bike share and e-scooter share

Shared micromobility schemes, including bike share and e-scooter share, have a demonstrated benefit in supporting active transport mode share. These forms of policy interventions are not mentioned in current Austroads Guides, such as *Guide to Traffic Management*, although other non-infrastructure programs are. This is an omission that is recommended to be addressed through the updating of Austroads Guides in future.

In particular, bike share/e-scooter share should be discussed in greater detail in:

- **Guide to Traffic Management**
  - **Part 4: Network Management Strategies**
    - **Section 4.6** – Recommendation to include discussion about bike share/e-scooter share as a facilitator to active travel, particularly in the subsection ‘bicycle programs’.
    - **Appendix C Bicycle Programs** – Recommendation to include bike share/e-scooter share, in what contexts they are most appropriate, and what resulting mode shift could be expected.
  - **Part 7:** Activity Centre Transport Management
    - **Section** 4.3 – Recommendation to include discussion about the role of bike share/e-scooter share in activity centres, and how they can support active transport mode shift.

9.5 E-bike incentive

Subsidising micro-mobility purchases can be an effective strategy to induce mode shift. E-bikes offer a range of environmental, social and individual benefits, however, high cost can discourage their uptake. Subsidies for e-bikes have been shown to be successful in other jurisdictions. E-bike subsidies are not mentioned in current Austroads Guides, such as Guide to Traffic Management, although other non-infrastructure programs are. This omission should be addressed in future updates of the Austroads Guides.

In particular, e-bike incentives should be discussed in greater detail in:

- **Guide to Traffic Management**
  - **Part 4: Network Management Strategies**
    - **Section 4.6** – Recommendation to include discussion about e-bike incentive schemes as a facilitator to active travel, particularly in the subsection 'bicycle programs'.
    - **Appendix C Bicycle Programs** – Recommendation to include an e-bike incentive, in what contexts they are most appropriate, and what resulting mode shift could be expected.

9.6 Travel behaviour change programs

Travel behaviour change programs support the uptake of walking and cycling where infrastructure has been delivered and land use patterns are favourable. They are a key recommendation of this report in supporting mode shift to active travel. They are currently discussed in the *Austroads Guide to Traffic Management Part 7: Activity Centre Transport Management* Section 4.3 and Appendix C, but lack depth and discussion about impacts on mode share. There is scope to increase the depth of this discussion, especially as it relates to mode shift.

In particular, travel behaviour change programs should be discussed in greater detail in:

- **Guide to Traffic Management**
  - **Part 4: Network Management Strategies**
    - **Section 4.6** – Recommendation to include discussion about the role of travel behaviour change programs in supporting mode shift to cycling, and the contexts they are most suitable for.
    - **Appendix C Bicycle Programs** – Recommendation to include greater discussion about what types of travel behaviour change programs are possible and the contexts they are most suitable for. Also recommended discussion of what level of mode shift could be expected in different contexts.
  - **Part 7: Activity Centre Transport Management**
    - **Section 4.3** – Recommendation to include discussion of travel behaviour change programs, especially in section 4.3.1 which contains outdated examples.

9.7 Other initiatives

More generally, the recommendations here should be considered when updating all Austroads Guides. It is suggested that particular attention should be given to the guides listed below:

- Guide to Road Design
  - Part 1: Objectives of Road Design
    - All sections
  - Part 3: Geometric Design
    - Section 4 – Cross-section

- Part 4: Intersections and Crossings - General
  - All sections
- Part 4A: Unsignalised and Signalised Intersections
  - All sections
- Part 4B: Roundabouts
  - Section 5 – Pedestrian and Cyclist Treatments
- Part 6A: Paths for Walking and Cycling
  - All sections
- Part 6B: Roadside Environment
  - Section 4 – Roadside Infrastructure
- Part 7: New and Emerging Treatments
  - All sections

- Guide to Road Safety
  - Part 7: Road Safety Strategy and Management
    - All sections
- Guide to Traffic Management
  - Part 4: Network Management Strategies
    - Section 3 – Movement and Place
    - Section 4.6 – Movement and Place Considerations – Bicycle Networks
    - Section 4.7 – Movement and Place Considerations – Pedestrian Networks
    - Appendix B Categories and Characteristics of Cyclists and Their Type of Trips
    - Appendix C Bicycle Programs
    - Commentary 9
  - Part 6: Intersections, Interchanges and Crossings Management
    - Section 3 – Selection of Intersection Type
    - Section 4 – Roundabouts
    - Section 7 – Road Interchanges
    - Section 9 – Pedestrian and Cyclist Crossings
  - Part 7: Activity Centre Transport Management
    - Section 4.8 – Providing for Pedestrians and Cyclists
    - Section 5 – Examples and Summary Issues for Each Type of Activity Centre
    - Appendix C – Road Hierarchy and Pedestrians
    - Appendix E – Speed Management in Pedestrian Areas
  - Part 8: Local Street Management
    - Section 4 – Steps in the LATM Process
    - Section 8 – Selection of LATM Devices
  - Part 10: Transport Control – Types of Devices
    - Section 4 – Principles and Applications

    - Section 5 – Signing and Marking Schemes
    - Section 8 – Pavement Markings
    - Section 9 – Guide Posts and Delineators
    - Section 10 – Traffic Signals
    - Section 11 – Traffic Islands
  - Part 12: Integrated Transport Assessments for Developments
    - All sections
- Cycling Aspects of Austroads Guides

References

ABS. (2021). *Census*, Australian Bureau of Statistics [website], <https://www.abs.gov.au/census>.

Agarwal S and Koo KM (2016) 'Impact of electronic road pricing (ERP) changes on transport modal choice', *Regional Science and Urban Economics*, *60*:1–11, https://doi.org/10.1016/j.regsciurbeco.2016.05.003.

Albalate D and Gragera A (2020) 'The impact of curbside parking regulations on car ownership', *Regional Science and* Urban *Economics*, *81*(103518), https://doi.org/10.1016/j.regsciurbeco.2020.103518

Alderman L (12 June 2020) 'Corona Cycleways' Become the New Post-Confinement Commute', *The New York Times*, <https://www.nytimes.com/2020/06/12/business/paris-bicycles-commute-coronavirus.html>.

Aldred R and Croft J (2019) 'Evaluating active travel and health economic impacts of small streetscape schemes: An exploratory study in London', *Journal of Transport & Health*, *12*:86–96, https://doi.org/10.1016/j.jth.2018.11.009.

Alexander SE, Alfonzo M and Lee K (2021) *Safeguarding Equity in Off-Site Vehicle Miles Traveled (VMT) Mitigation in California*, Mineta Transportation Institute, https://doi.org/10.31979/mti.2021.2027.

Andersson D and Nässén J (2016) 'The Gothenburg congestion charge scheme: A pre–post analysis of commuting behavior and travel satisfaction', *Journal of Transport Geography*, *52*:82–89, https://doi.org/10.1016/j.jtrangeo.2016.02.014.

Auchincloss AH, Michael YL, Kuder JF, Shi J, Khan S and Ballester LS (2019) 'Changes in physical activity after building a greenway in a disadvantaged urban community: A natural experiment', *Preventive Medicine Reports*, *15*:100941, https://doi.org/10.1016/j.pmedr.2019.100941.

Austroads (2020) *Guide to Traffic Management Part 4: Network Management Strategies*, AGTM04-20, Austroads, Sydney, NSW.

Badia H and Jenelius E (2023) 'Shared e-scooter micromobility: Review of use patterns, perceptions and environmental impacts', *Transport Reviews*, 43(5):811-837, https://doi.org/10.1080/01441647.2023.2171500

Basford L, Reid S, Lester T, Thomson J and Tolmie A (2002) *Drivers' perceptions of cyclists*, TRL549, Transport Research Laboratory, Wokingham, Berkshire.

Bennett P (28 October 2021) 'Paris plans to be completely cyclable by 2026', *World Economic Forum*, <https://www.weforum.org/agenda/2021/10/paris-plans-completely-cyclable-by-2026/>.

Benton JS, Cotterill S, Anderson J, Macintyre VG, Gittins M, Dennis M and French DP (2021) 'A natural experimental study of improvements along an urban canal: Impact on canal usage, physical activity and other wellbeing behaviours', *International Journal of Behavioral Nutrition and Physical Activity*, *18*(1):19, https://doi.org/10.1186/s12966-021-01088-w.

Bicycle Network (23 September 2020) 'Paris to make pop-ups permanent | Newsroom', *Bicycle Network*, <https://bicyclenetwork.com.au/newsroom/2020/09/23/paris-to-make-pop-ups-permanent/>.

Bicycle Network (3 June 2021) 'From pop-ups to permanent in Sydney | Newsroom', *Bicycle Network*, <https://bicyclenetwork.com.au/newsroom/2021/06/03/from-pop-ups-to-permanent-in-sydney/>.

Bicycle Network (2022) 'E-scooters may reduce active travel', *Bicycle Network*, <https://bicyclenetwork.com.au/newsroom/2022/05/04/e-scooters-reduce-active-travel/>.

Böcker L, Priya Uteng T, Liu C and Dijst M (2019) ‘Weather and daily mobility in international perspective: A cross-comparison of Dutch, Norwegian and Swedish city regions’, *Transportation Research Part D: Transport and Environment*, 77:491-505, https://doi.org/10.1016/j.trd.2019.07.012.

Börjesson M and Kristoffersson I (2015) ‘The Gothenburg congestion charge. Effects, design and politics’, *Transportation Research Part A: Policy and Practice*, 7:134–146, https://doi.org/10.1016/j.tra.2015.03.011.

Boufous S, Beck B, Macniven R, Pettit C and Ivers R (2021) ‘Facilitators and barriers to cycling in older residents of New South Wales, Australia’, *Journal of Transport & Health*, *21*, 101056, https://doi.org/10.1016/j.jth.2021.101056.

Braza M, Shoemaker W and Seeley A (2004) ‘Neighborhood Design and Rates of Walking and Biking to Elementary School in 34 California Communities’, *American Journal of Health Promotion*, 19(2):128–136, https://doi.org/10.4278/0890-1171-19.2.128.

Brown B, Smith K, Tharp D, Werner C, Tribby C, Miller H and Jensen W (2016) ‘A Complete Street Intervention for Walking to Transit, Non-Transit Walking, and Bicycling: A Quasi-Experimental Demonstration of Increased Use’, *Journal of Physical Activity & Health*, 13, https://doi.org/10.1123/jpah.2016-0066.

Buehler R and Pucher J (2021) *Cycling for Sustainable Cities*. MIT Press, Cambridge Massachusetts.

Buehler R and Pucher J (13 October 2022) ‘Cycling Through COVID-19: Paris’, *Streetsblog USA*, <https://usa.streetsblog.org/2022/10/13/cycling-through-covid-19-paris-france/>.

Burke M and Brown AL (2007) ‘Distances People Walk for Transport’, *Road & Transport Research*, 16(3):16–29, https://doi.org/10.3316/informit.880016006301032.

Cairns S, Behrendt F, Raffo D, Beaumont C and Kiefer C (2017) ‘Electrically-assisted bikes: Potential impacts on travel behaviour’, *Transportation Research Part A: Policy and Practice*, 103:327–342, https://doi.org/10.1016/j.tra.2017.03.007.

Cambra P and Moura F (2020) ‘How does walkability change relate to walking behavior change? Effects of a street improvement in pedestrian volumes and walking experience’, *Journal of Transport & Health*, 16, 100797. https://doi.org/10.1016/j.jth.2019.100797.

Carson V, Kuhle S, Spence JC and Veugelers PJ (2010) ‘Parents’ perception of neighbourhood environment as a determinant of screen time, physical activity and active transport’, *Canadian Journal of Public Health = Revue Canadienne De Sante Publique*, 101(2):124–127, https://doi.org/10.1007/BF03404356.

CDM Research and ASDF Research (2017) ‘Nearmarket cycling infrastructure research’, *ASDF Research*, <https://asdfresearch.com.au/portfolio-items/nearmarket/>.

Census | Australian Bureau of Statistics. (2022, June 28). https://www.abs.gov.au/census

Cervero R, Caldwell B and Cuellar J (2013) ‘Bike-and-Ride: Build It and They Will Come’, *Journal of Public Transportation*, 16(4), https://doi.org/10.5038/2375-0901.16.4.5.

Cheshmehzangi A and Thomas SM (2016) ‘Prioritizing Accessible Transit Systems for Sustainable Urban Development: Understanding and Evaluating the Parameters of a Transportation System in Mumbai’, *Journal of Urban Planning and Development*, 142(4):05016005, https://doi.org/10.1061/(ASCE)UP.1943-5444.0000338.

City of Sydney (n.d.) *Creating pop-up cycleways in Sydney*. City of Sydney. accessed 21 February 2023, <https://www.cityofsydney.nsw.gov.au/building-new-infrastructure/creating-pop-up-cycleways-in-sydney>.

City of Sydney (2012) Cycling: Community Research to Optimise Program Effectiveness.

City of Sydney (2020) Wilson Burren Lawson COM-B report.

Clark C, Mokhtarian P and Circella G (2019) *User Preferences for Bicycle Infrastructure in Communities with Emerging Cycling Cultures*, 2673(12): doi.org/10.1177/0361198119854084.

Cornago E, Dimitropoulos A and Oueslati W (2019) 'Evaluating the Impact of Urban Road Pricing on the Use of Green Transport Modes: The Case of Milan', *OECD Environment Working Papers*, no. 143, OECD Publishing, Paris, https://doi.org/10.1787/ddaa6b25-en.

Crane M, Rissel C, Standen C, Ellison A, Ellison R, Wen LM and Greaves S (2017) 'Longitudinal evaluation of travel and health outcomes in relation to new bicycle infrastructure, Sydney, Australia', *Journal of Transport & Health*, 6:386–395, https://doi.org/10.1016/j.jth.2017.07.002.

CROW (2016) *Design manual for bicycle traffic – CROW Platform*. CROW, <https://crowplatform.com/product/design-manual-for-bicycle-traffic/>.

Cycling and Walking Australia and New Zealand (CWANZ) (2021) *National Walking and Cycling Participation Survey*, <https://www.cwanz.com.au/wp-content/uploads/2021/08/NWCPS_2021_report_v2.0.pdf>.

'Cycling in the City' Post-course survey results, Summer. (2018).

De Gruyter C, Davies L and Truong L (2021) 'Examining spatial variations in minimum residential parking requirements in Melbourne', *Journal of Transport Geography*, 94, 1–20.

De Gruyter C, Hooper P and Foster S (2023) 'Do apartment residents have enough car parking? An empirical assessment of car parking adequacy in Australian cities', *Journal of Transport Geography*, 107:1–11.

De Gruyter C, Rose G and Currie G (2015) 'Understanding Travel Plan Effectiveness for New Residential Developments', *Transportation Research Record: Journal of the Transport Research Board*, 2537(1):126–136, https://doi.org/10.3141/2537-14.

De Gruyter C, Truong L and Taylor E (2020) 'Can high quality public transport support reduced car parking requirements for new residential apartments?' *Journal of Transport Geography*, 82:1–11.

Deehr RC and Shumann A (2009) 'Active Seattle', *American Journal of Preventive Medicine*, *37*(6):S403–S411, https://doi.org/10.1016/j.amepre.2009.09.026.

Delbosc A, Naznin F, Haslam N and Haworth N (2019) 'Dehumanization of cyclists predicts self-reported aggressive behaviour toward them: A pilot study', *Transportation Research Part F: Traffic Psychology and Behaviour*, 62:681–689, https://doi.org/10.1016/j.trf.2019.03.005.

Department of Transport (n.d.) *About Your Move—Travel Behaviour Change Program*. Your Move. Retrieved 3 October 2023, from https://www.yourmove.org.au/about-your-move/

DeRobertis M (2016) 'Traffic-Restricted Zones in Italy', *Institute of Transport Engineers Journal*, 86(12):44-49.

Duncan MJ, Winkler E, Sugiyama T, Cerin E, duToit L, Leslie E and Owen N (2010) 'Relationships of land use mix with walking for transport: Do land uses and geographical scale matter?' *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 87(5):782–795, https://doi.org/10.1007/s11524-010-9488-7.

Edwina (10 October 2018) *The Social Impacts of Road Pricing*, ITF, <https://www.itf-oecd.org/social-impacts-road-pricing>.

Eliasson J (2014) *The Stockholm congestion charges: An overview*, *Centre for Transport Studies*, Stockholm, Sweden.

Elvik R (2009) 'The non-linearity of risk and the promotion of environmentally sustainable transport', *Accident Analysis & Prevention*, 41(4):849–855.

Evers C, Boles S, Johnson-Shelton D, Schlossberg M and Richey D (2014) 'Parent safety perceptions of child walking routes', *Journal of Transport & Health*, *1*(2):108–115, https://doi.org/10.1016/j.jth.2014.03.003.

Ferrari G, Oliveira Werneck A, Rodrigues da Silva D, Kovalskys I, Gómez G, Rigotti A, Yadira Cortés Sanabria L, García M, Pareja R, Herrera-Cuenca M, Zimberg I, Guajardo V, Pratt M, Cofre Bolados C, Saldía E, Pires C, Marques A, Peralta M, Rossato de Victo E, … on behalf of the ELANS Study Group. (2020) 'Association between Perceived Neighborhood Built Environment and Walking and Cycling for Transport among Inhabitants from Latin America: The ELANS Study', *International Journal of Environmental Research and Public Health*, 17(18):6858, https://doi.org/10.3390/ijerph17186858.

Fishman E (2019) *Bike Share*, Routledge, New York.

Fishman E and Davies L (2021) *E-Bike Subsidy for Australians*, Institute for Sensible Transport, <https://www.weride.org.au/wp-content/uploads/2022/04/WeRide_e-Bike_Subsidy_Report_FINAL-lores.pdf>.

Fishman E and Schepers P (2016) 'Global bike share: What the data tells us about road safety', *Journal of Safety Research*, 56:41–45.

Fishman E, Washington S and Haworth N (2012) 'Understanding the fear of bicycle riding in Australia', *Journal of the Australian College of Road Safety*, 23(3):12-27.

Fishman E, Washington S and Haworth N (2014) 'Bike share's impact on car use: Evidence from the United States, Great Britain, and Australia', *Transportation Research Part D: Transport and Environment*, 31:13–20, https://doi.org/10.1016/j.trd.2014.05.013.

Fishman E, Washington S, Haworth N and Mazzei A (2014) 'Barriers to bikesharing: An analysis from Melbourne and Brisbane', *Journal of Transport Geography*, 41(Dec).

Frater J and Kingham S (2020) 'Adolescents and bicycling to school: Does behaviour setting/place make a difference?' *Journal of Transport Geography*, 85:102724, https://doi.org/10.1016/j.jtrangeo.2020.102724.

Fyhri A and Beate Sundfør H (2020) 'Do people who buy e-bikes cycle more?' *Transportation Research Part D: Transport and Environment*, 86:102422, https://doi.org/10.1016/j.trd.2020.102422.

Fyhri A, Heinen E, Fearnley N and Sundfør HB (2017) 'A push to cycling—Exploring the e-bike's role in overcoming barriers to bicycle use with a survey and an intervention study', *International Journal of Sustainable Transportation*, 11(9):681–695, https://doi.org/10.1080/15568318.2017.1302526.

Fyhri A, Sundfør HB and Weber C (2016) 'Effect of subvention program for electric bicycle in Oslo on bicycle use, transport distribution and CO_2 emissions', TØI Report, 1498/2016.

Garrard J, Crawford S and Hakman N (2006) *Revolutions for Women: Increasing women's participation in cycling for recreation and transport*, Deakin University.

Garrett N, Schluter PJ and Schofield G (2012) 'Physical Activity Profiles and Perceived Environmental Determinants in New Zealand: A National Cross-Sectional Study', *Journal of Physical Activity and Health*, 9(3):367–377, https://doi.org/10.1123/jpah.9.3.367.

Giles-Corti B, Macaulay G, Middleton N, Boruff B, Bull F, Butterworth I, Badland H, Mavoa S, Roberts R and Christian H (2014) 'Developing a research and practice tool to measure walkability: A demonstration project', *Health Promotion Journal of Australia: Official Journal of Australian Association of Health Promotion Professionals*, 25(3):160–166, https://doi.org/10.1071/HE14050.

Global Designing Cities Initiative (2016) *Global Street Design Guide*, Island Press, Washington DC, <https://islandpress.org/books/global-street-design-guide>.

Goel R, Goodman A, Aldred R, Nakamura R, Tatah L, Garcia LMT, Zapata-Diomedi B, de Sa TH, Tiwari G, de Nazelle A, Tainio M, Buehler R, Götschi T and Woodcock J (2022) ‘Cycling behaviour in 17 countries across 6 continents: Levels of cycling, who cycles, for what purpose, and how far?’, *Transport Reviews*, 42(1):58–81. https://doi.org/10.1080/01441647.2021.1915898.

Goodman A and Woodcock J (28 August 2014) ‘Hard Evidence: Do bikeshare schemes lead to more head injuries among cyclists?’, *The Conversation*, <http://theconversation.com/hard-evidence-do-bikeshare-schemes-lead-to-more-head-injuries-among-cyclists-30135>.

Graves JM, Pless B, Moore L, Nathens AB, Hunte G and Rivara FP (2014) ‘Public Bicycle Share Programs and Head Injuries’, *American Journal of Public Health*, 104(8):e106–e111, https://doi.org/10.2105/AJPH.2014.302012.

Groote JD, Ommeren JV and Koster HRA (2016) ‘Car ownership and residential parking subsidies: Evidence from Amsterdam’, *Economics of Transportation*, 6:25–37, https://doi.org/10.1016/j.ecotra.2016.07.001.

Gunn LD, Lee Y, Geelhoed E, Shiell A and Giles-Corti B (2014) ‘The cost-effectiveness of installing sidewalks to increase levels of transport-walking and health’, *Preventive Medicine*, 67:322–329, https://doi.org/10.1016/j.ypmed.2014.07.041.

Guo Z and Ren S (2013) ‘From Minimum to Maximum: Impact of the London Parking Reform on Residential Parking Supply from 2004 to 2010?’, *Urban Studies*, 50(6):1183–1200.

Heesch K, Sahlqvist S and Garrard J (2012) ‘Gender differences in recreational and transport cycling: A cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints’, *The International Journal of Behavioral Nutrition and Physical Activity*, 9(106), https://doi.org/10.1186/1479-5868-9-106.

Heinen E, van Wee B and Maat K (2010) ‘Commuting by Bicycle: An Overview of the Literature’, *Transport Reviews*, 30(1):59–96, https://doi.org/10.1080/01441640903187001.

Hudson M (1982) *Bicycle Planning: Policy and Practice*. Architectural Press, New York.

Hull A and O’Holleran C (2014) ‘Bicycle infrastructure: Can good design encourage cycling?’, *Urban, Planning and Transport Research*, 2(1):369–406, https://doi.org/10.1080/21650020.2014.955210.

Hunt JD and Abraham JE (2007) ‘Influences on bicycle use’, *Transportation*, 34(4):453–470, https://doi.org/10.1007/s11116-006-9109-1.

IDB (n.d.) ‘Bicycle Inclusion in Latin America and the Caribbean: A new guide from the IDB’, *Despacio.* accessed 14 April 2023, <https://www.despacio.org/2015/03/13/bicycle-inclusion-in-latin-america-and-the-caribbean-a-new-guide-from-the-idb/>.

Institute for Transportation and Development Policy (2018) *Pedestrians First: Tools for a walkable city*, <https://itdpdotorg.wpengine.com/wp-content/uploads/2018/02/pedestrians_FINAL.pdf>.

Johnson M, Charlton J, Newstead S and Oxley J (2010) ‘Painting a designated space: Cyclist and driver compliance at cycling infrastructure at intersections’, *Journal of the Australasian College of Road Safety*, *21*(3):67–72.

Johnson M and Rose G (2-4 October 2013) ‘Electric bikes – cycling in the New World City: An investigation of Australian electric bicycle owners and the decision making process for purchase’ [conference presentation], *Australian Transport Research Forum 2013*, Brisbane, Australia.

Jonkeren O, Kager R, Harms L and te Brömmelstroet M (2021) 'The bicycle-train travellers in the Netherlands: Personal profiles and travel choices', *Transportation*, 48(1):455–476, https://doi.org/10.1007/s11116-019-10061-3.

Kavanagh A, Thornton L, Thomas L, Jolley D and Turrell G (2007) *Place does matter for your health: Victorian Lifestyle and Neighbourhood Environment Study*, VicLANES, Melbourne, <https://apo.org.au/node/2638>.

Kuss P and Nicholas KA (2022) 'A dozen effective interventions to reduce car use in European cities: Lessons learned from a meta-analysis and transition management', *Case Studies on Transport Policy*, 10(3):1494–1513, <https://doi.org/10.1016/j.cstp.2022.02.001>.

Latz P (10 November 2021) 'Paris Unveils Even Bolder 'Plan Velo: Act 2', *Micromobility Report*, <https://micromobilityreport.com.au/infrastructure/policy-and-funding/paris-unveils-even-bolder-plan-velo-act-2/>.

Leferink T (2017) *Why Cycle to the Railway Station?* [TU Delft]. https://repository.tudelft.nl/islandora/object/uuid%3A7653ce93-3a2a-4a1f-b804-0b1c4c206eb1

Litman T (2022) *Evaluating Active and Micro Mode Emission Reduction Potentials*, Victoria Transport Policy Institute, Melbourne Victoria.

Lynch G and Atkins S (1988) 'The influence of personal security fears on women's travel patterns', *Transportation*, 15(3):257–277, <https://doi.org/10.1007/BF00837584>.

Mackie Research and NZ Transport Agency (2021) *Innovating Streets for People*, NZ Transport Agency/Waka Kotahi, <https://www.nzta.govt.nz/assets/Roads-and-Rail/streets-for-people/innovating-streets-for-people-2020-2021-programme-full-report.pdf>.

MacMichael S (4 February 2021) 'Six in ten users of pop-up bike lanes in Paris are new to cycling, says city's government', *road.cc*, <https://road.cc/content/news/6-10-users-pop-bike-lanes-paris-new-cycling-280681>.

Manaugh K and El-Geneidy A (2015) 'Overcoming barriers to active transportation: Understanding reasons for not cycling in a University setting' [conference presentation], *94th Annual Meeting Transportation Research Board*, <https://trid.trb.org/view/1338143>.

Metz D (2018) 'Tackling urban traffic congestion: The experience of London, Stockholm and Singapore', *Case Studies on Transport Policy*, 6(4):494–498, https://doi.org/10.1016/j.cstp.2018.06.002.

Monsere C, Dill J, McNeil N, Clifton K, Foster N, Goddard T, Berkow M, Gilpin J, Voros K, van Hengel D and Parks J (2014) *Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S,* Transport Research Education Center, Portland Oregon, https://doi.org/10.15760/trec.115.

Morrison CN, Thompson J, Kondo MC and Beck B (2019) 'On-road bicycle lane types, roadway characteristics, and risks for bicycle crashes', *Accident Analysis & Prevention*, 123:123–131, https://doi.org/10.1016/j.aap.2018.11.017.

Mutrie N, Carney C, Blamey A, Crawford F, Aitchison T and Whitelaw A (2002) '"Walk in to Work Out": A randomised controlled trial of a self help intervention to promote active commuting', *Journal of Epidemiology & Community Health*, 56(6):407–412, https://doi.org/10.1136/jech.56.6.407.

Nicholls H, Rose G, Johnson M and Carlisle R (27-29 November 2017) 'Cyclists and Left Turning Drivers: A Study of Infrastructure and Behaviour at Intersections' [conference presentation], *Australasian Transport Research Forum 2017 Proceedings*, Auckland, New Zealand.

Nieuwenhuijsen MJ (2020) ‘Urban and transport planning pathways to carbon neutral, liveable and healthy cities; A review of the current evidence’, *Environment International*, 140:105661, https://doi.org/10.1016/j.envint.2020.105661.

Notthoff N and Carstensen LL (2014) ‘Positive messaging promotes walking in older adults’, *Psychology and Aging*, 29(2):329, https://doi.org/10.1037/a0036748.

NZ Transport Agency (2019) *A deeper understanding of bikelash*, NZ Transport Agency/Waka Kotahi, <https://www.nzta.govt.nz/assets/Walking-Cycling-and-Public-Transport/docs/NZTA-x-Empathy-Understanding-Bikelash-17.08.2017.pdf>.

O’Fallon C (2010) ‘Bike Now: Exploring Methods of Building Sustained Participation in Cycle Commuting in New Zealand’, *Road & Transport Research*, 19(2):77–89, <https://doi.org/10.3316/informit.406386084755362>.

Ogilvie D, Foster CE, Rothnie H, Cavill N, Hamilton V, Fitzsimons CF and Mutrie N (2007) ‘Interventions to promote walking: Systematic review’, *BMJ*, *334*(7605):1204, https://doi.org/10.1136/bmj.39198.722720.BE.

Oostendorp R and Hardinghaus M (2022) ‘Shared vs. Private e-scooters: Same vehicle-different mode? Empirical evidence on e-scooter usage in Germany’, *Transport Research Procedia*, 72:2173-2180, doi.org/10.1016/j.trpro.2023.11.703.

O’Sullivan F (23 October 2021) ‘How Paris Will Become ‘100% Cyclable’, *Bloomberg*, <https://www.bloomberg.com/news/articles/2021-10-22/how-paris-will-become-100-cyclable>.

Pearson L, Dipnall J, Gabbe B, Braaf S, White S, Backhouse M and Beck B (2021) The potential for bike riding across entire cities: Quantifying spatial variation in interest in bike riding, *MedRxiv*, https://doi.org/10.1101/2021.03.14.21253340.

Pearson L, Gabbe B, Reeder S and Beck B (2023) ‘Barriers and enablers of bike riding for transport and recreational purposes in Australia’, *Journal of Transport & Health*, 28:101538, https://doi.org/10.1016/j.jth.2022.101538.

Popovich N, Gordon E, Shao Z, Xing Y, Wang Y and Handy S (2014) ‘Experiences of electric bicycle users in the Sacramento, California area’, *Travel Behaviour and Society*, 1(2):37–44, https://doi.org/10.1016/j.tbs.2013.10.006.

Pucher J and Buehler R (2008) ‘Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany’, *Transport Reviews*, 28(4):495–528, https://doi.org/10.1080/01441640701806612.

Région Île-de-France (28 November 2022) ‘RER-Vélo: Plus de pistes cyclables pour les déplacements quotidiens’, *Région Île-de-France*, <https://www.iledefrance.fr/rer-velo-de-pistes-cyclables-pour-les-deplacements-quotidiens>.

Road Safety Toolkit (2021) *Speed Management and Traffic Calming – Road Safety Toolkit*, <https://toolkit.irap.org/safer-road-treatments/speed-management-and-traffic-calming/>.

Rose G (2008) ‘Encouraging Sustainable Campus Travel: Self-Reported Impacts of a University TravelSmart Initiative’, *Journal of Public Transportation*, 11(1):85–108, https://doi.org/10.5038/2375-0901.11.1.5.

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):351–364, https://doi.org/10.1016/j.tra.2006.10.001.

Sallis JF, Cain KL, Conway TL, Gavand KA, Millstein RA, Geremia CM, Frank LD, Saelens BE, Glanz K and King AC (2015) ‘Is Your Neighborhood Designed to Support Physical Activity? A Brief Streetscape Audit Tool’, *Preventing Chronic Disease*, 12, E141, https://doi.org/10.5888/pcd12.150098.

Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK and Kerr J (2006) ‘An ecological approach to creating active living communities’, *Annual Review of Public Health*, 27:297–322, https://doi.org/10.1146/annurev.publhealth.27.021405.102100.

Sanders RL, da Silva Brum-Bastos V and Nelson TA (2022) ‘Insights from a pilot investigating the impacts of shared E-scooter use on physical activity using a single-case design methodology’, *Journal of Transport & Health*, 25:101379, https://doi.org/10.1016/j.jth.2022.101379.

Sarmiento OL, Díaz del Castillo A, Triana CA, Acevedo MJ, Gonzalez SA and Pratt M (2017) ‘Reclaiming the streets for people: Insights from Ciclovías Recreativas in Latin America’, *Preventive Medicine*, 103, S34–S40, https://doi.org/10.1016/j.ypmed.2016.07.028.

Savaria M, Apparicio P and Carrier M (2021) ‘Assessing filtered permeability around the globe: The unknown beloved principle of cycling cities’, *Transportation Research Part D: Transport and Environment*, 97, 102964, https://doi.org/10.1016/j.trd.2021.102964.

SGS Economics and Planning (13 June 2018) ‘The economics of deserves far more attention’, *SGS Economics and Planning*, <https://sgsep.com.au/publications/insights/the-economics-of-walking-deserves-far-more-attention>.

Shoup D (2011) ‘The High Cost of Free Parking: Updated Edition’ (1st edition), Routledge, New York.

Söderberg f.k.a. Andersson A, Adell E and Winslott Hiselius L (2021) ‘What is the substitution effect of e-bikes? A randomised controlled trial’, *Transportation Research Part D: Transport and Environment*, 90, 102648, https://doi.org/10.1016/j.trd.2020.102648.

Solomonow S and Sadik-Khan J (2017) *Streetfight: Handbook for an Urban Revolution*, Penguin, London and New York.

Soto GW, Whitfield GP, Webber BJ, Omura JD, Chen TJ, Zaganjor H and Rose K (2022) ‘Traffic as a barrier to walking safely in the United States: Perceived reasons and potential mitigation strategies’ *Preventive Medicine Reports*, 30:102003, https://doi.org/10.1016/j.pmedr.2022.102003.

Southworth M (2005) ‘Designing the Walkable City’, *Journal of Urban Planning and Development*, 131(4):246–257, https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246).

Standen C (2017) *The value of slow travel: An econometric method for valuing the user benefits of active transport infrastructure* [PhD Thesis], The University of Sydney Business School, institute of Transport and Logistics Studies, The University of Sydney, https://ses.library.usyd.edu.au/handle/2123/17914.

Stats NZ Tatauranga Aotearoa (2018) *2018 Census | Stats NZ*, <https://www.stats.govt.nz/2018-census/>.

Stopher P, Zhang Y, Zhang J and Halling B (2010) *Results of an evaluation of TravelSmart in South Australia* [Working Paper], <https://ses.library.usyd.edu.au/handle/2123/19549>.

Taylor MAP (2007) ‘Voluntary Travel Behavior Change Programs in Australia: The Carrot Rather Than the Stick in Travel Demand Management’ *International Journal of Sustainable Transportation*, 1(3):173–192, https://doi.org/10.1080/15568310601092005.

Teschke K, Harris MA, Reynolds CCO, Winters M, Babul S, Chipman M, Cusimano MD, Brubacher JR, Hunte G, Friedman SM, Monro M, Shen H, Vernich L and Cripton PA (2012) ‘Route Infrastructure and the Risk of Injuries to Bicyclists: A Case-Crossover Study’, *American Journal of Public Health*, 102(12):2336–2343, https://doi.org/10.2105/AJPH.2012.300762.

Teschke K and Winters M (2014) Letter to the Editor about the recently published article by Graves et al. “Public bicycle share programs and head injuries”.

Torres AD (2012) ‘The Bogota ciclovia-recreativa and cicloruta programs: Promising interventions to promote physical activity, and social capital in the city of Bogota’ [Master’s thesis], Georgie State University.

Transport for NSW (30 January 2023) *Pop-up transport* [Interactive Resource], Transport for NSW, < https://www.transport.nsw.gov.au/sites/default/files/media/documents/rww/projects/01documents/popup-covid-19-infrastructure/popup-covid-19-infrastructure-fact-sheet-for-high-street.pdf >.

Van Der Spek SC and Scheltema N (2015) ‘The importance of bicycle parking management’, *Research in Transportation Business & Management*, 15, 39–49, https://doi.org/10.1016/j.rtbm.2015.03.001.

van Hagen M (2018) *Dutch rail passenger satisfaction* [Face to face interview].

van Lierop D, Grimsrud M and El-Geneidy A (2015) ‘Breaking into Bicycle Theft: Insights from Montreal, Canada’, *International Journal of Sustainable Transportation*, 9(7):490–501, https://doi.org/10.1080/15568318.2013.811332.

Veillette M-P, Grisé E and El-Geneidy A (2018) ‘Park ‘n’ Roll: Identifying and Prioritizing Locations for New Bicycle Parking in Québec City, Canada’, *Transportation Research Record: Journal of the Transportation Research Board*, 2672(36):73–82, https://doi.org/10.1177/0361198118776522.

VicRoads (28 July 2022) Pop Up Bike Lanes (Victoria), *VicRoads*, <https://www.vicroads.vic.gov.au/traffic-and-road-use/cycling/pop-up-bike-lanes>.

Victorian Department of Transport and Planning (2022) ‘Victorian Integrated Survey of Travel and Activity (Victoria)’, <https://dtp.vic.gov.au:443/about/data-and-research/vista>.

Waitt G and Stanes E (2022) ‘Reactivating commuter cycling: COVID-19 pandemic disruption to everyday transport choices in Sydney, Australia’, *Journal of Transport Geography*, 98, 103270, https://doi.org/10.1016/j.jtrangeo.2021.103270.

Waka Kotahi NZ Transport Agency (2013) *Christchurch—Ilam Road separated cycleway | Waka Kotahi NZ Transport Agency*, <https://www.nzta.govt.nz/walking-cycling-and-public-transport/cycling/cycling-standards-and-guidance/cycling-network-guidance/case-studies/christchurch-ilam-road-separated-cycleway>.

Walk Score Methodology (2023) ‘Walk Score’, <https://www.walkscore.com/methodology.shtml>.

Walker I (2007) ‘Drivers overtaking bicyclists: Objective data on the effects of riding position, helmet use, vehicle type and apparent gender’, *Accident Analysis & Prevention*, 39(2):417–425.

Wall SP, Lee DC, Frangos SG, Sethi M, Heyer JH, Ayoung-Chee P and DiMaggio CJ (2016) ‘The Effect of Sharrows, Painted Bicycle Lanes and Physically Protected Paths on the Severity of Bicycle Injuries Caused by Motor Vehicles’, *Safety*, 2(4):26, https://doi.org/10.3390/safety2040026.

Wang K, Qian X, Fitch DT, Lee Y, Malik J and Circella G (2023) ‘What travel modes do shared e-scooters displace? A review of recent research findings’, *Transport Reviews*, 43(1):5–31.

Wang Y and Kockelman KM (2013) ‘A Poisson-lognormal conditional-autoregressive model for multivariate spatial analysis of pedestrian crash counts across neighborhoods’, *Accident Analysis & Prevention*, 60, 71–84, https://doi.org/10.1016/j.aap.2013.07.030.

Wardman M, Tight M and Page M (2007) ‘Factors influencing the propensity to cycle to work’, *Transportation Research Part A: Policy and Practice*, 41(4):339–350, https://doi.org/10.1016/j.tra.2006.09.011.

Wen LM, Orr N, Bindon J and Rissel C (2005) ‘Promoting active transport in a workplace setting: Evaluation of a pilot study in Australia’, *Health Promotion International*, 20(2):123–133, https://doi.org/10.1093/heapro/dah602.

Witten K and Field A (2020) ‘Chapter Eleven—Engaging children in neighborhood planning for active travel infrastructure’, in EOD Waygood, M Friman, LE Olsson, & R. Mitra (Eds.), *Transport and Children’s Wellbeing* (pp. 199–216). Elsevier. https://doi.org/10.1016/B978-0-12-814694-1.00014-2

Woodcock J, Tainio M, Cheshire J, O’Brien O and Goodman A (2014) ‘Health effects of the London bicycle sharing system: Health impact modelling study’, *Bmj*, 348.

Yang Y, Sasaki K, Cheng L and Tao S (2022) ‘Does the built environment matter for active travel among older adults: Insights from Chiba City, Japan’, *Journal of Transport Geography*, 101, 103338. https://doi.org/10.1016/j.jtrangeo.2022.103338.

Yen BTH, Mulley C, Burke M and Tseng W-C (2020) ‘Parking and restaurant business: Differences in business perceptions and customer travel behaviour in Brisbane, Queensland, Australia’, *Land Use Policy*, 92, 103818. https://doi.org/10.1016/j.landusepol.2019.01.021.

Zahnow R, Kimpton A, Corcoran J and Mielke G (2022) ‘Neighbourhood correlates of average population walking: Using aggregated, anonymised mobile phone data to identify where people walk’, *Health & Place*, 77, 102892, https://doi.org/10.1016/j.healthplace.2022.102892.

Austroads

Level 9, 570 George Street
Sydney NSW 2000 Australia

Phone: +61 2 8265 3300

austroads@austroads.com.au
www.austroads.com.au