Australian Government | Infrastructure Australia

Outer Urban Public Transport

Improving accessibility in lower-density areas

October 2018

REFORM SERIES

Infrastructure Australia™ is an independent statutory body that is the key source of research and advice for governments, industry and the community on nationally significant infrastructure needs.

It leads reform on key issues including means of financing, delivering and operating infrastructure and how to better plan and utilise infrastructure networks.

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Cover: Ringwood Railway Station, Melbourne, Australia, 2018. Ringwood Railway Station is an outer suburban station in the Melbourne Metro network. It was rebuilt in 2016 and serves as a public transport interchange.

Contents

Executive Summary

Australia's cities are growing rapidly and are increasingly important to our prosperity. Over the next 30 years, Australia will grow by over 11 million people. Close to 80% of this growth will be in our five largest cities: Adelaide, Brisbane, Melbourne, Perth and Sydney.[1] Much of this growth will be accommodated at the fringes of our cities and in low-density developments.

More than ever, Australia's prosperity is linked to the performance of our cities. Australia is becoming increasingly urbanised and so is our economy. In 2015–16, our five largest cities contributed about 66% of our GDP.[2] Over time, this contribution is expected to increase.[3] Since the middle of the 20th century, the focus of our national economy has gradually shifted from agriculture, manufacturing, and more recently resources, towards largely knowledge-intensive service sectors. These sectors now make up about 60% of our nation's economy and are largely concentrated in our biggest cities.[4] The social and economic growth of our cities provides immense opportunities for the nation. As cities grow, businesses take advantage of larger and more skilled labour markets, and workers are given opportunities to develop and broaden their skill base.

However, the rapid growth of our cities also brings into focus issues with how they are structured and how they function. Australia's cities are generally defined by a central core surrounded by low-density suburbs. While they began as small trade and agricultural hubs, usually based around a port, our cities have gradually expanded outwards. This growth was initially along public transport routes. However, in the post-war era, as car ownership grew sharply, the outer parts of our cities expanded rapidly.

The growth in private car ownership enabled decentralisation, allowing people to move away from their workplaces and public transport. At the time, the growth of our outer suburbs represented growing freedom of movement, and allowed people to move out of the busy and congested inner city. Many of these benefits still exist today, with many people choosing to live in the outer suburbs for the lifestyle. However, the expansion of our cities away from public transport routes, particularly high-capacity railways, has resulted in a range of challenges, particularly around access to jobs, services and leisure activities.

This paper focuses on one of the key enablers of access: public transport. It presents new spatial analysis of our five largest cities in order to:

- investigate the challenges in delivering outer urban public transport
- quantify the extent of public transport disadvantage
- recommend a range of policy responses for government.

Public transport connectivity is critical to the economic prosperity and liveability of our cities

Today, our urban economies are shifting towards knowledge sectors that tend to cluster in centres. This means jobs, particularly high-value jobs, are now located further away from residential developments on the fringes of our cities. At the same time, our roads are struggling to deal with increasing traffic and without action, this trend will continue. Congestion is not only inconvenient, it can also lessen people's quality of life and act as a drag on the economy by reducing access to skilled labour and jobs. The *Australian Infrastructure Audit* found that current congestion trends would cost the economy $53 billion by 2031 if no action were taken.[5]

Large and growing cities need high-quality public transport. This is because it is the most efficient means of moving large volumes of people. Infrastructure Australia's report *Future Cities: Planning for our growing population*, modelled land use scenarios for Melbourne and Sydney to 2046.[6] This modelling showed that public transport will play an increasingly important role in providing access to jobs for people in a large city of 7 million, while the potential to access jobs by car will decrease.

Most governments are responding to these challenges with significant public transport investments. Billions of dollars are being spent by all levels of government – federal, state, territory and local – acknowledging the importance of public transport to the health and productivity of our cities. This is a welcome development, and governments will need to continue investing in public transport as our cities grow.

Infrastructure Australia commissioned new, spatial analysis of outer urban public transport to provide an evidence base for decision makers

This paper assesses the quality and accessibility of public transport services in our five largest cities: Sydney, Melbourne, Brisbane, Perth and Adelaide. Infrastructure Australia commissioned spatial analysis from GTA Consultants to compare transport behaviours and job accessibility in inner, middle and outer urban areas. It revealed the extent of disadvantage in some areas compared to others, and the impact on travel patterns and liveability. Two key trends emerged:

- **Public transport disadvantage in outer suburbs is significant.** Access to public transport services and service frequencies are lower, while travel times and distances to major employment centres are longer in outer suburbs.
- **Public transport use is lower for people living and working in the outer suburbs.** Fewer people use public transport in outer suburbs than other areas, and those who do are more likely to drive to reach local services. As a result, car operating costs are higher in the outer suburbs.

Outer urban areas of our cities are being left behind

While Australian cities, particularly Melbourne and Sydney, have experienced a degree of concentrated growth in inner city areas in recent years, outer urban areas continue to grow rapidly. Close to half the population of our five largest cities live in the outer suburbs. It is critical that they have access to the services and opportunities that inner-city residents enjoy.

Inadequate access to public transport and poor service levels are important drivers of disadvantage for people in outer urban areas.[7] These conditions can have a tangible impact on the quality of life and prosperity of these communities by limiting access to employment, education and other social infrastructure within reasonable travel time.

Although there are significant differences within and between Australia's largest cities, outer urban public transport is generally characterised by three consumer problems:

1. **Lower levels of access:** about 1 million people in both Sydney and Brisbane's outer suburbs, and 1.4 million in Melbourne's, are not within walking distance of reasonable quality public transport. Low residential densities and fewer public transport access points mean residents generally live farther away from public transport stops and stations than those residing in middle or inner urban areas.
2. **Poor frequencies:** our five largest cities all have much higher service frequencies in the inner city than outer urban areas. Our public transport networks are designed so that routes merge closer to the city centre. As a result the further away a passenger is from the centre, the more likely they will have poor frequencies.
3. **Longer travel times:** people in outer urban areas travel further and take more time to get to work. About 45% of these people travel more than 20 km each day to work, while in the inner suburbs only 7% of people travel that far.

As a result, people residing in these areas have become more reliant on private vehicles. Subsequently, they pay more for operating their vehicles and have less money to spend on other household expenses.

Traditional public transport is suited to high density – governments need to increase the efficiency of existing networks and consider new models

The case for improving public transport in outer urban areas is clear, however the solution is not always straight forward. Traditionally, governments have relied on increases to passenger numbers to support business cases for further investment in infrastructure or additional services. This has rightly led to public transport investment being centred on high-density corridors.

However, this approach means low-density outer urban areas receive little public transport investment. Public transport is often a poor option in these areas, making private vehicles a preferred choice. In turn, car dependency risks being 'locked-in', due to the high upfront costs associated with car purchases. As a result, mode shift to public transport is stubborn and slow once public transport becomes accessible.

In the absence of a high-quality public transport option in low-density areas, a vicious cycle of policy challenge develops for government:

- **Lower ridership:** outer suburban passengers are less likely to use public transport due to the previously identified consumer problems and pre-existing behavioural preferences.
- **Low cost recovery:** governments generally have lower cost recovery in outer suburbs compared to inner metropolitan areas due to low ridership and the higher cost of running longer routes.
- **Lack of investment:** low patronage can make it less economical for governments to invest in new infrastructure or service upgrades in outer urban areas.
- **Poor service levels:** as a result of this lack of investment, passengers are faced with less accessible, less frequent and longer services.

This paper examines the role of new models of transport provision (popularly demonstrated by the emergence of companies such as Uber) in breaking this cycle by providing cost-effective public transport for low-density areas. If incorporated into integrated transport networks, new transport models – such as on-demand services and sharing – can provide attractive services to areas of low transport demand. Additionally, governments must focus more on encouraging interchanging between transport services and modes particularly in areas of low density, where direct services cannot be provided in a cost-effective way.

New technology, greater availability of data and the emergence of new trends in shared consumption offer the opportunity to break the cycle of under provision of public transport at the urban fringe. In addition, the integration of land use and transport is critical to ensuring the reach and service levels of our transport networks reflect community needs.

Reduction in car dependency and the growth of public transport use will require strong engagement with the community to ensure their needs are met. Governments should seek the support of communities to undertake reviews of long-established transport services with a view to major changes. Many existing public transport services have not been updated for decades, or worse rely on the corridors of century-old former tram networks. Network design should involve a collaborative approach among transport agencies, operators and the community to examine changing community needs and preferences, and to design new networks that service the needs of people today and into the future.

This paper builds on previous Infrastructure Australia recommendations

Infrastructure Australia has previously recommended increasing investment and improving our transport infrastructure, particularly in outer urban areas. This paper builds on these recommendations, providing further evidence of the need for reform and practical, cost-effective actions for governments.

Recommendations from the *Australian Infrastructure Plan* (2016) include:

- **Recommendation 3.1:** Governments should upgrade legacy capital city passenger transport infrastructure to deliver higher-capacity, high-frequency services across all modes.
- **Recommendation 3.2:** Governments should increase funding to address gaps in access to passenger transport on the outskirts of Australian cities.

Recommendations from *Future Cities: Planning for our growing population* (2018) include:

- **Recommendation 8:** Australian governments should increase investment in public transport infrastructure in cities experiencing significant population growth.
- **Recommendation 11:** Australian governments should focus on improving access to jobs, education and services for the outer areas of our largest cities.

Recommendations

This paper provides seven recommendations to governments on how to improve public transport and accessibility in outer urban areas. Governments have a range of transport and land use options. While building more public transport is desirable and we recommend governments continue investing in new infrastructure, there are other actions that can improve and augment the efficiency of existing networks at lower cost.

Recommendation 1:

While progress is being made in most jurisdictions, state and territory governments should prioritise the seamless integration of transport networks for users by coordinating service planning, timetabling, fare policy, digital tools and operations.

Governments should work in partnership with transport agencies, operators and communities to:

- maintain an efficient transport hierarchy through maximising service frequencies on trunk routes and encouraging interchange for first-and-last mile connections
- incorporate flexibility in planning and contracts to allow them to monitor and respond to poorly utilised services
- ensure the integration and coordination of services are undertaken with an understanding of customers' needs and perspective
- undertake periodic holistic redesigns of public transport networks to match changing land use patterns and consumer preferences.

Recommendation 2:

Australian governments should embrace new transport modes, such as on-demand services, which are well suited to low-density areas.

Governments should:

- work in partnership with the private sector to understand potential network impacts, business models and operating requirements of new modes and technologies, such as demand-responsive services, in-market competition or automated vehicles
- develop coordinated whole-of-government implementation and communication strategies to support the adoption of connected and automated vehicles, including the use of pilots and trials.

Recommendation 3:

State and territory governments should implement a coordinated policy approach to encourage interchanging within an integrated transport network by:

- minimising passenger waiting times by coordinating services at interchanges, such as through timetable integration, timed transfers, high-service frequencies and active network management
- providing passengers with the ability to reduce their waiting times through booking connections, including using on-demand transport
- reviewing fare policies and structures including removing interchange fare penalties and introducing incentives
- prioritising the customer experience when designing transport interchanges, such as by minimising physical obstacles, providing real-time service and wayfinding information, and co-locating value-adding services at interchanges.

Recommendation 4:

State, territory and local governments should improve the physical integration of the public transport network with private, active and emerging transport modes by:

- prioritising access for public transport, including dedicated drop-off and waiting areas for buses and on-demand modes near interchanges
- improving access for private transport to interchanges, including providing additional car parking where appropriate, drop-off facilities, as well as bike storage
- providing car-share, e-bike and bike-share facilities at major interchanges to support a broader range of end-journeys
- integrating active transport, including walking and cycling, through dedicated infrastructure, improved lighting and all-weather protection.

Recommendation 5:

Australian governments should openly embrace technological innovation in transport, working with third-party operators to improve the user experience.

Governments need to:

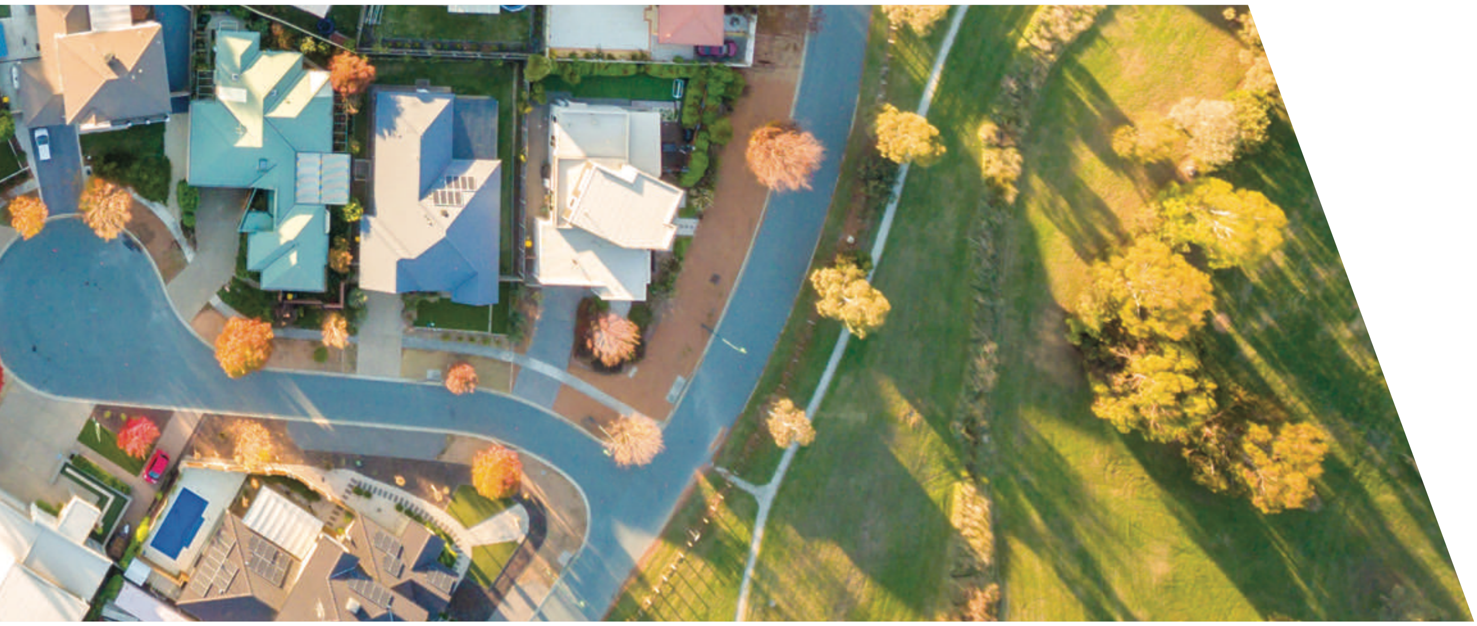
- adopt an outcomes-based regulatory approach
- improve open data distribution to facilitate third parties providing complementary services such as timetable information and integrated ticketing
- leverage open data and systems to support new subscription models for transport, such as Mobility-as-a-Service.

Recommendation 6:

Australian governments should undertake integrated land use and transport planning to examine opportunities for employment and residential densification at key sites adjacent to public transport.

Governments should:

- identify appropriate sites adjacent to trunk transport infrastructure to support densification
- develop corresponding metropolitan and local strategic plans to reflect potential for densification, including adequately assessing the capacity of existing social and economic infrastructure
- ensure that increases in density also reflect local character and amenity and are commensurate with improvements to local infrastructure and services
- establish implementation strategies and institutions with the right governance, funding and authority to ensure the planned infrastructure enhancements occur alongside densification
- for transport projects, explore the feasibility of value capture mechanisms.



Recommendation 7:

Australian governments should support the development and growth of suburban and outer urban employment centres to improve job accessibility.

In planning for new centres, governments should:

- be clear and transparent about their role and policy objectives – milestones for growth should be clearly defined, measurable, and frequently assessed
- identify the appropriate sectors to target and specific roles for government and partners, including the development of specialised knowledge precincts
- identify the supporting infrastructure requirements, particularly transport to and within employment centres.

The public transport challenge

At a glance

- **Investing in public transport is crucial, particularly for fast-growing cities.** An efficient public transport network is crucial in ensuring people have access to jobs, social infrastructure and leisure activities. As our cities grow, public transport will play an increasingly important role.
- **Investing in public transport is important, but not the only answer.** Public transport is very expensive to build and also requires indefinite operating subsidies. It is important governments complement increased investment with better planning and efficient use of existing assets.
- **Providing public transport in outer suburbs is particularly challenging.** Outer urban areas can be difficult environments for public transport because they are generally lower density and have fewer, smaller and more dispersed employment centres. As a result, ridership is likely to be lower than other parts of the city, as well as cost recovery.
- **Outer urban public transport can become caught in a cycle of poor financial performance and service levels.** Public transport in lower-density suburbs often falls into a vicious cycle, where existing services are poorly patronised, so governments are reluctant to spend more money on new infrastructure or service upgrades. In turn, this leads to poor service levels and performance, which further deteriorates ridership and cost recovery.

Public transport is critical for our growing cities

Our cities are experiencing significant population growth and it is important that governments invest in public transport in response. Over the next 30 years, Australia's population is expected to grow by over 11 million people, and close to 80% of this growth will be located in our five largest cities: Sydney, Melbourne, Brisbane, Perth and Adelaide.[8] Population growth inevitably means more pressure is placed on our transport networks and, while there is no single solution to congestion, public transport is an important part of the answer.

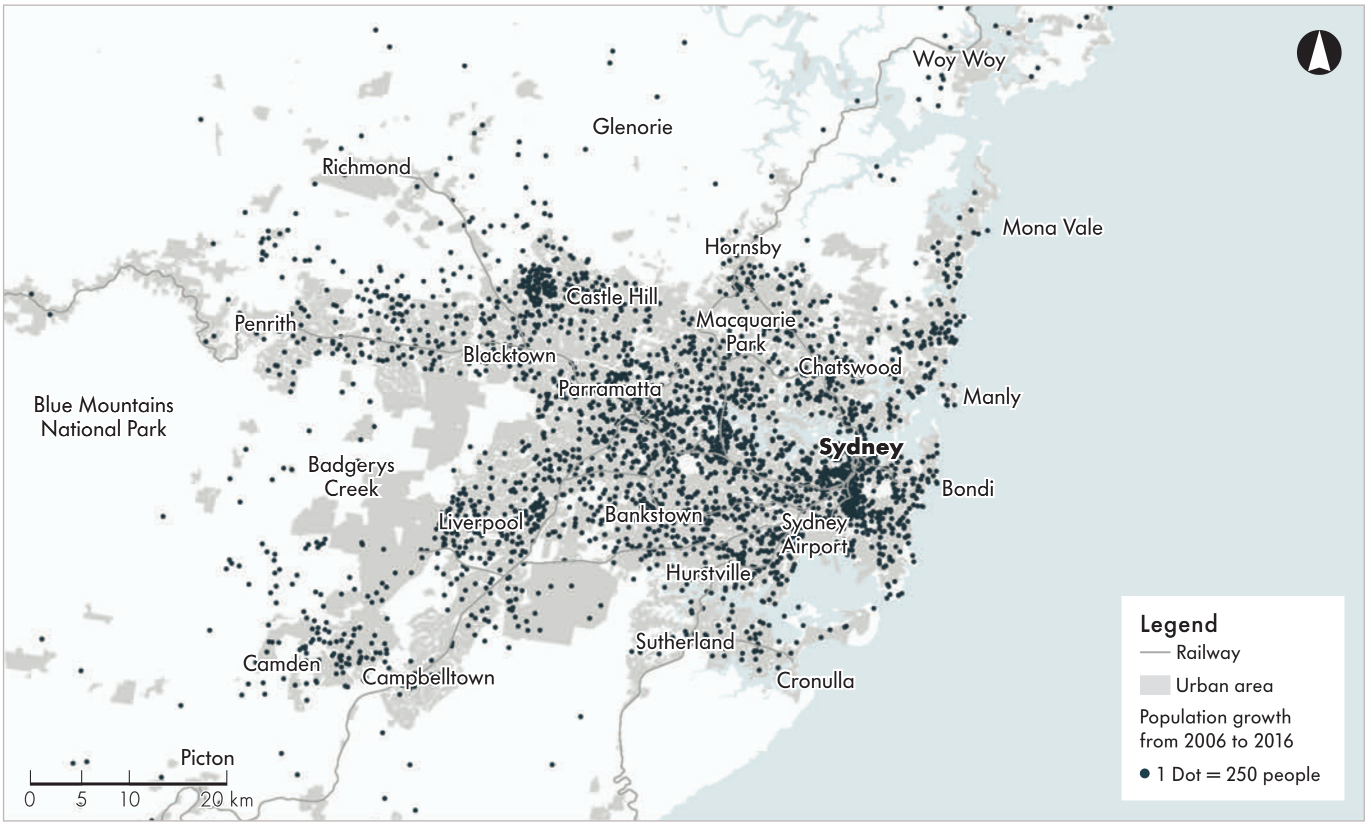
Infrastructure Australia's recent report *Future Cities: Planning for our growing population* modelled land use scenarios for Sydney and Melbourne to 2046.[9] It found that under all scenarios, for both cities, congestion on our roads will get worse over the next 30 years. This means more time spent on congested roads and a decline in job accessibility for drivers. In contrast, job accessibility by public transport was projected to increase by 2046, showing that, in general, mass transit will become increasingly suited to the transport task as our cities grow in population and density.

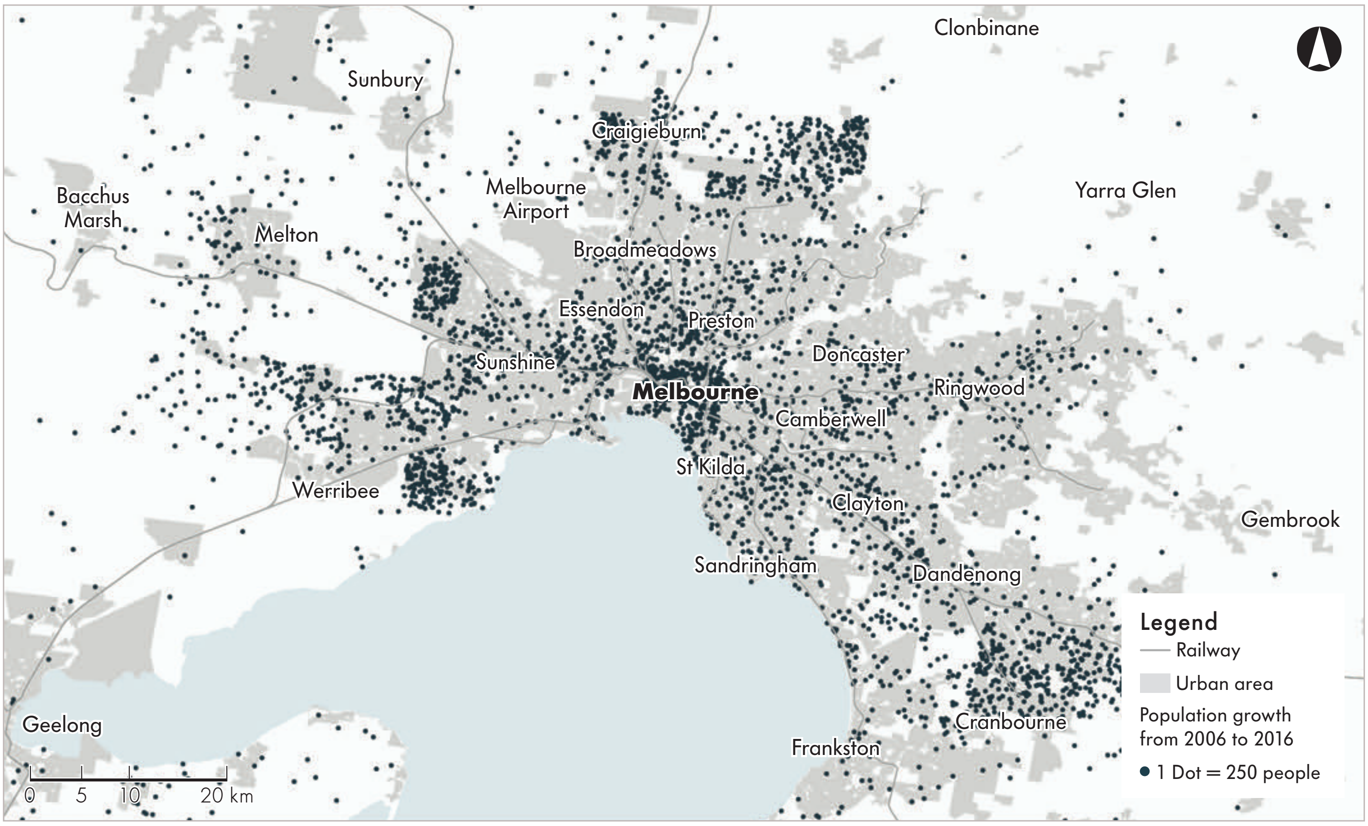
Spending more on public transport is important, but is not the only answer

Although most of our cities have been undergoing varying degrees of densification and urban consolidation in the inner city, there remains strong growth in outer urban areas. Both of these growth trends are clearly visible in **Figure 1**, which shows the spatial distribution of population growth in Sydney and Melbourne between 2006 and 2016.

If we continue to service outer suburbs poorly, there will be millions of people who are not well served by our publicly-subsidised networks. Infrastructure Australia has previously argued for greater levels of infrastructure investment in outer suburban areas. However, it is also important to recognise that resources are limited and investments need to be made on a case-by-case basis. This chapter investigates the challenges and costs of providing public transport, particularly in low-density environments, and why increasing expenditure needs to be complemented by better planning and more efficient use of existing assets.

Figure 1: Distribution of population growth, Sydney and Melbourne, 2006–16





Note: *Each dot represents an increase of 250 people for each SA2. SA2s are geographic regions created by the Australian Bureau of Statistics, which represent a large suburb or a collection of small suburbs. Dots are randomly distributed within each SA2. SA2s that had an increase of less than 250 people are not represented by a dot. Population figures are for 30 June 2006 to 30 June 2016.*

Source: *Australian Bureau of Statistics (2017)*[10]

Public transport is expensive to build

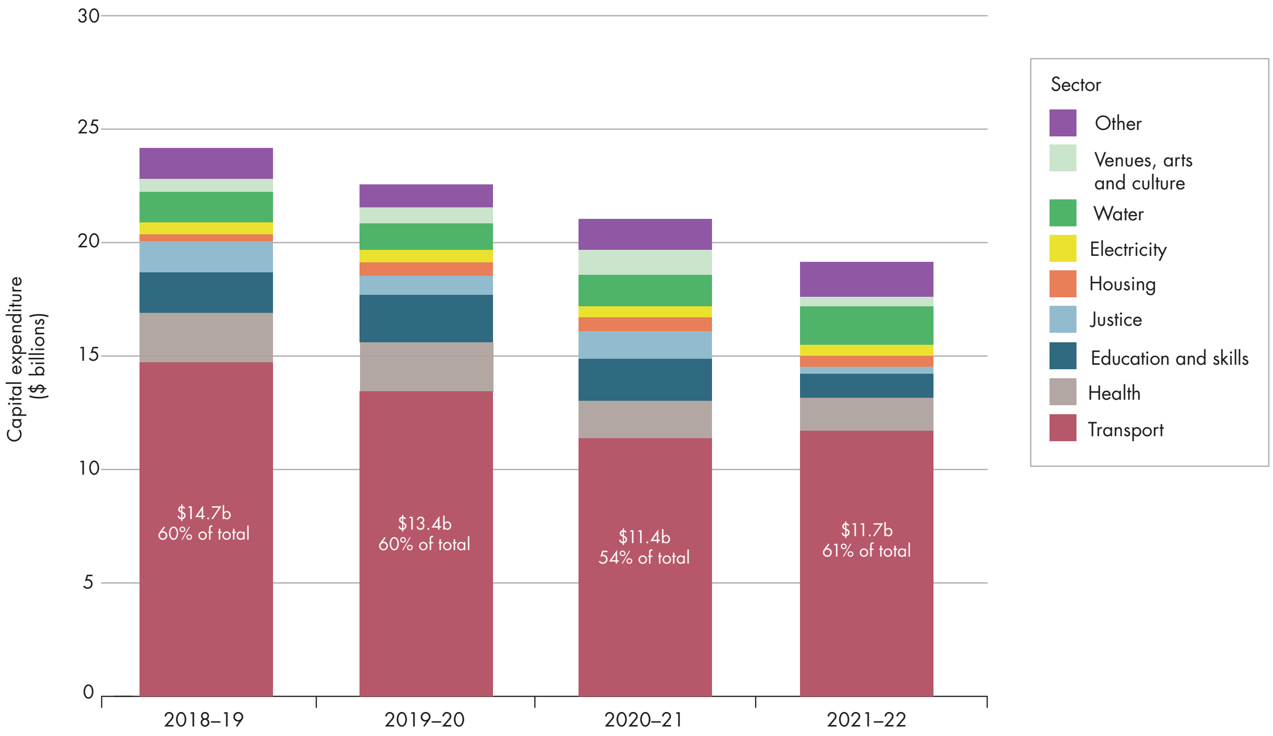
Transport infrastructure can be very expensive to build, and large-scale expansions of the network can have significant impacts on government budgets. Resources are always limited and all expenditure has an opportunity cost – that is, funding one project means that alternative projects, potentially in sectors of equal need in a growing city like health and education, can't be funded.

There are large variations in the cost of projects, depending on their scale, location, land acquisition requirements, type of construction, and intended purpose. State and territory governments predominantly shoulder the responsibility for delivering our urban transport networks, particularly public transport. In New South Wales alone, transport accounted for close to 60% of the state's infrastructure capital budget in 2018–19 and the forward estimate years.[11]

Figure 2 shows the breakdown of capital expenditure by sector in the New South Wales Budget over 2018–19 to 2021–22, with transport accounting for over half of the total budget over the full period.

Investment in public transport is currently booming in Australia, with numerous large projects under construction, funded, or in the planning stages, including the Sydney Metro Northwest ($8.3 billion), Sydney Metro City and Southwest ($11.5–12.5 billion),[13] Melbourne Metro ($10.9 billion),[14] Brisbane's Cross River Rail ($5.4 billion),[15] and Perth's METRONET ($3.6 billion).[16] The significant capital costs of transport infrastructure highlights the need for robust business case development to support decision-making on infrastructure investment, as well as options assessment to explore alternatives that use existing infrastructure more efficiently.

Figure 2: Capital expenditure by sector in the 2018–19 NSW Budget



Note: Includes money from federal grants.

Source: NSW Treasury (2018)[12]

Once constructed, public transport requires ongoing subsidy

One of the most challenging aspects of delivering public transport in the Australian context is that in most cases it will require ongoing government subsidy to operate. Public transport cost recovery (the proportion of costs that public transport services retrieve in fares) is low in Australia by international standards. The proportion can vary significantly by the type and location of the service, but on average, cost recovery is generally below 30%.[17] **Figure 3** shows the size of the difference between cost recoveries in Australia's largest cities compared to some international networks.

The international public transport networks in **Figure 3** that are close to, or more than, recovering costs operate in very different contexts to Australian cities.

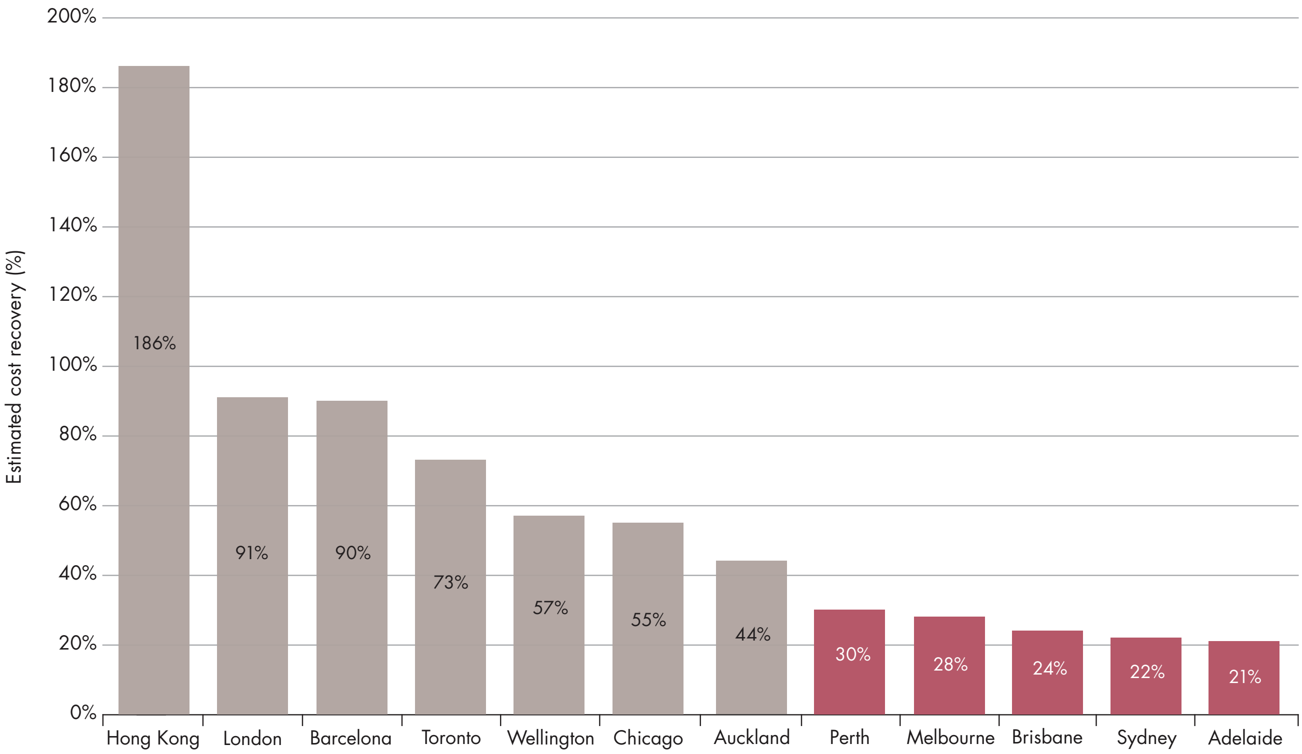
Hong Kong, for example, has the highest rate of cost recovery in the world for its public transport network. On top of its strong cost recovery from fare revenue, the Hong Kong Metro (operated by Mass Transit Rail) is granted exclusive developer rights for land around new stations and retains a share of future developer profits for re-investment into the transport network.[19]

Perhaps the most striking difference between Hong Kong and Australian cities is residential density. Across Hong Kong, there are about 6,700 people per square kilometre on average, and 45,000 people per square kilometre in the urban area of Kowloon. Such high residential density drives public transport use in the city, with 90% of journeys each day made by public transport.

In contrast, Sydney, the Australian city with the highest residential density and public transport use, has only 11% of journeys each day made by public transport.[20] While certain inner-city densities in Australia can be comparable to Hong Kong (for instance, Sydney's Green Square in the inner-south is due to increase to 61,000 people by 2030),[21] low density is the norm of Australian cities, including the majority of areas public transport must service. These lower densities can affect cost recovery.

Like Hong Kong, London and Barcelona have significantly higher population and employment density than Australia's cities, and are supported by high-capacity metro systems. This means it is often more convenient for people to catch public transport than drive. In addition, London has a congestion charge for drivers, which helps encourage people to catch public transport, thereby increasing fare revenue.

Figure 3: Estimated cost recovery of Australian and selected international public transport networks, 2012–13



Note: Data only includes revenue from fares. This means, for example, that Hong Kong excludes significant revenue from property developments and London excludes revenue from congestion charging.

Source: L.E.K. Consulting (2015), Bureau of Infrastructure, Transport, and Regional Economics (2013)[18]

Australian cities may reasonably aim to increase their cost recovery, and there are numerous measures that governments can take, such as:

- exposing service provision and key functions to market competition or contestability
- improving efficiency of operations through technological and labour force reforms
- more efficient use of infrastructure and fleets
- ensuring operating efficiency and fleet utilisation are central to route and service planning
- increasing the price of fares, at minimum in line with yearly CPI increases
- investigating value capture opportunities, particularly at new transport interchanges.

However, the density, structure and dominance of cars in Australian cities mean ongoing and indefinite subsidy of public transport is almost certain. This comes at a very significant cost to governments, as several Australian urban public transport operators spend billions of dollars per year on operating expenditure, as shown in **Table 1**.

Most additions to a transport network will add to that network's operating costs. There are of course exceptions, where individual routes/lines are heavily patronised and recover their costs, but given the low levels of overall cost recovery, these routes are the exception rather than the rule. Governments are therefore justifiably careful when planning for extensions to the public transport network. Any additions need to take into account both the upfront capital cost and the ongoing subsidy that the service will likely require, and then weigh these costs against potential alternative uses of public money.

Table 1: Average annual operating expenditure of key public transport operators, 2012–17

Location	Operator	Mode	Expenditure ($M)
Sydney	Sydney Trains	Rail	3,167
Sydney	State Transit Authority	Bus	635
Melbourne	Various train and tram operators	Rail and tram	1,507
Melbourne	Various metropolitan bus operators	Bus	1,080
South East Queensland	Queensland Rail	Rail	1,200
South East Queensland	Brisbane Transport	Bus	310
Perth	Transperth	Rail	362
Perth	Transperth	Bus	348
Adelaide	Adelaide Metro	Rail and tram	408

Note: Expenditure figures are presented in millions. Operating expenditure for the five financial years (2012–13 to 2016–17) were separately indexed to March 2018. These were added then divided by five to determine an average annual figure. This is not presented as a comprehensive view of public transport expenditure, as not all agencies publish their complete operating expenditure figures.

Source: PwC Australia (2017), Sydney Trains (2017), State Transit Authority (2018), Public Transport Victoria (2017), Queensland Rail (2017), Department of Transport and Main Roads (2017), Public Transit Authority (2017), Department of Planning, Transport and Infrastructure (2017)[22]

Providing public transport in outer urban areas is particularly challenging

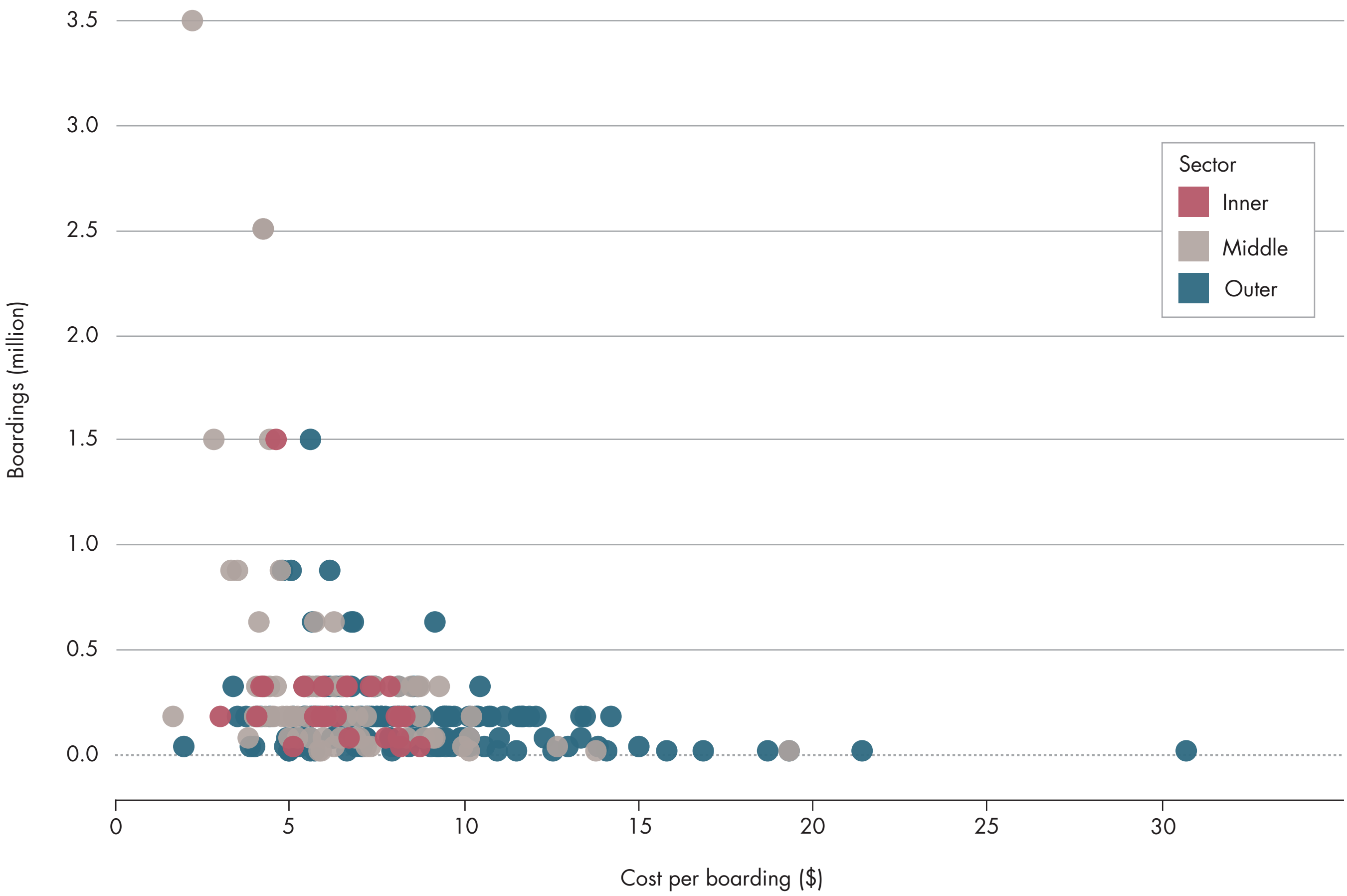
Cost recovery varies significantly across networks and by route. Some routes may be very efficient, with high ridership resulting in an efficient use of infrastructure, fleets and labour. However, all networks have routes that are provided as a community service obligation and are heavily loss making. These routes often provide an essential service, but have lower levels of ridership and/or high levels of use by people paying concession fares.

Public transport routes are generally most efficient when they service large numbers of people travelling between two or more points. The high levels of demand for these routes mean they benefit from economies of scale. The cost of providing a service (whether it is rail, tram, bus or ferry) is largely fixed, regardless of patronage, and is made up of wages, fuel/electricity, wear and tear to the vehicle, and infrastructure. On the other hand, revenue depends on how many people are using the service and what type of fares are being paid. Cost recovery will generally be higher for routes that are well patronised and tend to service areas with high levels of demand, such as employment centres.

Outer urban areas can be particularly challenging environments for public transport because they are generally lower density and have fewer, smaller and more dispersed employment centres. This means that travel patterns are often more dispersed, because there are fewer large drivers of travel demand. As a result, there are more likely to be routes that are necessarily provided as community service obligations, but have lower levels of ridership.

The relationship between ridership and costs per passenger is shown in **Figure 4**, in which we have categorised Perth's buses into routes that run primarily in inner, middle and outer urban sectors of the city (these sectors are defined in **Chapter 2**). Although there is significant overlap in operating costs between sectors, buses that operate in the outer suburbs generally have lower ridership and higher operating costs than those in the middle and inner suburbs.

Figure 4: Operating cost per boarding vs boardings for buses by sector, Perth, 2017



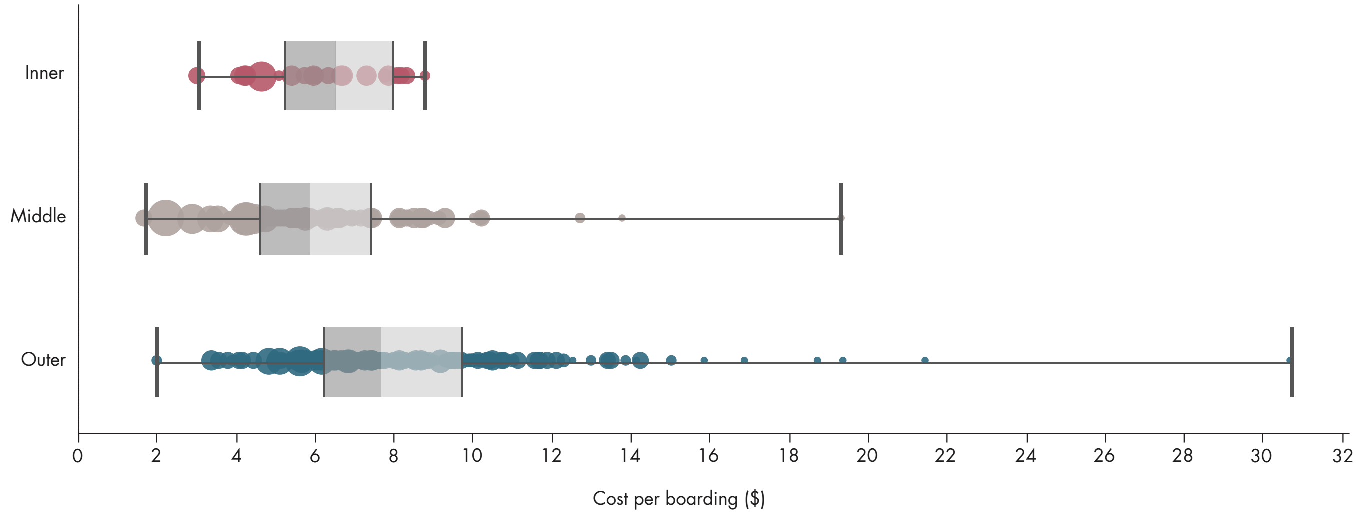
Note: Inner, middle and outer sectors are defined in ***Chapter 2****.*

Source: Based on Office of the Auditor General (2017)[23]

There is also much more variation in the cost per passenger for outer suburban services than in the middle and inner sectors. **Figure 5** presents the cost per passenger in a 'box and whisker plot'. The median operating cost per passenger for outer urban services is higher than the other sectors. But perhaps more noticeable is that the outer sector has numerous services that are significantly more costly to run than most other routes. Some of these routes are operated in semi-rural settings, which unsuprisingly come at greater cost to governments, however there are also some costly 'feeder routes' in the outer suburbs, which may struggle to compete against the car in lower-density settings.

The pattern is repeated across jurisdictions, where average cost recovery is likely to be lower in outer urban areas. In Sydney, for example, bus services are split between metropolitan and outer metropolitan contracts. As shown in **Table 2**, while metropolitan contracts in Sydney on average have cost recovery of about 30%, the outer metropolitan contracts are about one third of this rate, at 10%.

Figure 5: Operating cost per boarding of bus routes by sector, Perth, 2017



*Note: The middle line in this chart is the median while the grey shaded areas extend to the 25th and 75th percentiles. The outer lines (or 'whiskers') show the lowest and highest cost services. Inner, middle and outer sectors are defined in **Chapter 2**. Larger circles represent bus routes with higher passenger boardings.*

Source: Based on Office of the Auditor General (2017)[24]

Table 2: Metropolitan and outer metropolitan bus cost recovery, Sydney, 2008–12

Contract area	2008–09	2009–10	2010–11	2011–12
Metropolitan	41%	38%	32%	30%
Outer Metropolitan	14%	13%	11%	10%

Note: Although there is overlap, Sydney Outer Metropolitan bus contract boundaries differ from the 'outer sector' used in this report.

Source: Independent Pricing and Regulatory Tribunal (2012)[25]

Outer urban public transport is caught in a cycle of poor performance and service levels

The high capital and operating costs of public transport can make some investments difficult to justify for governments. This is particularly the case for low-density areas. Numerous academics and planners have noted that public transport in low-density suburbs often falls into a vicious cycle: existing services are poorly patronised, so governments do not spend more money on new infrastructure or service upgrades (instead prioritising alternative investments).[26] In turn, this leads to poor service levels and performance, which further deteriorates ridership and cost recovery (see **Figure 6**).

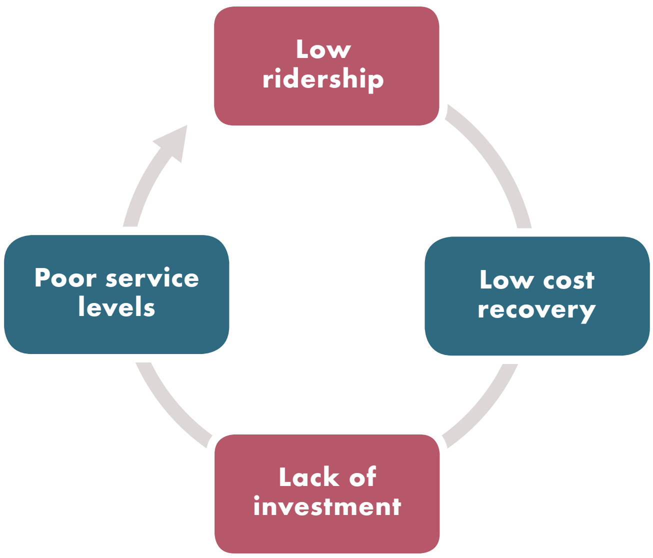
Policymakers and transport operators face a considerable challenge to break this cycle. One option is to continue to invest heavily in public transport to improve the quality or frequency of services and, sometimes, investments can tap into latent demand and draw many more customers into the network. The Mandurah railway line in Perth is a good example; after opening in 2007, patronage grew above projections[27] and it now adds about 20 million passenger boardings each year to the network.[28] The line not only added passengers in its own right but, because it expanded the reach of the network, patronage also grew on the other railway lines and bus services that connect with the new railway.[29] This success occurred despite the line being constructed through largely low-density, car-dominated suburbs.

However, large investments do not always prove to be justified, and there have been numerous transport projects that have not met the patronage projections that were used to justify their construction.[30] Furthermore, in areas where ridership is likely to be low and travel patterns are dispersed, travelling by car may be easier for the users and cost the taxpayer less. In such cases, new models or approaches to improving the efficiencies of existing networks may be better solutions.

At the very least, there is a strong case for ongoing government subsidisation of public transport, even on services to regions that have low-cost recovery. The Independent Pricing and Regulatory Tribunal (IPART) in New South Wales noted that subsidies have the dual purpose of funding the external benefits of public transport use (such as decreased congestion, air pollution and improved safety) and to help the government meet its social policy objectives through addressing social isolation.[31]

The answer to improving public transport in outer suburbs is not clear-cut. As large capital investments and network extensions can often be difficult to justify, governments need to look beyond 'big ticket' projects. Operational changes, frequency improvements, network redesigns, accessibility upgrades and on-demand transport may all have significant benefits but come at a fraction of the cost of larger projects.

Figure 6: Cycle of public transport performance in low-density suburbs




STOP

The extent of public transport disadvantage in Australian cities

At a glance

- **Infrastructure Australia has measured public transport access, service levels and usage in Australia's five largest cities.** We have divided each city into inner, middle and outer sectors, which enables comparison of public transport services between sectors.
- **Public transport disadvantage in outer suburbs is significant.** Access to public transport services and service frequencies are lower, while travel times and distances to major employment centres are longer in outer suburbs.
- **Public transport usage is lower for people living and working in the outer suburbs.** Fewer people use public transport in outer suburbs, and those who do are more likely to also need to drive to reach local services.
- **Car operating costs are higher in the outer suburbs.** People in the outer suburbs pay more for operating their vehicles. A significant part of the costs is from fuel, lubricants, and additives, which increases as people travel longer distances.

The outer areas of our cities are being left behind

This chapter assesses the quality and accessibility of public transport services in Australia's five largest cities: Sydney, Melbourne, Brisbane, Perth and Adelaide. We establish and compare the extent to which public transport disadvantage exists in the the inner, middle and outer regions of Australia's cities, and determine how this affects travel patterns and liveability.

We found that although half the population of our four largest cities live in the outer suburbs, and one-third of Adelaide's population, levels of service and accessibility to public transport is significantly lower in these areas. Public transport in the outer suburbs is typically characterised by three consumer problems:

1. **Lower levels of access.** People generally live further away from public transport stops and stations, meaning it takes them longer to access the networks.
2. **Poor frequencies.** Our cities have radial transport networks, which spread out from a central point. This means routes often merge closer to the city centre, so that the further away a passenger is from the centre, the more likely they will have poor frequencies.
3. **Longer travel times.** This is because accessibility to the network is poorer and travel distances are longer. Disparities in journey times are particularly prevalent for accessing employment centres.

Travel patterns are therefore very different in the outer suburbs. People are more reliant on cars, are more likely to own more than one car, and travel longer distances. These patterns are reflected in household expenditure, with the costs of operating vehicles in the outer suburbs higher than other parts of the city.[32]

Methodology: defining the inner, middle and outer sectors of each city

The criteria used to divide the five cities into inner, middle, and outer sectors was based on the Bureau of Infrastructure, Transport and Regional Economics (BITRE) report series: *Population growth, jobs growth and commuting flows*.[33] However, there are some differences in how we define these boundaries, the most important probably being that Infrastructure Australia used the Australian Statistical Geography Standard (ASGS), updated for the Australian Bureau of Statistics (ABS) 2016 Census, to define sector and greater capital city boundaries.

Table 3 summarises the characteristics that define the inner, middle and outer sectors. These sectors, which were solely created for the purpose of this study, are centred on each city's Central Business District (CBD). Infrastructure Australia acknowledges that there is significant variation within each sector and a degree of subjectivity in defining them. For example, while the outer sector is generally lower density in each city, there are pockets of higher-density development, particularly in some of the newer subdivisions and in the centre of satellite cities such as Gosford, in New South Wales.

It is important to note that this analysis is intended to identify high-level trends for the purposes of making recommendations that are appropriate for five jurisdictions. There are differences in the history, densities, transport networks and structures of each city that may not be captured in this analysis.

Each sector was created by allocating ABS Statistical Area Level 2 (SA2) geographies as 'inner', 'middle' or 'outer' – with each SA2 representing a large suburb or a group of small suburbs. As a small number of SA2s were geographically large, they were split between sectors – for example, Fremantle SA2 was allocated to Inner Perth, but also contained Rottnest Island, which was split and allocated to Outer Perth.

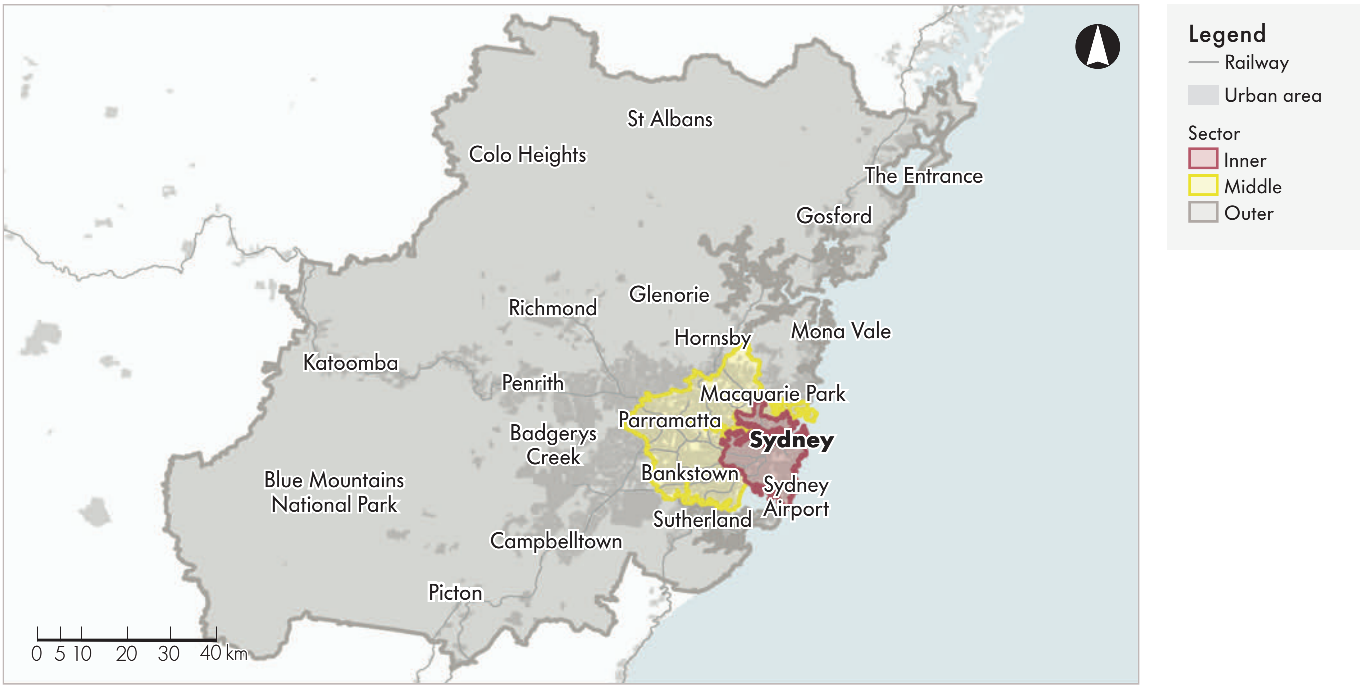
Table 3: Characteristics of urban sectors

Urban sector	Typical travel time to CBD	Typical distance to CBD	Typical urban form
Inner	Up to 30 minutes	Up to 10 km	▪ Significant pre-1940s housing. ▪ Streets originally built prior to the motor car. ▪ Originally serviced by tram networks. ▪ Significant high- and medium-density development in recent years.
Middle	30 to 60 minutes	10 km to 20 km	▪ Housing largely constructed from 1950s to 1970s. ▪ Mix of arterial roads/motorways and residential streets. ▪ Generally serviced by heavy rail and bus. ▪ Mostly low density housing with some medium- to high-density developments recently.
Outer	More than 60 minutes	Greater than 20 km	▪ Housing mostly constructed since the 1970s. ▪ Mix of arterial roads/motorways and residential streets. ▪ Mostly low-density housing, although some medium- to high-density housing, particularly in newer suburbs. ▪ Includes some neighbouring towns and cities.

Figure 7 illustrates the extent of the inner, middle and outer sectors for the five cities. It shows that the outer sector in each city has substantially larger land area than the middle and inner sectors. However, large parts of the outer sectors have very low or no population, such as national parks. In assessing the performance of our public transport networks, our metrics are weighted by population. This ensures that the results mostly reflect the experiences of people who live in established suburbs, rather than those in semi-rural or rural areas.

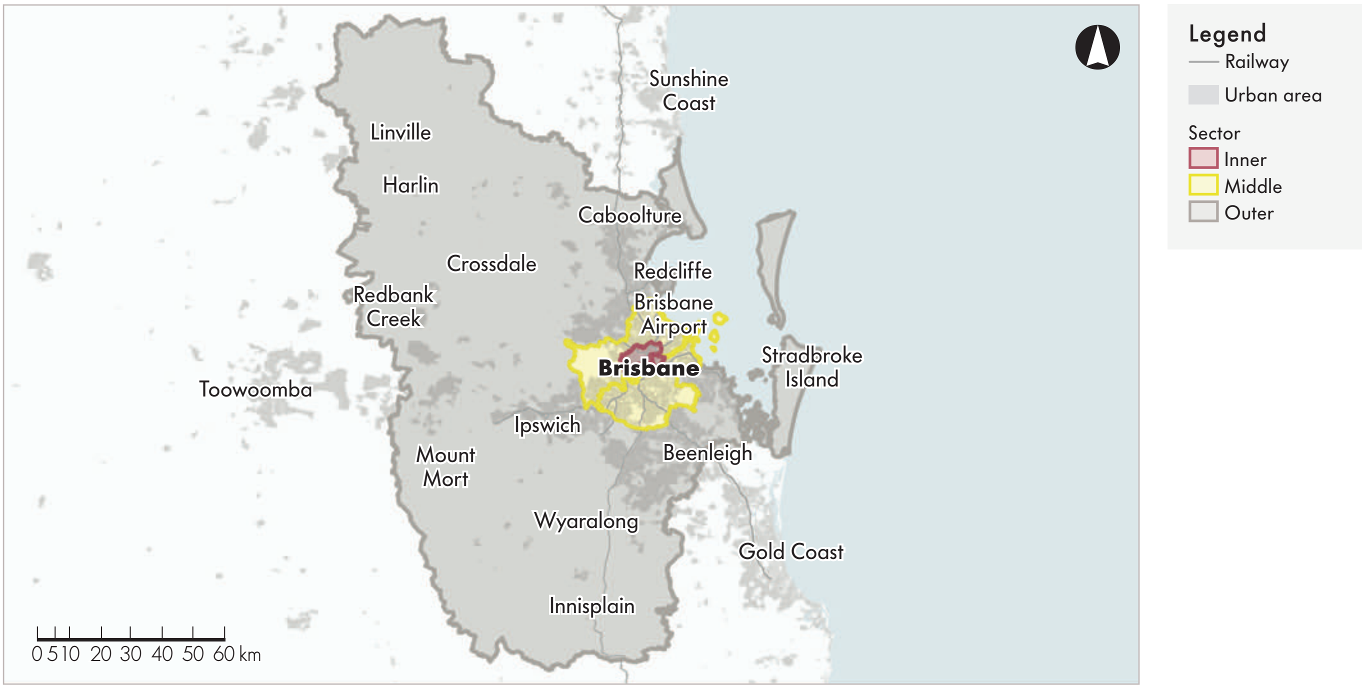
Figure 7: Inner, middle and outer sectors, all five cities

Greater Sydney

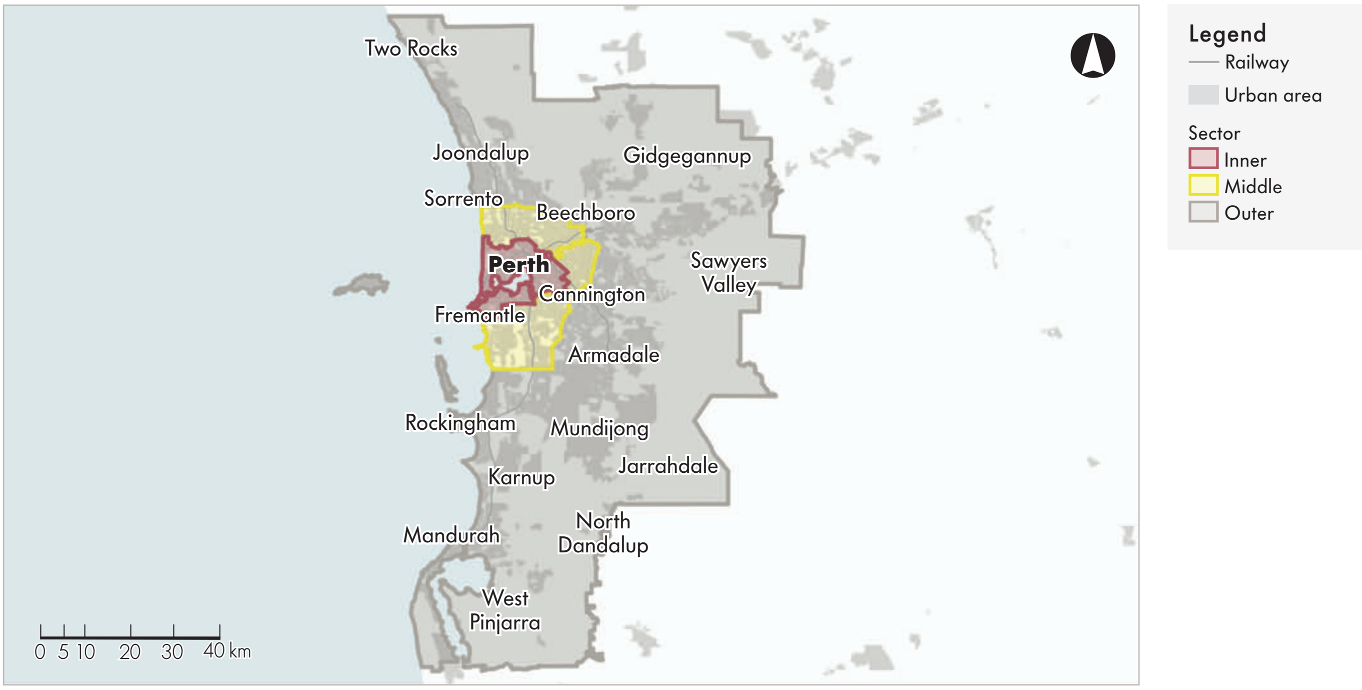


Greater Melbourne

Greater Brisbane



Greater Perth



Greater Adelaide

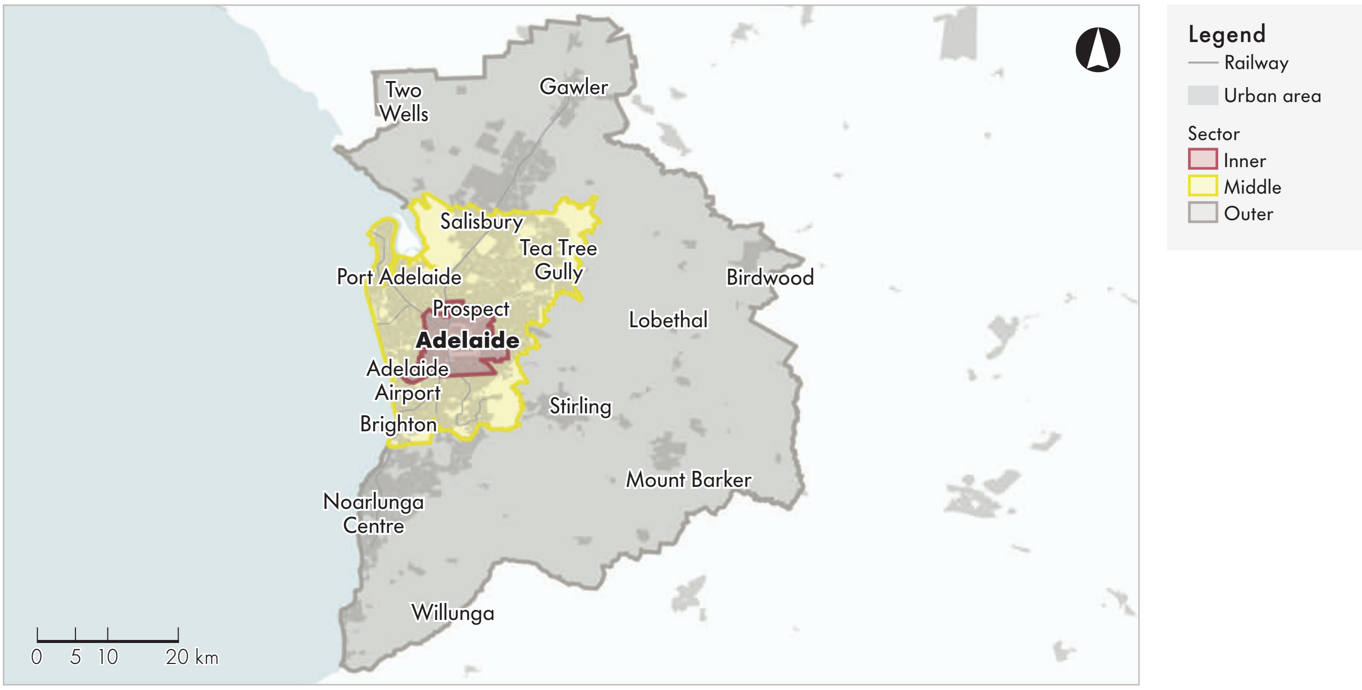
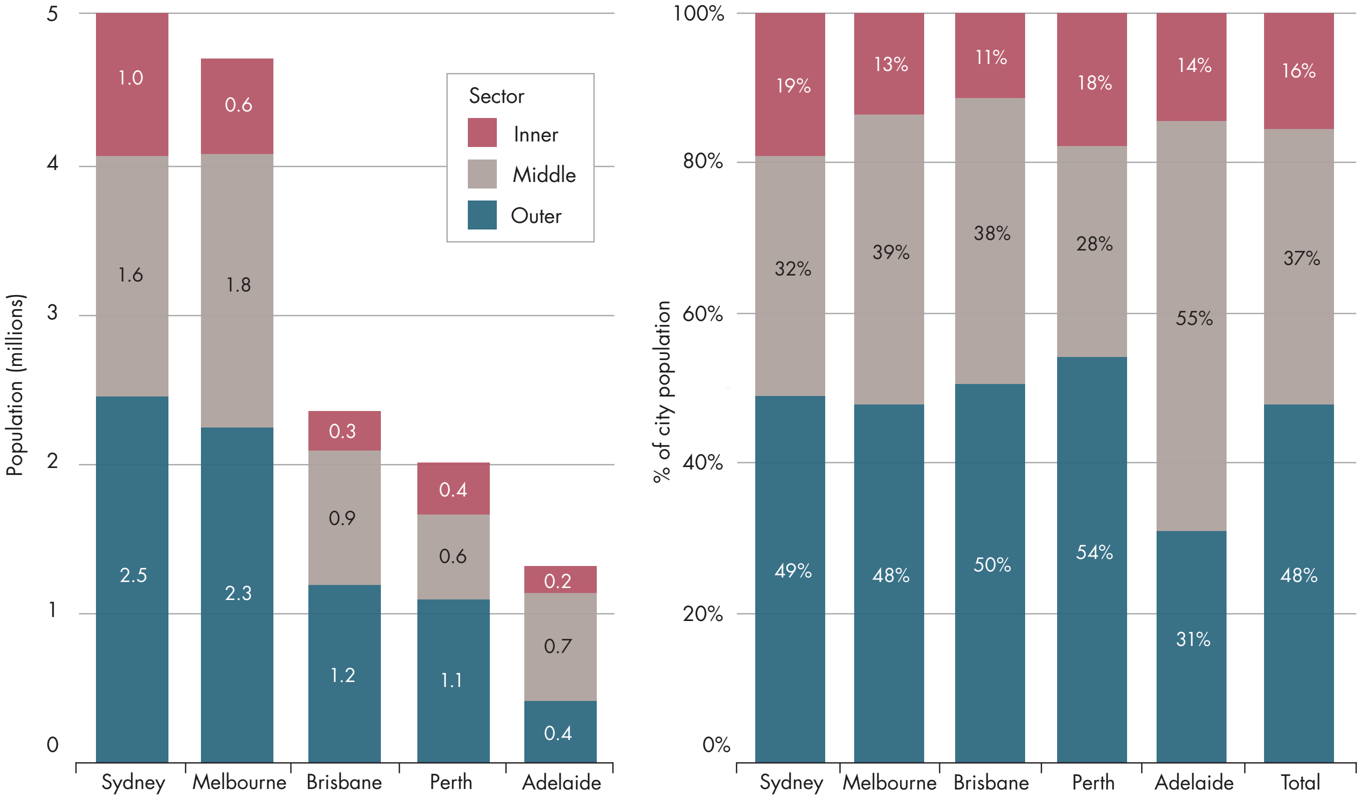


Figure 8 shows that the distribution of population between sectors is consistent across most cities – with about half of each city's population living in the outer sector and the smallest percentage living in the inner sector. Adelaide is a clear exception, as over half its population lives in the middle sector.

For some cities, the outer sector includes satellite cities or towns that are considered by the ABS to be included as part of the capital city area. An example is Gosford on the New South Wales Central Coast, which is counted as a part of Sydney's greater capital city area. This is because the ABS definition is designed to capture the labour market of each capital city based on commuting flows.[34] In the context of this report, this definition is important because it captures most (but not all) long-distance public transport commutes.

Figure 8: Estimated resident population by sector, as count and proportion of city population, all five cities, 2016



Note: Figures shown are for 30 June 2016.

Source: Australian Bureau of Statistics (2017)[35]

Public transport walking access is significantly lower in outer suburbs

Walking access to public transport is an important social equity issue and particularly challenging for people living in our outer suburbs. Our public transport networks are heavily subsidised by government, so all residents reasonably expect to have sufficient access to them. However, the outer parts of our cities are geographically large and have low residential densities. This means that public transport accessibility is lower compared to denser inner-city areas, as there are fewer people living near each railway station, light rail stop or bus stop.

We measured the proportion of the population in the outer, middle and inner sectors of each city who do not have a medium- to high-frequency public transport service within walking distance. A medium- to high-frequency service is defined as four or more services during weekday AM peak, while walking distance is defined as 800 metres for heavy rail stations and 400 metres for all other services.

Figure 9 shows that, across all five cities, access is significantly lower in the outer sector than the middle and inner (56% of sector population without walking access, compared to 19% and 4%, respectively). This demonstrates that a substantial proportion of residents in the outer suburbs are not within a reasonable walking distance of medium- to high-frequency public transport. Sydney, Melbourne and Brisbane, for example, each have over 1 million people in the outer suburbs who fall into this category, representing 42%, 64% and 80% of population in those sectors, respectively.

There are also disparities between cities, which is likely a result of differences in historical development, the extent of their respective public transport networks, and residential densities.

Sydney, for example, historically developed along its waterfront, then rail routes as the city expanded and allowed people to live further from their workplaces at the city centre. Sydney's inner and middle suburbs are often based around a shopping strip, with a public transport node at its centre. Also, Sydney is Australia's densest city, and higher land values around transport nodes incentivise higher densities in these areas. As a result, Sydney generally has higher levels of accessibility to public transport relative to other Australian cities (an average of 75% with walking access).

On the other hand, Perth has lower accessibility levels across all sectors. Perth has lower urban density, meaning fewer people live near the public transport network. However, Perth also has less disparity between its inner, middle and outer sectors, which reflects uniform density levels throughout the city and a public transport network which has expanded significantly in outer urban areas in recent years.

Figure 9: Walking access to medium- to high-frequency public transport by city and by sector during weekday AM peak, as count and proportion of city population, all five cities, 2017

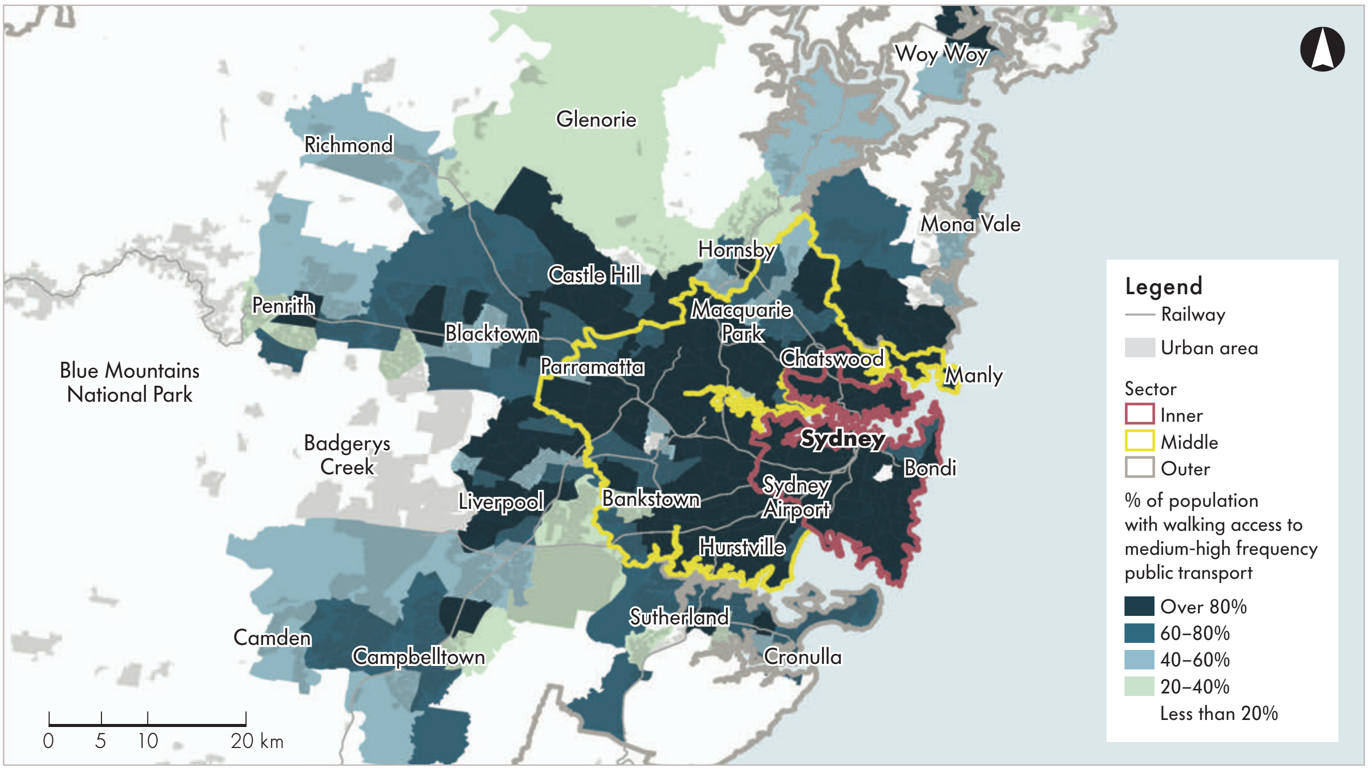
Note: A medium- to high-frequency service is defined as four or more services during weekday AM peak, while walking distance is defined as 800 metres for heavy rail stations and 400 metres for all other services.

Source: Based on GTA Consultants (2017), Australian Bureau of Statistics (2016)[36]

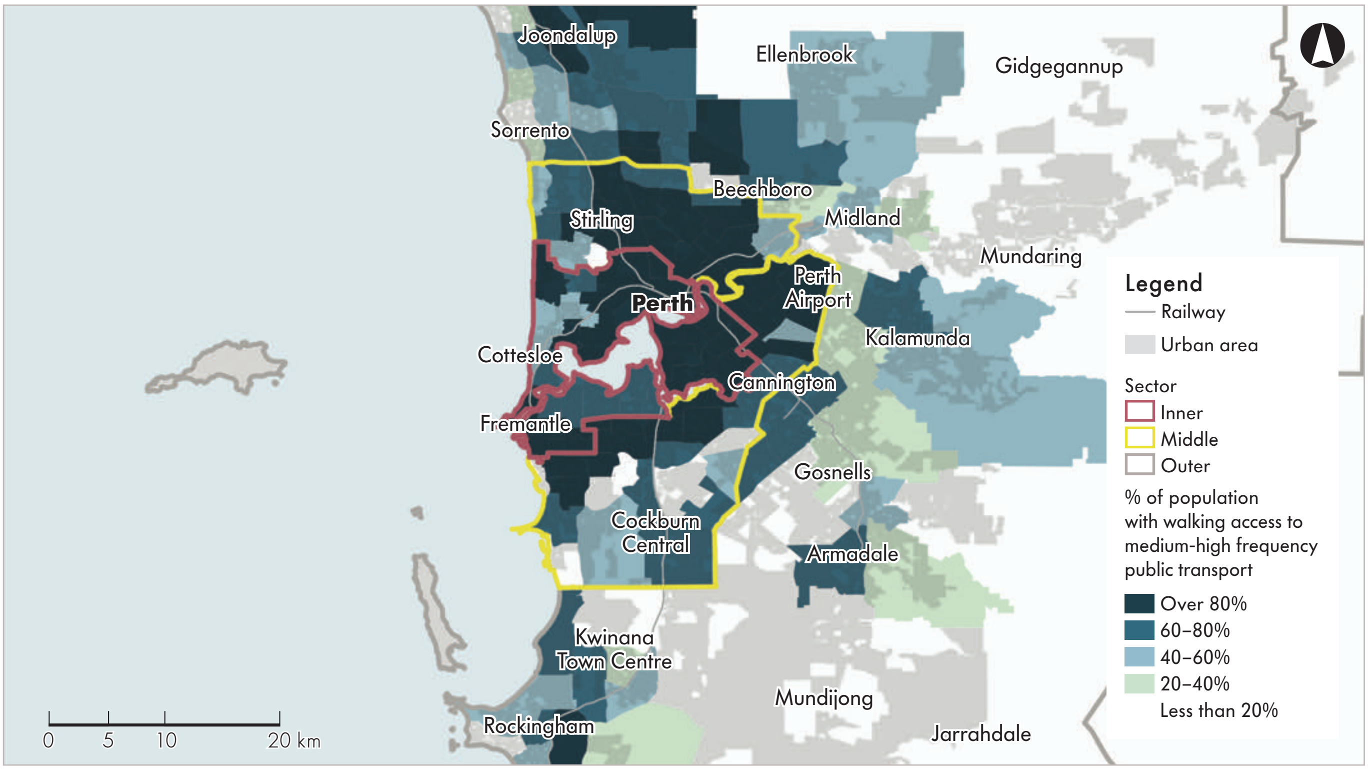
Figure 10 shows the spatial contrast between Sydney and Perth. Inner Sydney has high walking access throughout, while parts of inner Perth have lower walking access, such as around Cottesloe. Additionally, a higher proportion of suburbs in outer Sydney have high walking access (e.g. Liverpool, Castle Hill) compared to outer Perth.

Figure 10: Walking access to medium- to high-frequency public transport by SA2, Sydney and Perth, 2017

Sydney



Perth



Note: A medium- to high-frequency service is defined as four or more services during weekday AM peak, while walking distance is defined as 800 metres for heavy rail stations and 400 metres for all other services.

Source: Based on GTA Consultants (2017), Australian Bureau of Statistics (2016)[37]

Service frequency is much higher in the inner city

Frequency of services is an important indicator when measuring the quality of public transport, as it influences how flexible people can be when travelling. Frequent services are particularly important for passengers who have changing routines and responsibilities, and so do not consistently catch the same timetabled service. It also allows people to make changes to their travel plans at the last minute, or narrowly miss a service and not be concerned about when they will arrive at their destination.

High frequency is also important for interchanging between services. Public transport networks provide the best service when they allow people to interchange between services or modes with relative ease. Interchanging prevents passengers from being restricted to a single route (such as from their local station to the CBD in radial networks), by allowing them to change services or modes and travel in numerous different directions. This extends the reach of the network by increasing the number of destinations a passenger can reach within a reasonable amount of time. The importance of interchanging is explored further in **Chapter 3**.

Infrastructure Australia has analysed service frequency by looking at each city's public transport stops and stations. In all cities we analysed, high-frequency stops are overwhelmingly concentrated within the inner suburbs, and quickly decline in density in the middle and outer suburbs. The pattern is particularly stark in the off-peak period, and in all cities there are few frequent services outside of the inner suburbs over the weekend.

Figure 11 maps service frequencies during the weekday AM peak and weekend off-peak periods for Melbourne and Brisbane. Frequency mapping was undertaken by GTA Consultants using public transport timetables in effect between April and June 2017. Infrastructure Australia acknowledges that jurisdictions have since changed and upgraded timetables.

Infrastructure Australia has defined high-frequency services as 12 or more per hour, which is designed to reflect a 'turn up and go' service, where no timetable is required.[38] Medium-frequency services are defined as four to 11 per hour, which is considered a general standard for allowing easy interchanges, and low-frequency services are those below four per hour. It is important to note these definitions were developed for this study only and jurisdictions have their own internal definitions regarding service frequency.

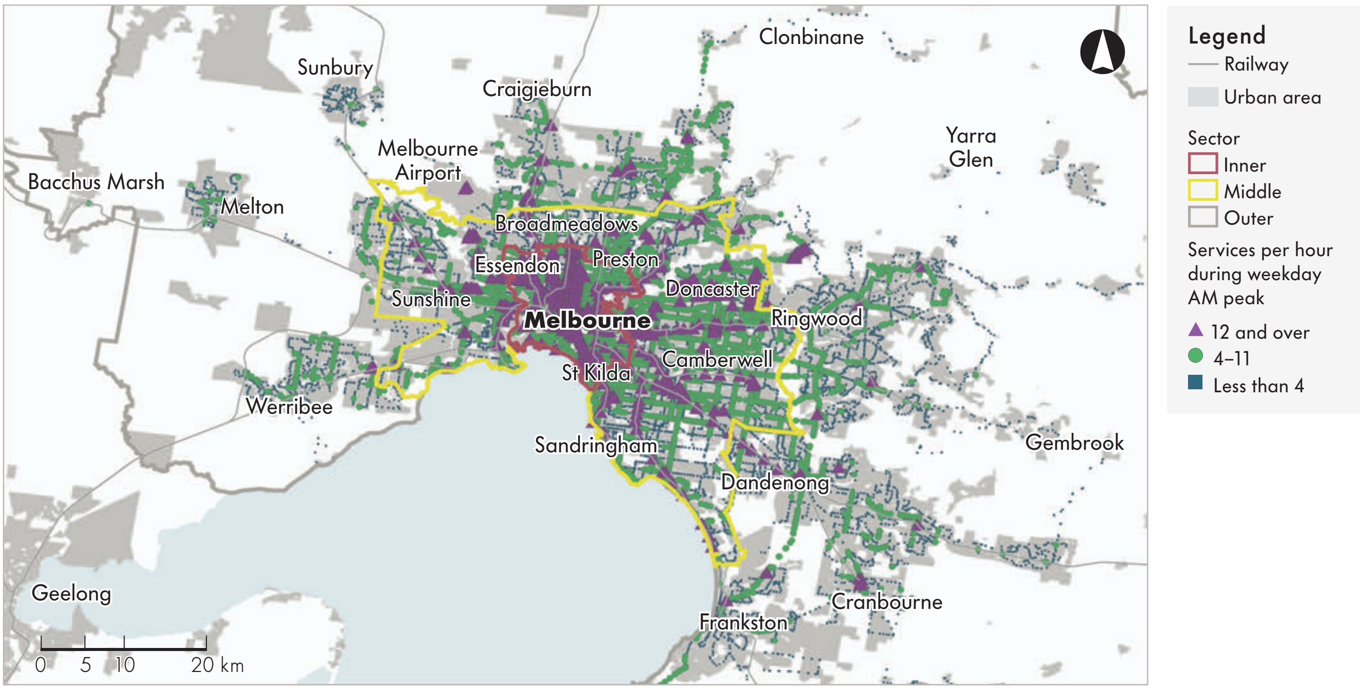
The extent of high-frequency services varies considerably depending on the city and on the route. In Brisbane, outside of the inner city, only the south east is serviced by a large amount of high-frequency routes, while in Melbourne there is a greater spread of high-frequency services in all directions. However, in both cities, there are few high-frequency services that extend into the outer sector. Furthermore, when comparing by time period, the difference in service frequencies between weekday AM peak and off-peak periods is substantial. High-frequency services are confined almost entirely to the inner city on weekends in both cities.

Higher frequencies at inner urban stops/stations are typical of traditional radial networks, with many services that begin in the suburbs joining major corridors as they get closer to the city centre. However, increasingly in global cities, planners acknowledge the need for a hierarchy of routes and for frequent trunk line services, that operate over extended hours, including weekends. Trunk services are the high-frequency, high-capacity 'backbone' routes that connect centres with high levels of demand. Cross-regional trunk lines are important to support interchanging at alternative locations to CBDs and therefore to reducing journey times.

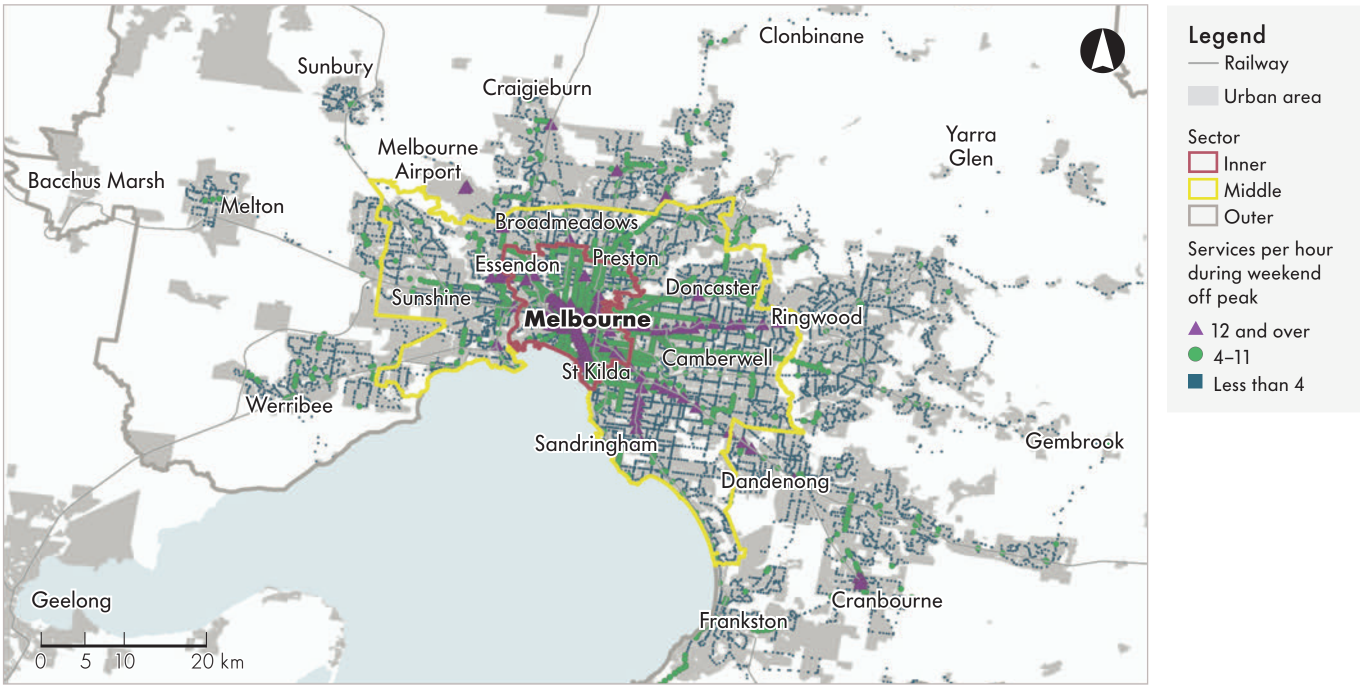
The importance of trunk services in transport planning hierarchies is discussed in greater detail in **Chapter 3.**

Figure 11: Public transport service frequency during weekday AM peak and weekend off peak, Melbourne and Brisbane, 2017

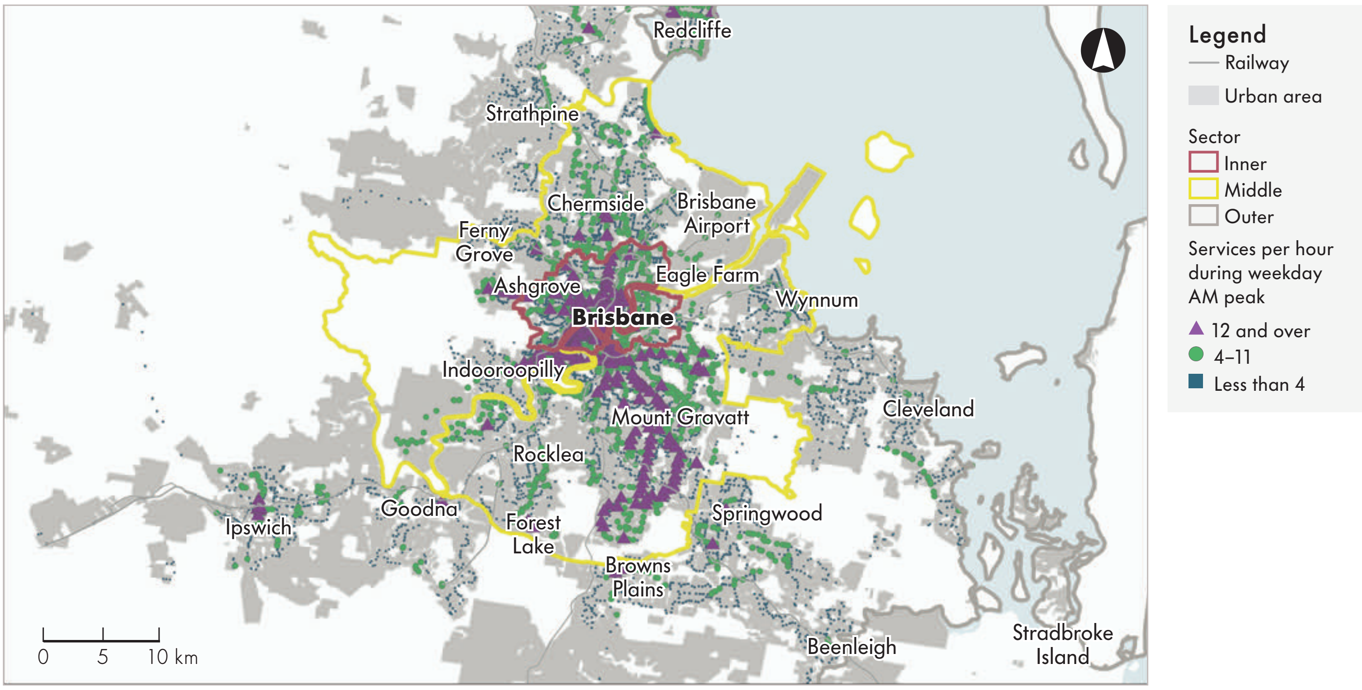
Melbourne weekday 8–9am



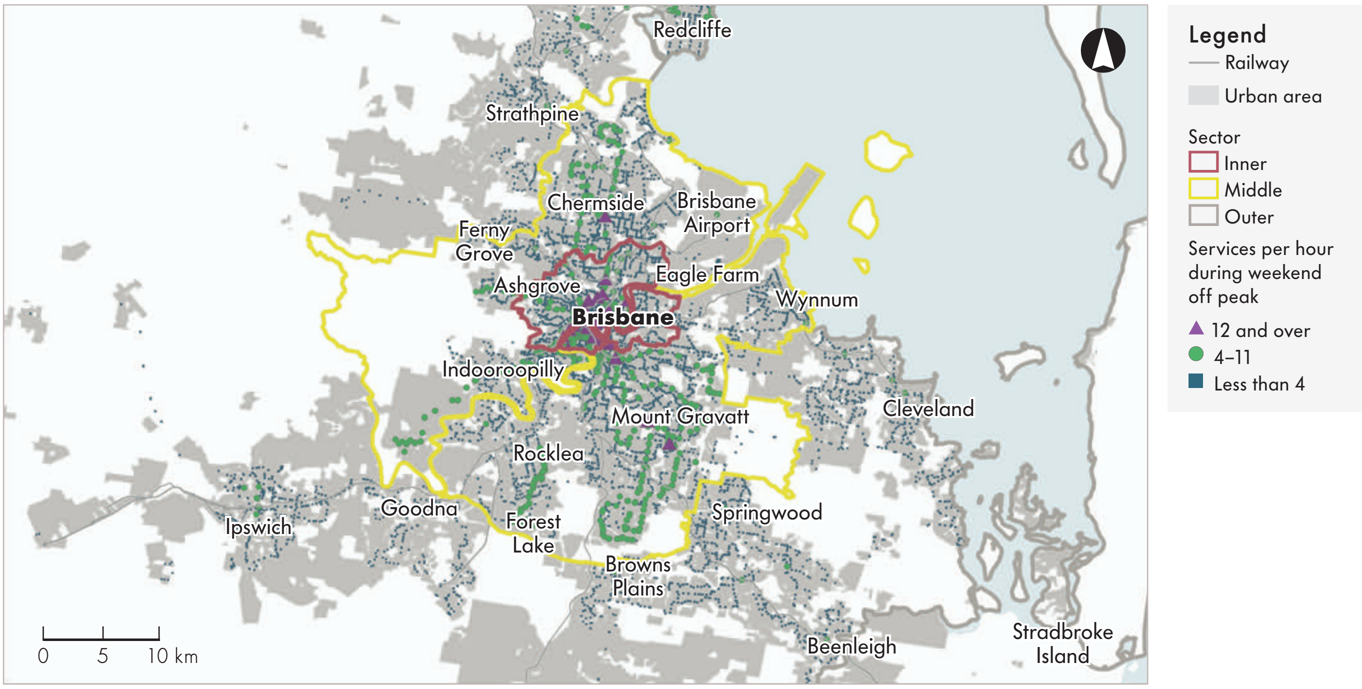
Melbourne weekend 11am–12pm



Brisbane weekday 8–9am



Brisbane weekend 11am–12pm



Source: Based on GTA Consultants (2017)[39]

People in the outer suburbs travel longer distances to work

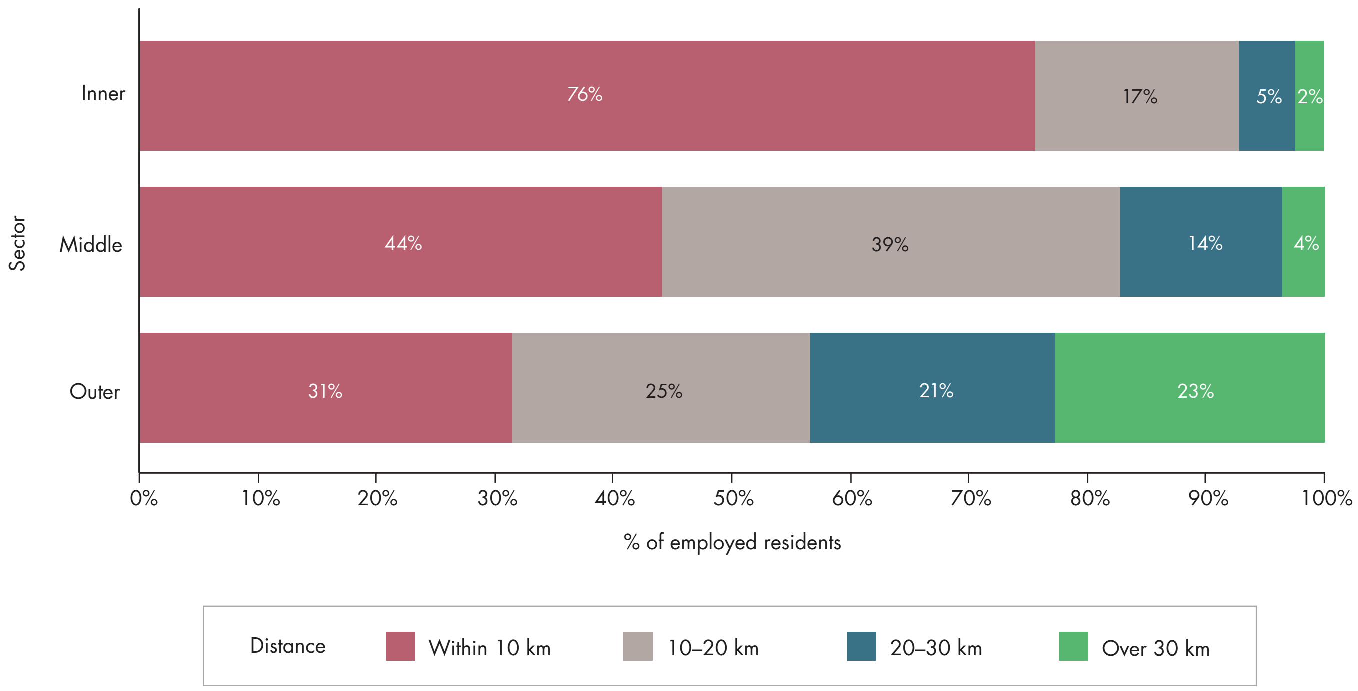
Journeys to work comprise a major portion of trips made in our cities. So considering the relationship between where people live and where people work helps us establish how well our public transport services cater to where people are travelling and assess the performance of our public transport systems.

Figure 12 summarises the distances people travel to work in the inner, middle and outer sectors for all five cities combined. People who live in the outer suburbs travel considerably further to work than middle sector residents and inner sector residents (17 km median distance compared to 11 km and 6 km, respectively). Over three-quarters of inner-sector residents travel 10 km or less to work, while the majority of people in the middle and outer sectors travel more than 10 km to work (56% and 69% respectively). Almost half (44%) of outer sector residents travel over 20 km to work, compared to 18% in the middle sector and 7% in the inner city.

These differences in travel time reflect the location and distribution of jobs across the three sectors. **Figure 13** shows the proportion of the workforce residing in each sector by their place of employment. This is an indicator of economic activity, opportunity and self-sufficiency in each part of the city because it shows the proportion of people who are able to live and work in the same city sector. In all sectors, the majority of people work within their sector of residence (50% to 78%), showing that most people choose to work close to home.

There are more employment opportunities (per capita) in the inner suburbs than other parts of the city. Far fewer inner-sector residents commute out of their sector for work than middle- or outer-sector residents (22% compared to 50% and 42%, respectively). Outer- and middle-sector residents are far more likely to travel outside of their area for work, resulting in significantly longer travel distances. Even when outer sector residents choose to work within their own area, they are likely to travel longer distances because of the dispersed nature of employment in the outer suburbs. Outer-sector residents are more likely to travel to local employment centres, but still face longer travel times than those in other sectors travelling to work within their sector. These long distances and dispersed trip patterns pose a significant challenge for public transport planners because they make public transport trip times uncompetitive with cars. It is important to note that the prevalence of particular job types within each sector also affects transport mode choice. Driving may be a suitable form of transport for some job types, such as sales representatives, truck drivers and people carrying tools of trade.

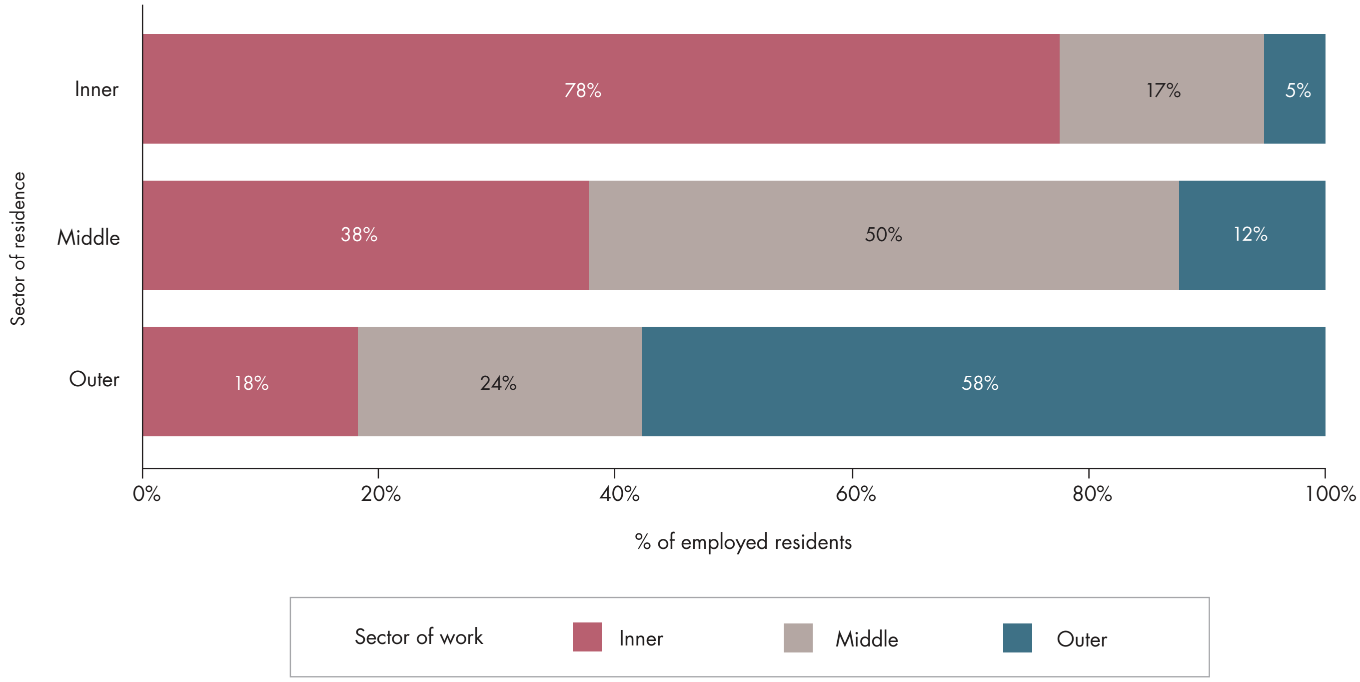
Figure 12: Distance travelled to work by sector, as proportion of employed residents in sector, all five cities combined, 2016



Note: Percentages represent the proportion of the working population residing in the sector on the left, who travel to work within the distance represented by colour. Percentages may not total to 100% due to rounding.

Source: Australian Bureau of Statistics (2016)[40]

Figure 13: Sector of work vs sector of residence, as proportion of employed residents in sector, all five cities combined, 2016



Note: Percentages represent the proportion of the working population residing in the sector on the left, who work within the sector of work represented by colour.

Source: Australian Bureau of Statistics (2016)[41]

Travel times to major employment centres are longest in outer suburbs

Another key indicator of public transport performance is travel time. Although numerous factors are considered when deciding on a travel mode, people prioritise time saving. Generally, people prefer to get from one point to another in the shortest time possible.

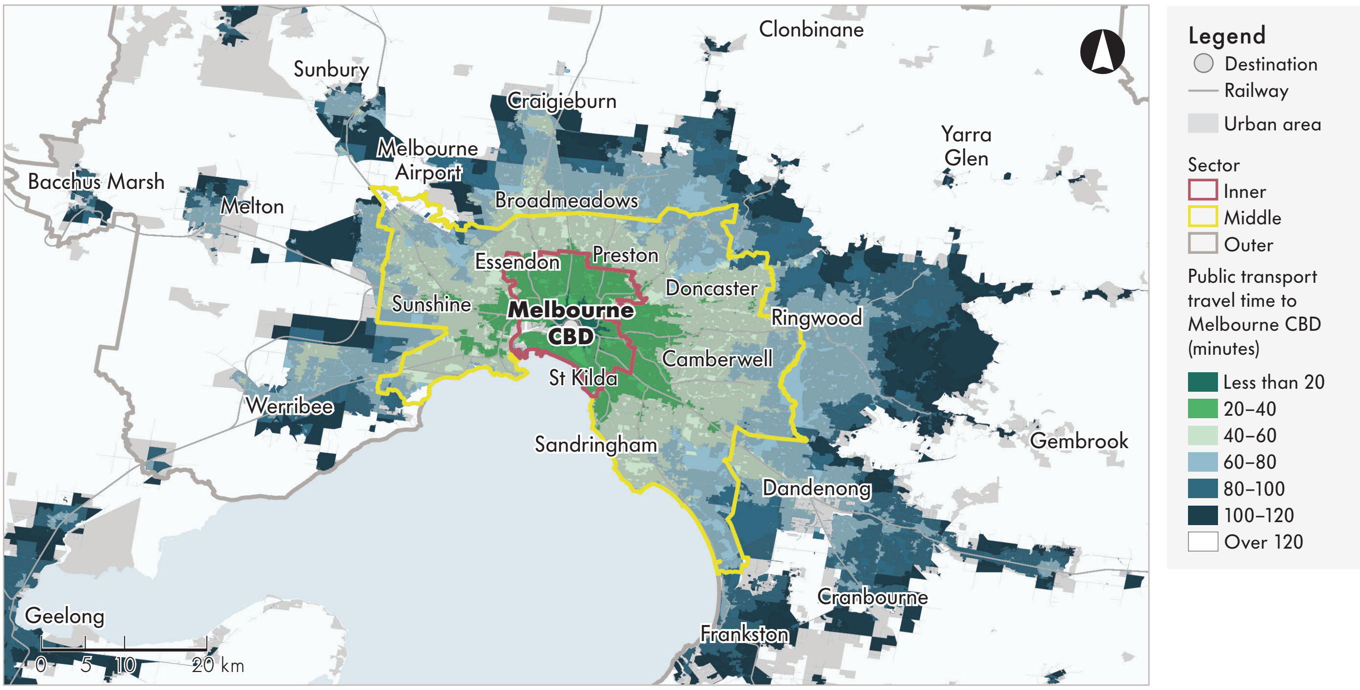
Time is of particularly high importance when travelling to work, as it is a regular and necessary trip, and can take up a substantial proportion of a worker's time throughout the week. People generally value their time more highly when it is for work purposes than when it is for leisure, when they are less time-constrained.[42]

To assess travel time performance across the five cities, Infrastructure Australia commissioned GTA Consultants to produce contour maps of public transport journey times during the weekday AM peak, using timetables that were in effect between April and June 2017. Infrastructure Australia acknowledges that jurisdictions have since changed and upgraded timetables.

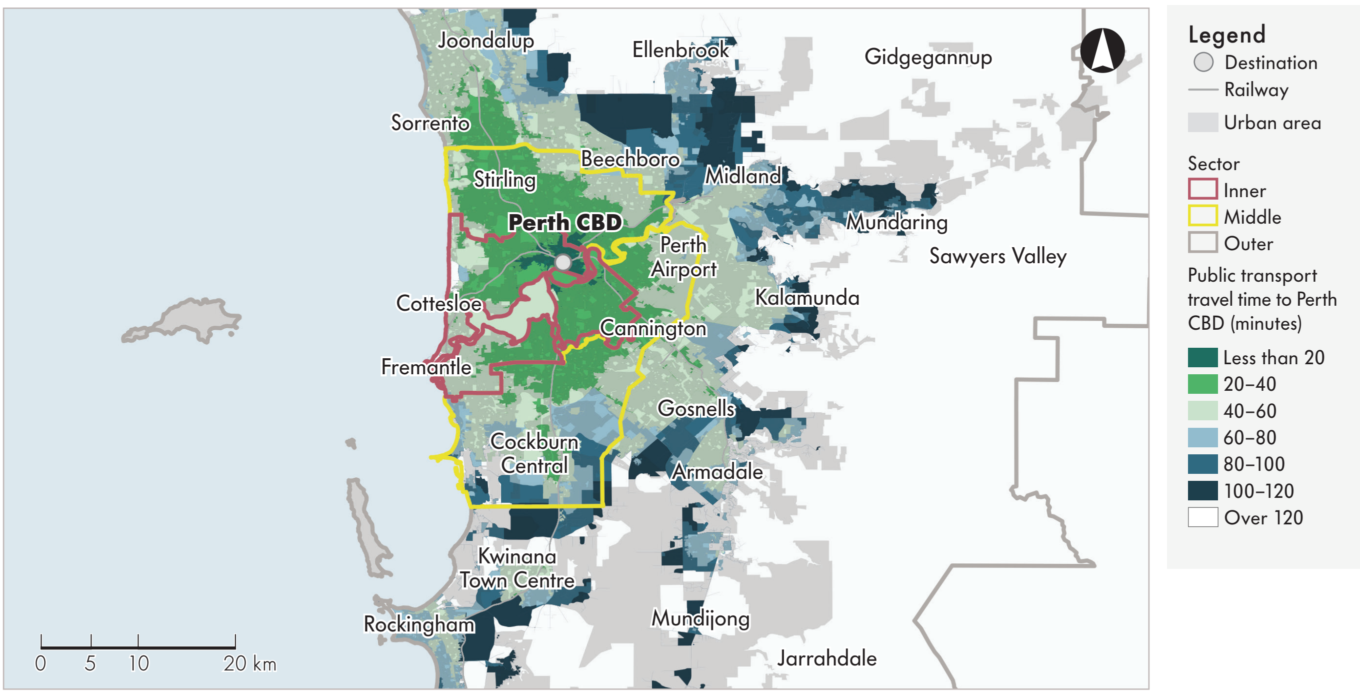
Residents living in our cities' outer suburbs face substantially longer public transport travel times to the CBD. However, there are differences between the cities. Overall, larger cities have greater spatial disadvantage compared to smaller cities. For example, as shown in **Figure 14**, residents living in major centres 30 km beyond Melbourne CBD, such as Frankston or Werribee, face travel times of over 80 minutes to the CBD, while the vast majority of Perth's population enjoy journey times of 60 minutes or less to Perth CBD.

Figure 14: Public transport travel times to Melbourne CBD and Perth CBD during weekday AM peak, 2017

Melbourne CBD



Perth CBD



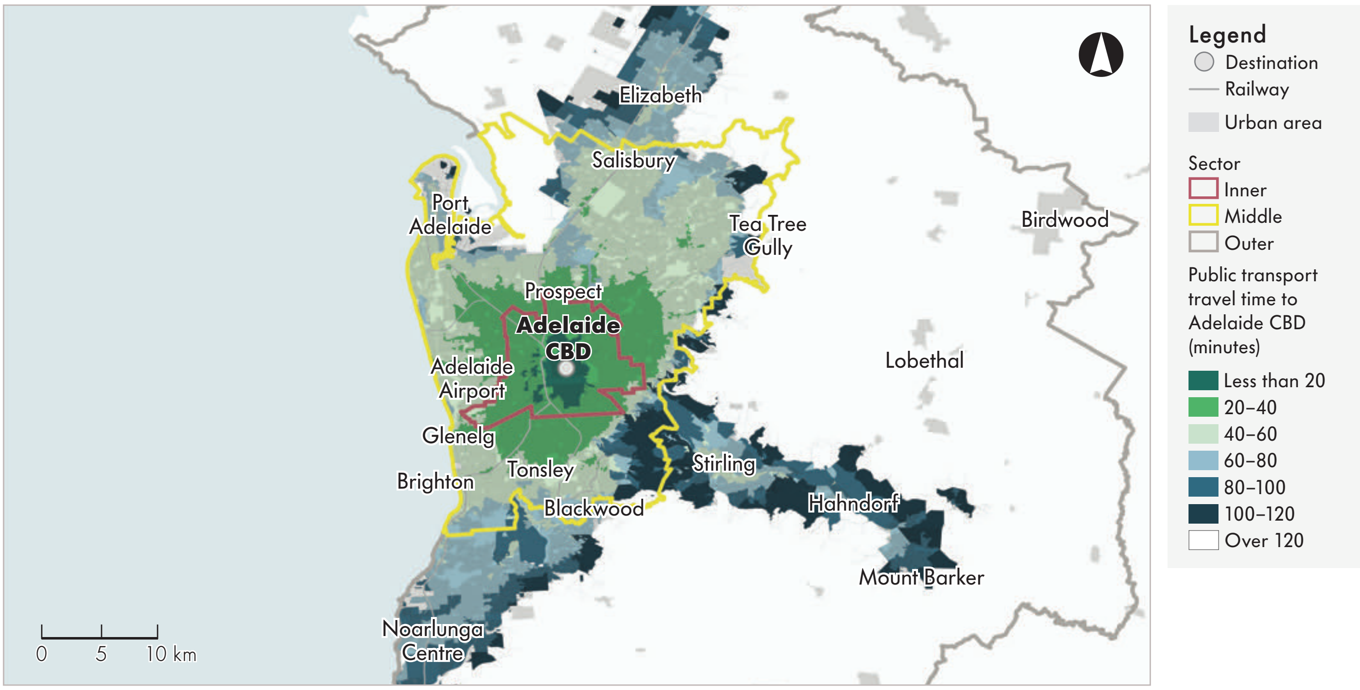
Source: Based on GTA Consultants (2017)[43]

It is also useful to analyse travel time to employment centres in the middle and outer sectors of the city. Generally, travel time to non-CBD employment centres tends to be longer. Historical transport planning in Australian cities was primarily designed to serve passengers travelling to and from the CBDs. This has resulted in inner-sector residents having short public transport journeys to multiple employment centres, while middle- and outer-sector residents have fewer choices of employment centres that are accessible via public transport within a short amount of time.

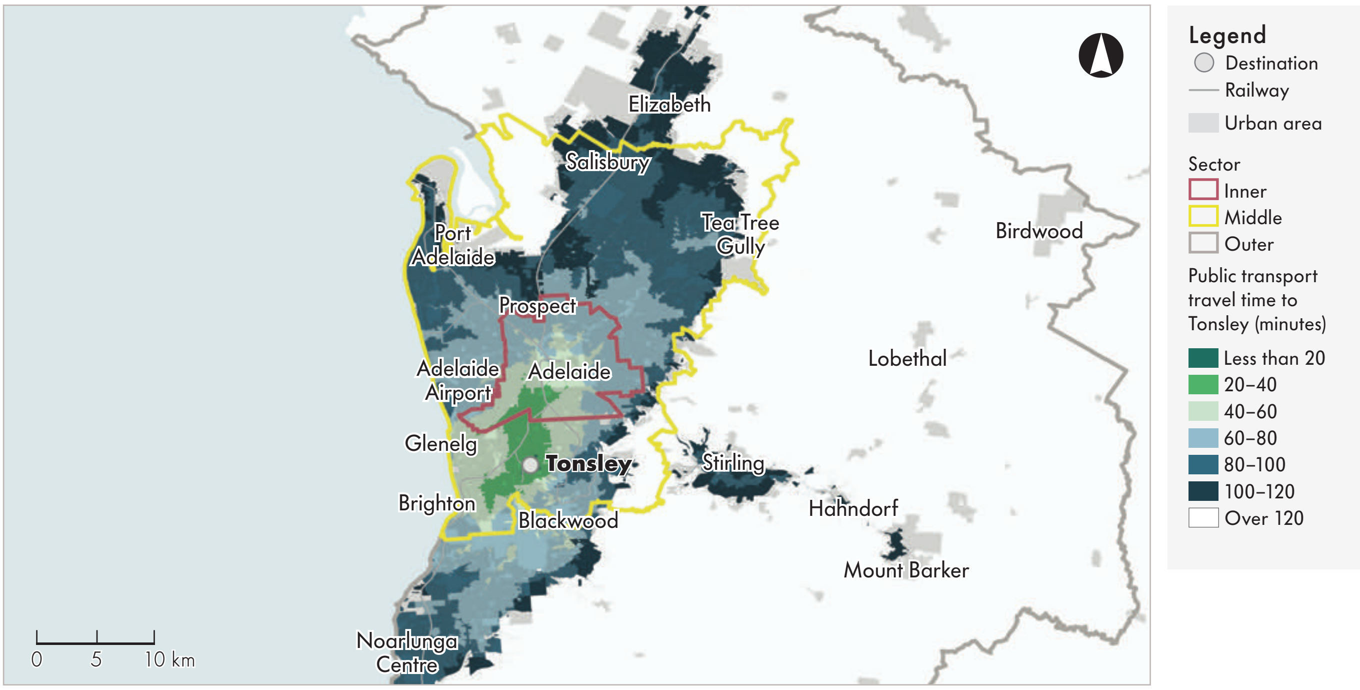
Figure 15 demonstrates the result of this historical development for Adelaide. Workers residing in the inner sector have public transport access under 40 minutes to Mawson Lakes in the north, Tonsley in the south, and the CBD in the centre. However, outer-sector workers residing in the south (in Noarlunga Centre, for instance) and outer-sector workers residing in the north (in Elizabeth, for instance) face journey times of over 60 minutes to Mawson Lakes and Tonsley, respectively.

Figure 15: Public transport travel times to Adelaide CBD, Mawson Lakes and Tonsley during weekday AM peak, 2017

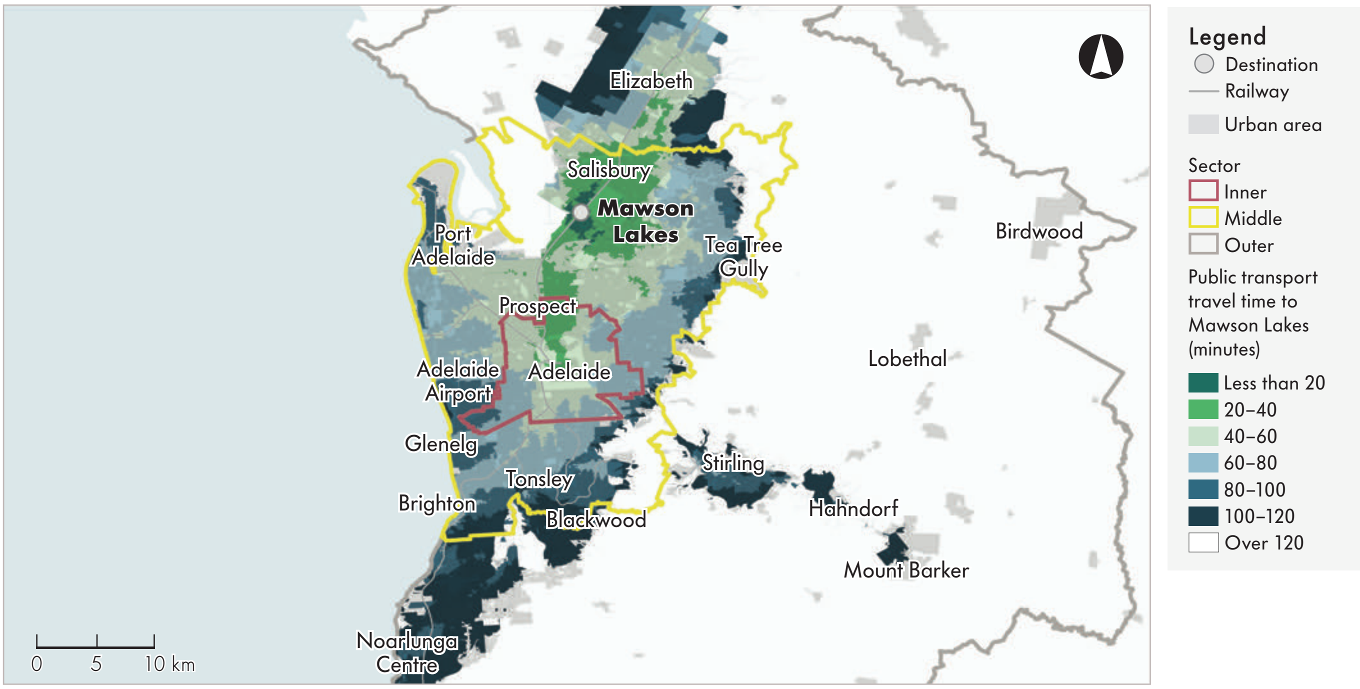
Adelaide CBD



Tonsley



Mawson Lakes



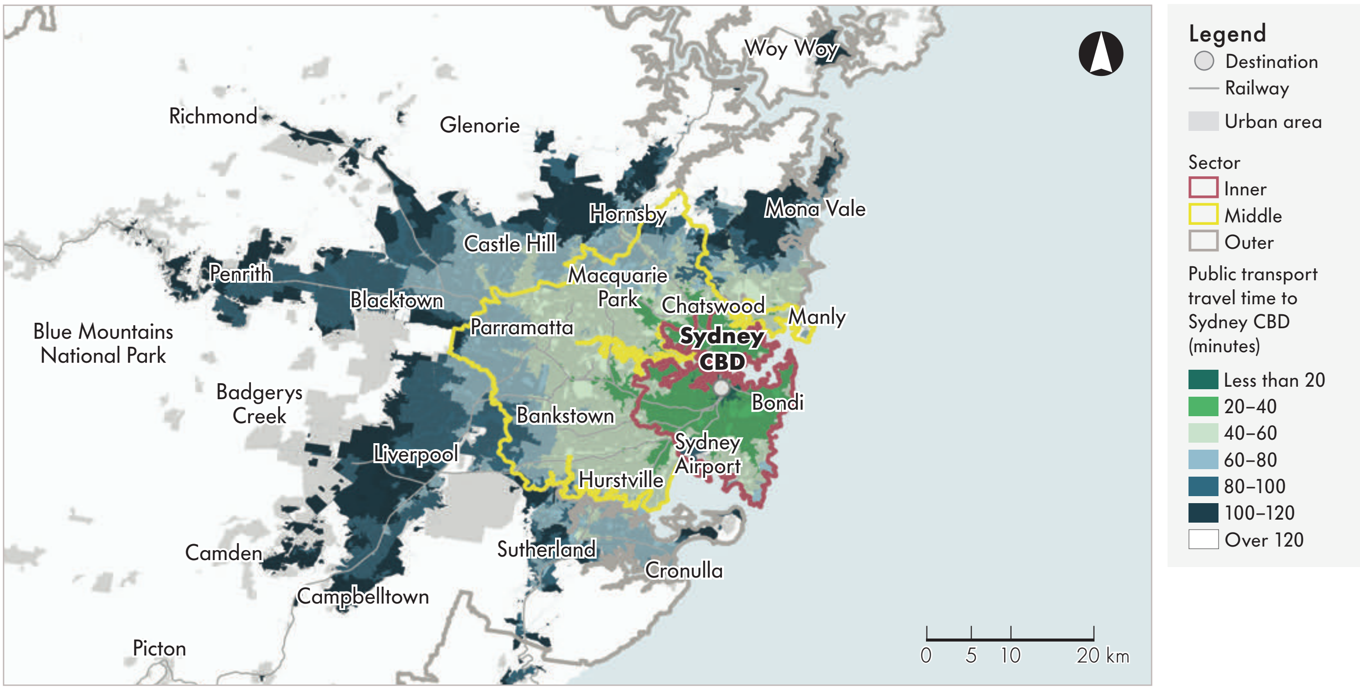
Source: Based on GTA Consultants (2017)[44]

The impact of Sydney's unique geographic character on public transport travel time is also worth exploring. Sydney CBD is located in the city's east, unlike the other four cities, which have geographically central CBDs. This exacerbates Sydney's spatial disadvantage, especially in its outer western suburbs. However, Sydney is also the most polycentric of Australia's major cities, with middle-sector employment centres such as Parramatta, Macquarie Park and Chatswood rivalling smaller cities in terms of economic output and employment. This provides workers in Sydney's outer regions with a greater range of accessible jobs away from the CBD, compared to the other four cities.

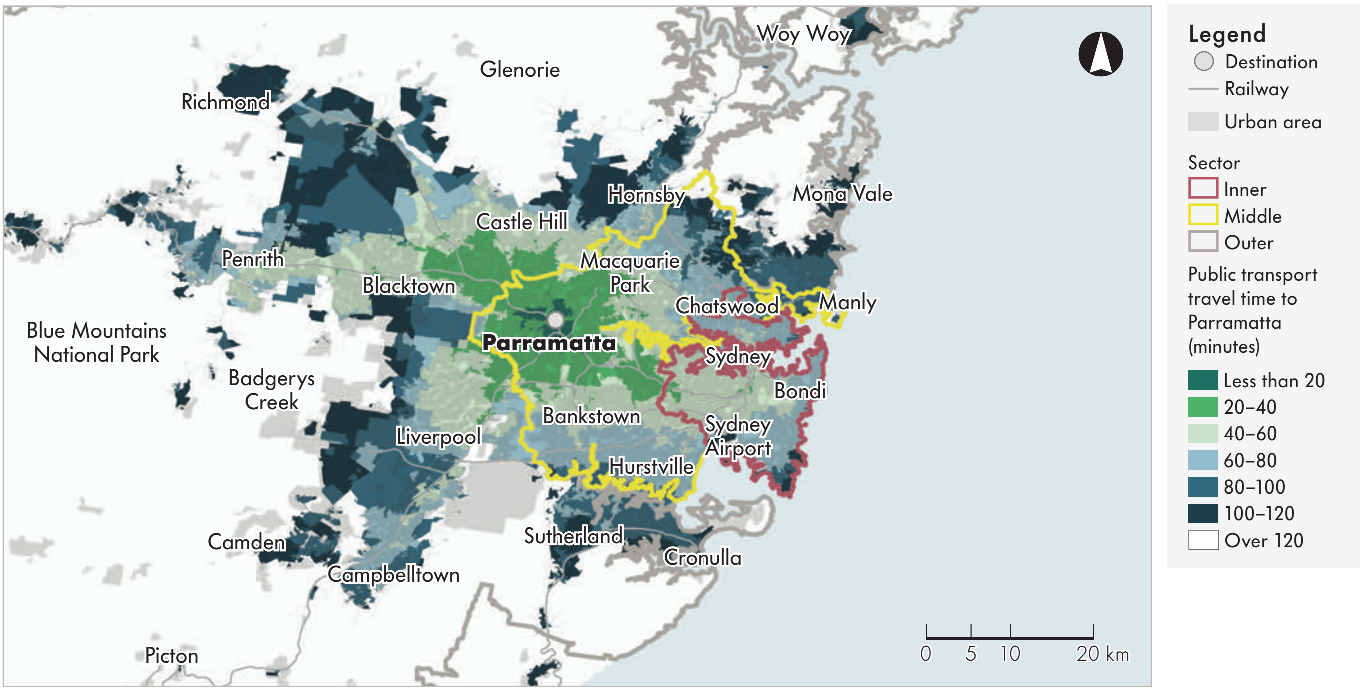
Figure 16 shows a comparison of public transport travel times to the eastern-located Sydney CBD and to the centrally located Parramatta. Parramatta is situated closer to Sydney's true geographic centre, and this is reflected through its more balanced distribution of travel times, particularly for workers residing further west, such as in Liverpool or Penrith.

Figure 16: Public transport travel times to Sydney CBD and Parramatta during weekday AM peak, 2017

Sydney CBD



Parramatta



Source: Based on GTA Consultants (2017)[45]

Public transport usage is lower for people living and working in the outer suburbs

Walking access, service levels, and travel times all affect people's choices about whether or not to use public transport. Infrastructure Australia analysed commuting patterns using ABS 2016 Census data to examine where and how public transport is being used.

Figure 17 shows clear differences in public transport use between sectors, both by where people live and where people work.

By where people live, the outer sector has the lowest proportion of people using public transport to get to work (12% combined across the five cities, from 7% in Adelaide to 18% in Sydney). This increases markedly for residents living closer to the CBD (22% for middle and 31% for inner sector residents across the five cities).

Looking at where people work, the difference between the proportion of people using public transport for their commute is even starker between the inner and outer sectors. Across the five cities, 41% of workers who travel to the inner sector use some public transport. Far fewer workers do in the middle and outer sectors (9% and 4%, respectively).

Clear differences can be observed between cities. Sydney and Melbourne have substantially greater city-wide public transport mode share than Brisbane, Perth and Adelaide (27% and 19%, compared to 14%, 12% and 11%, respectively). For people who work in the inner sector, this contrast is even stronger – 51% in Sydney and 44% in Melbourne use public transport to get to work, compared to 25% in Perth and 22% in Adelaide. Sydney also has considerably higher public transport mode share for middle sector workers compared to the next highest (17% compared to 8% in Melbourne).

The higher levels of public transport use are in part a reflection of the service levels of public transport in Sydney and Melbourne compared to the other cities. Sydney has the most significant urban rail network in Australia, as well as a well-established bus network. The scale of ferry services in Sydney is also unique in the Australian context. Melbourne is well known for its tram network, one of the largest in the world, carrying more than 200 million passengers each year. Also, both cities have comparatively higher levels of road congestion and lower availability of parking spots, which make public transport a more attractive option.

Figure 17: Public transport mode share for journeys to work, by place of residence and by place of work, all five cities, 2016

Note: Percentages show employed persons who travelled using train, bus, tram and/or ferry, in addition to any other modes, divided by all employed persons who travelled (excluding 'did not to go work' and 'worked at home').

Source: Australian Bureau of Statistics (2016)[46]

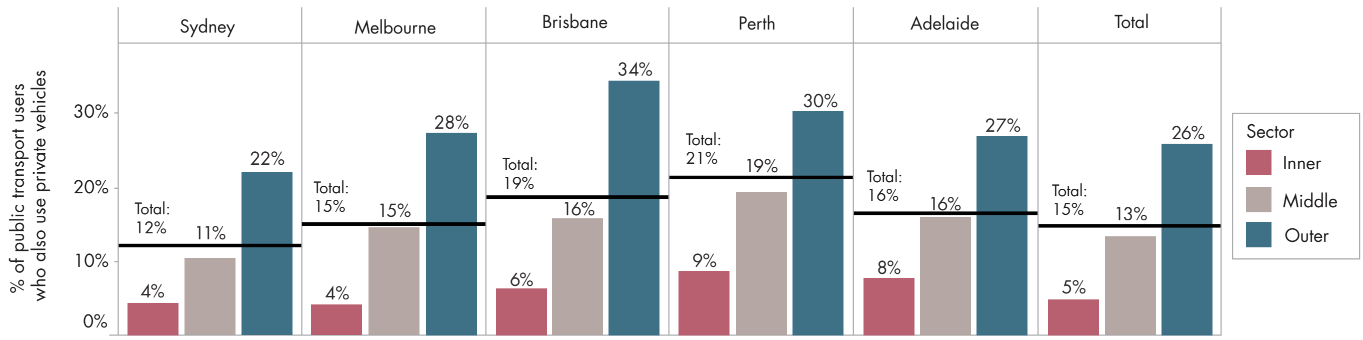
Outer suburbs residents are more likely to drive to public transport stops

People who live in the outer suburbs are much more likely to use their cars to access the public transport network than inner-city residents. **Figure 18** shows the proportion of public transport commuters who also travelled to work by private vehicle. Although the ABS Census data does not specify, it is reasonable to assume that most people who both drive and use public transport for their journey to work are driving to a stop or station. Across all cities, 15% of public transport users travel by private vehicle to reach their bus stop, tram stop or train station. In the outer suburbs, this proportion is substantially higher, at about 26%.

This is a direct result of the disparities shown in **Figure 9**. As walking access to public transport is lower in the outer sector, many residents in these areas have no option but to rely on private vehicles to reach the network. This is driven by low population densities, which results in a spreading of population further away from the public transport network.

Brisbane, as the city with the lowest overall access to public transport within walking distance, has a high use of private vehicles by public transport users (19%). However, Perth has the greatest use of private vehicles to access public transport (21%). This may be due to uniformly low residential densities throughout Perth, and the Western Australian Government's provision of 'Park and Ride' facilities at railway stations, notably along the Mandurah and Joondalup railway lines.

Figure 18: Proportion of public transport travellers who also use private vehicle, all five cities, 2016



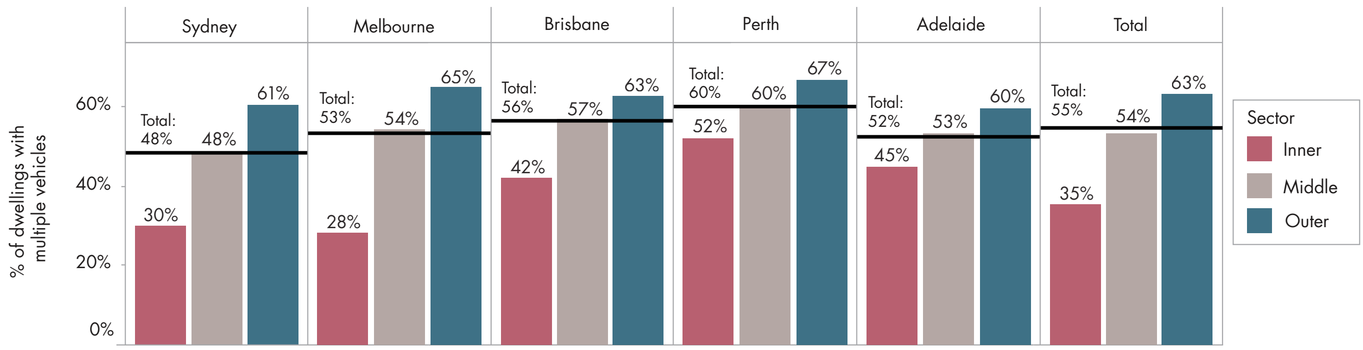
Note: *Percentages show employed persons who travelled using both public transport and private vehicle, divided by all employed persons who travelled using public transport. Public transport modes are train, bus, tram and ferry. Private vehicle modes are car, truck and motorbike.*

Source: Australian Bureau of Statistics (2016)[47]

Car ownership is higher in the outer suburbs

Across all cities, car ownership levels are higher in the outer suburbs. **Figure 19** shows the proportion of dwellings with two or more private vehicles by sector, for all five cities. The differences between sectors are clear – 63% of dwellings in the outer suburbs have multiple vehicles, compared to 35% of dwellings in the inner city, for all five cities combined. These mirror the lower levels of public transport use in the outer sector, as shown in **Figure 17**.

Figure 19: Proportion of dwellings with two or more private vehicles, all five cities, 2016

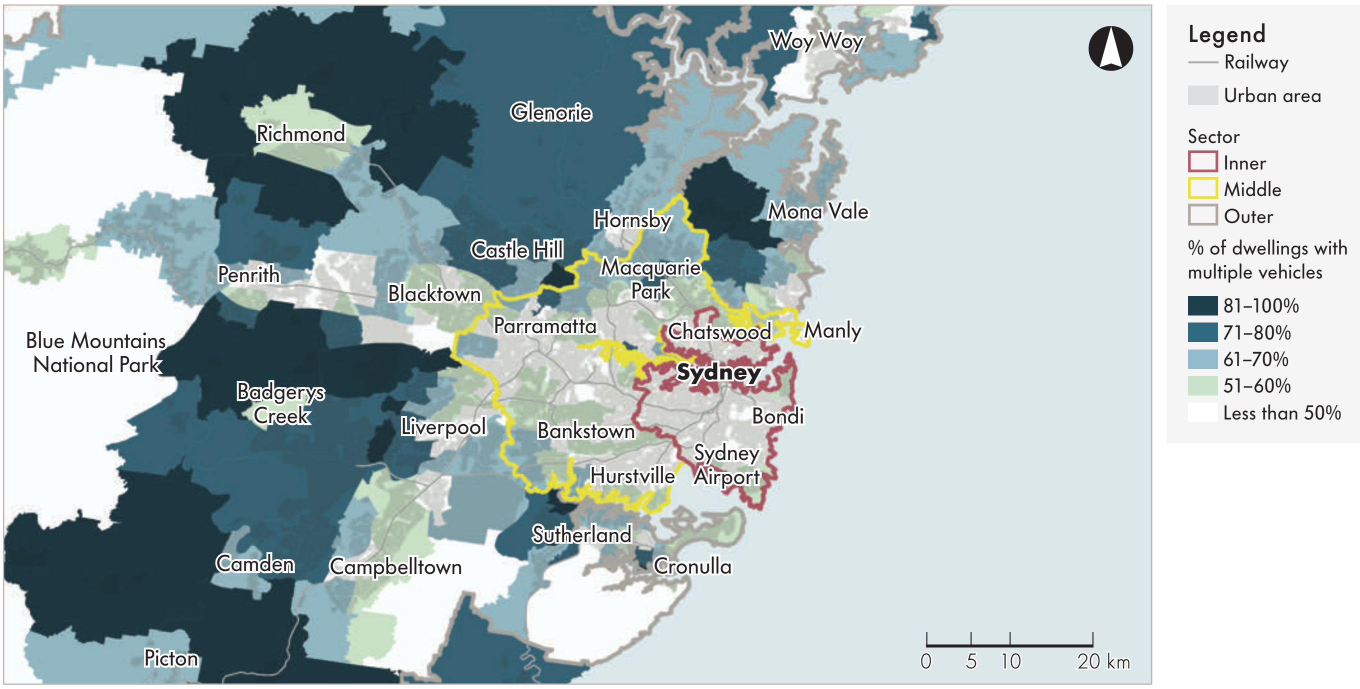


Source: Australian Bureau of Statistics (2016)[48]

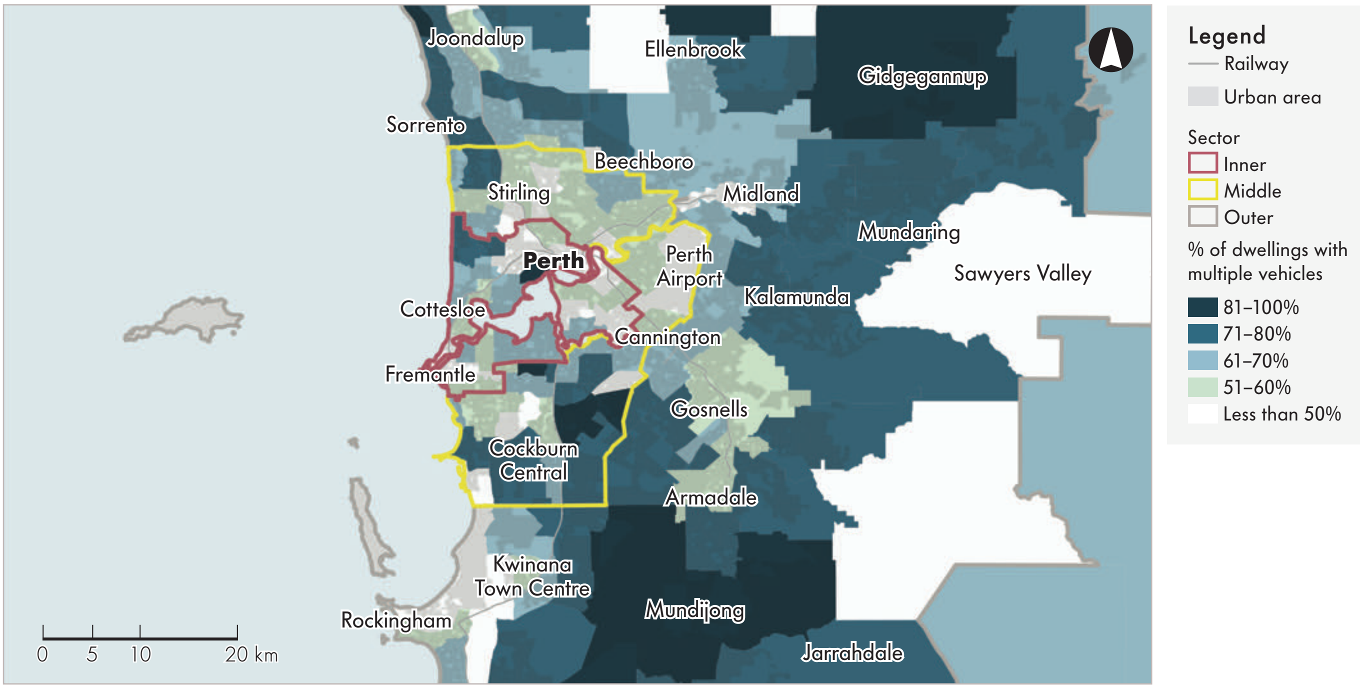
Differences in car ownership levels can also be observed between cities. Perth has substantially higher rates of car ownership compared to Sydney (60% compared to 48%). **Figure 20** shows that in Sydney, low levels of ownership run along the train lines, out to outer centres such as Campbelltown and Penrith. Perth, by way of contrast, is a more car reliant city, with substantial proportions of people owning more than one vehicle across the city, including along rail lines. This is partially due to Perth's relatively low residential and employment densities.

Figure 20: Proportion of dwellings with two or more private vehicles by SA2, Sydney and Perth, 2016

Sydney



Perth



Source: Australian Bureau of Statistics (2016)[49]

Outer urban residents pay more to operate their vehicles

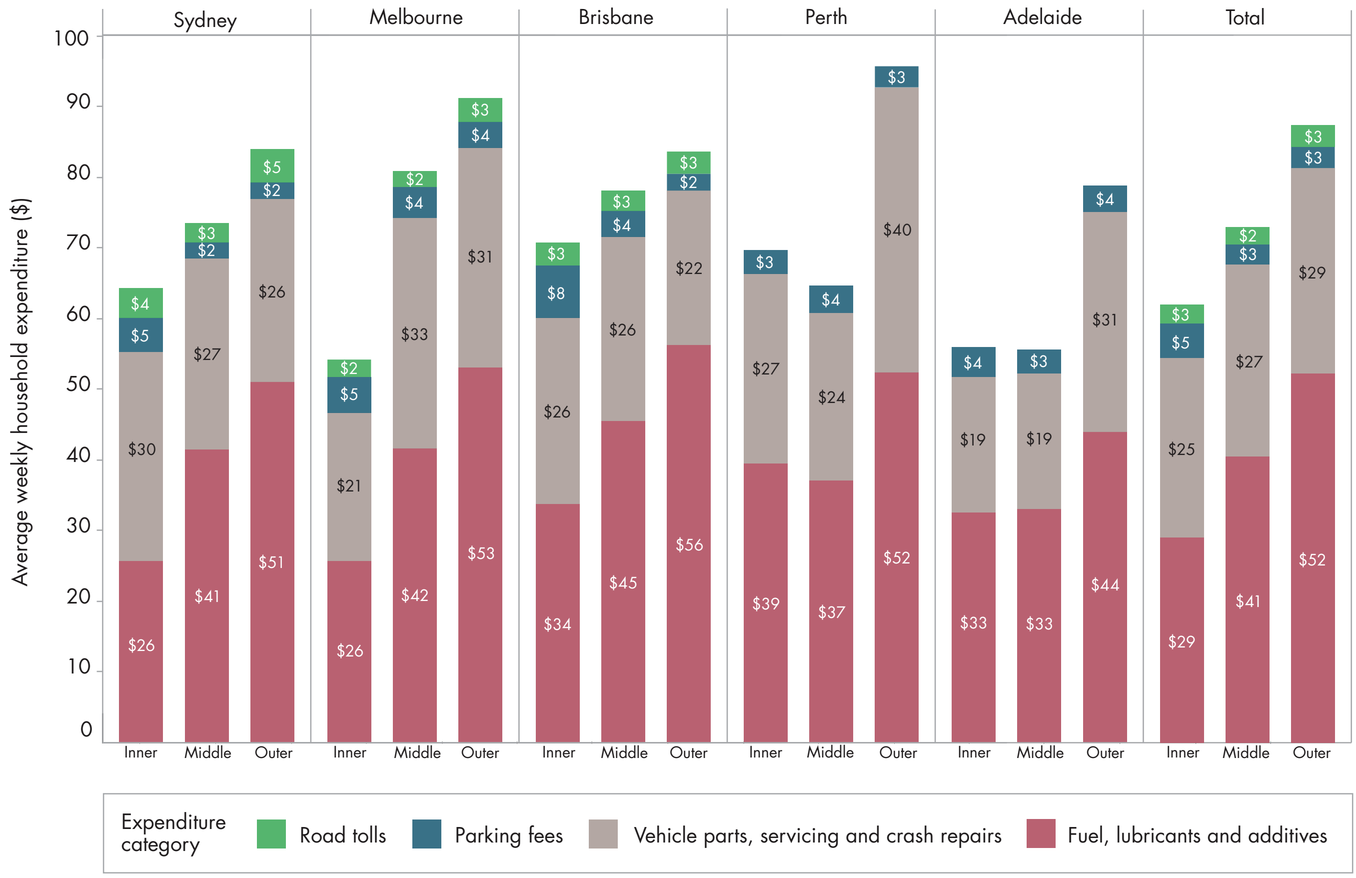
The impact of higher car ownership levels in the outer suburbs can be seen in higher car operating costs, as shown in **Figure 21**.

Operating costs are defined as the variable costs that are primarily caused by vehicle use. The most significant category of costs is fuel, lubricants, and additives, which indicates that people in the outer sectors pay more because they use their cars more and travel longer distances. This could also partially reflect different patterns of car ownership, with less efficient vehicles likely to cost more to run. Expenditure on road tolls is marginally higher in outer urban areas too, although the difference with the inner and middle suburbs is only small.

The pattern is repeated, and in some cases is stronger, when expenditure is normalised against household budgets. **Figure 22** shows that vehicle-operating costs make up a greater proportion of household budgets in the outer sectors of each city than the inner and middle ring suburbs.

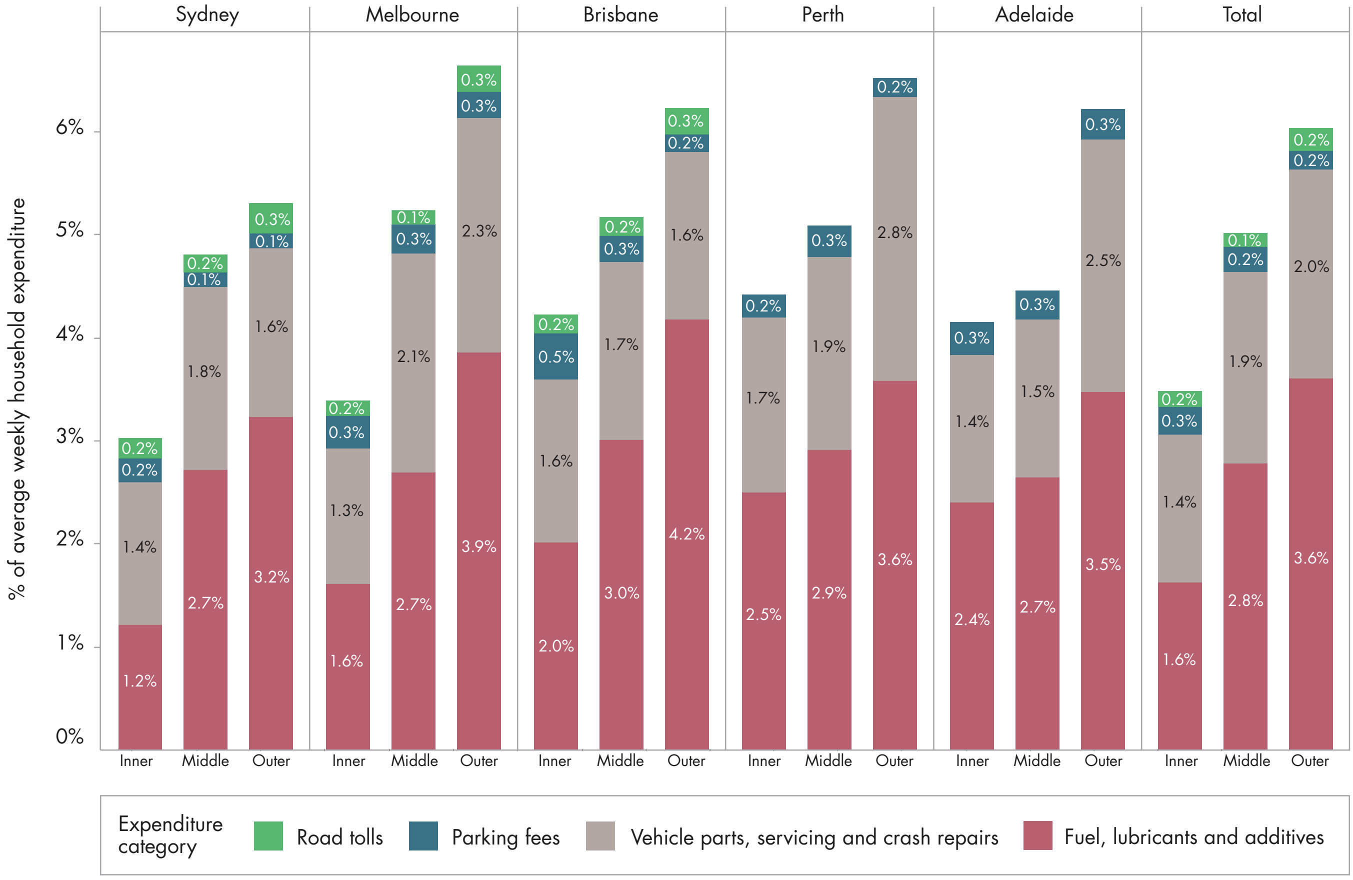
It is likely that outer urban residents pay for their reliance on cars and longer travel distances. The spatial features of outer urban areas, such as low densities and dispersed jobs, combined with uncompetitive public transport, result in significantly higher expenditure on variable car costs.

Figure 21: Average weekly household expenditure on operating vehicles by expenditure category and by sector, all five cities, 2015–16



Source: Australian Bureau of Statistics (2017)[50]

Figure 22: Average weekly household expenditure spent on operating vehicles as a proportion of total household expenditure, by expenditure category and by sector, all five cities, 2015–16



Source: Australian Bureau of Statistics (2017)[51]

A reform agenda for improving outer urban public transport

At a glance

- **Governments should ensure their existing networks are operating efficiently before investing in new infrastructure to expand capacity.** While capital investment is sometimes necessary, governments have a range of options to improve the efficiency and reach of their existing networks without significant expenditure.
- **Public transport routes should operate as parts of coordinated, integrated networks.** Coordinating public transport routes and modes can help improve service frequencies and the reach of the network.
- **New modes, such as on-demand services, have the potential to improve access to and the reach of the networks.** These modes need to be integrated into the existing network and ticketing system and be widely promoted over a sustained period.
- **Encouraging people to transfer between services is crucial to the reach of the network.** Each interchange represents an opportunity for a passenger to change their direction of travel and opens a greater diversity of potential destinations. Governments should make interchanging easy by coordinating services at interchanges, increasing frequencies, making sure fares are integrated, and prioritising the user experience when designing transport interchanges.
- **Public transport networks should be accessible by cars, active transport, car share and ride share.** A key challenge in outer urban areas is access to public transport. Governments should make access as easy as possible by providing parking and drop-off facilities for drivers and car passengers, integrating bicycle networks and providing secure storage for bikes, improving footpaths, and being open to innovation and technological change such as on-demand transport.
- **Efficient land use planning can make public transport more viable in outer suburbs.** A key challenge in planning public transport in outer suburbs is that demand is often low and dispersed. Governments can helpto concentrate demand and encourage public transport use by strategically increasing densities at key transport hubs and encouraging suburban employment centres.

3

Governments have a range of transport and land use options to improve public transport in outer suburbs

Public transport disadvantage in the outer suburbs is widely recognised, but the solution is not clear cut. The most obvious answer is to build more public transport infrastructure and add additional services. Provided it is justified by a robust business case, public transport investment can be an effective way to deal with a growing population. Infrastructure Australia's *Infrastructure Priority List* outlines nationally significant public transport projects and potential capital investments.

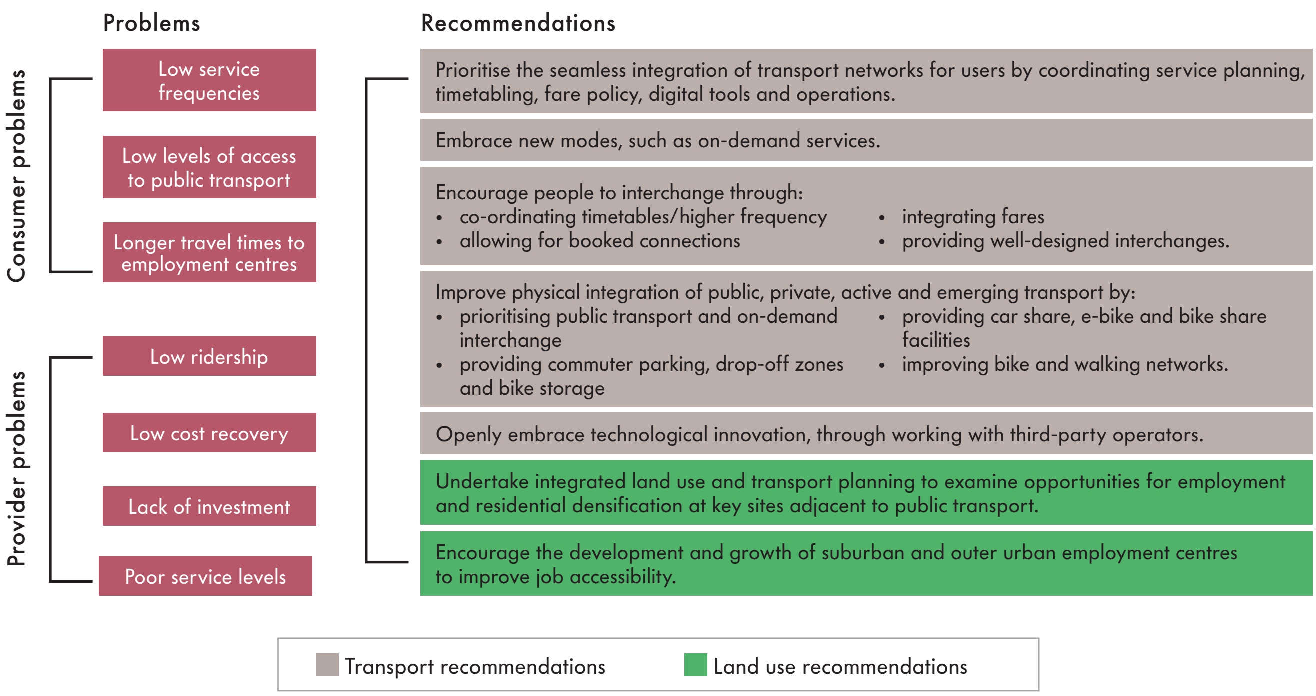
However, public transport is expensive to build and requires ongoing operating subsidies, as discussed in **Chapter 1**.

It is therefore important that governments investigate alternatives, such as making more efficient use of existing infrastructure, before significant additions or investments in the network are made.

This paper focuses on the policy options for governments who are trying to improve public transport service levels to areas of low density. Specifically, it makes policy recommendations to help deal with the problems that were identified in **Chapter 2**.

Figure 23 introduces these policy options and broadly splits them into transport and land use recommendations. These recommendations aim to highlight the principles and policy settings governments can use to help improve outer urban public transport.

Figure 23: Recommendations for improving outer urban public transport



Integration between public transport modes will help accessibility and frequency in outer suburbs

One of the key problems identified in **Chapter 2** is that people in outer urban sectors have significantly lower levels of walking access to medium- and high-frequency public transport. This is because the outer suburbs in each city are less dense, meaning population and jobs are spread over larger geographic areas. The issue is exacerbated by Australia's urban networks being largely radial – where major transport routes are designed to move people from the suburbs to the city centre. Routes converge closer to the city centre and there is a greater density of services and routes in the inner city than outer suburbs. Even with significant infrastructure investment in new public transport routes, walking access to public transport would remain lower in the outer suburbs.

Transport networks should be planned according to context. In higher-density, inner-city suburbs, it is reasonable to assume that most people will access public transport by walking or cycling. Shorter distances to transport stations and stops, limited parking and congested roads often make walking or cycling the most practical option.

In low-density suburbs, distances will often be too large for people to access major public transport corridors by walking. When trying to improve public transport in outer suburbs, governments need to focus on enhancements to the 'first and last mile' between people's origin/destination and trunk transport services.

Developing a hierarchy of public transport services

An integrated transport network is made up of an organised hierarchy of services that maximises the catchment of the network by linking key centres with high-capacity trunk routes and ensuring the stations/stops along these routes are serviced by 'feeder' transport. Transport services within this hierarchy will vary depending on capacity, service frequency, purpose, and service delivery cost.

Feeder services are particularly important in the outer urban context because distances are often too large to access trunk routes by walking and cycling. This means people need additional transport options from their origin or destination to major transport interchanges so they can access the network without using a car.

Most public transport agencies have defined service hierarchies they use in their planning, and many of these are publicly available. The specific hierarchies differ between jurisdictions and contexts, but they can generally be split into four broad categories. The below is a simplified version of this hierarchy, and in reality there are significant cross overs between each level.

- **Intercity/trunk services.** These are the backbone of the transport network. They normally connect origins and destinations that have high levels of demand, such as employment centres. They are designed to be the highest capacity service, so are generally characterised by high service frequency, high-capacity vehicles, longer station/stop spacing, and their own dedicated right of way. Depending on the network, they often include express services, which only stop at major stations/interchanges.
- **Intermediate/suburban services.** These services connect suburban employment centres, important social infrastructure (such as education and health facilities), and transport interchanges. In other words, they connect areas with significant demand for transport that are not on the scale of major centres such as Central Business Districts. They also interchange with trunk routes, allowing passengers to access the higher-capacity services.
- **Local services.** These services should be designed as feeder routes for the transport network. They are generally characterised by smaller-capacity vehicles that travel on suburban streets and interchange with trunk and suburban services. They will also service local town centres and social infrastructure.
- **Emerging modes.** New business models and transport modes have recently become available to service low-density regions, such as on-demand shuttles, ride share and car share. While these have lower capacity than all the traditional modes, they can cater closely to passengers' needs and will become an important aspect of the transport services hierarchy.

Transport planning should be ‘mode agnostic’ in choosing the transport mode best suited to the context. However, different types of transport have distinct operating capacities that are often better suited to specific tasks within the hierarchy. Each mode of transport, their characteristics, and role they are best suited to are shown in **Table 4**, while **Figure 24** demonstrates the suitability of modes based on the flexibility and passenger volume of the service to be provided.

Table 4: Operating characteristics and hierarchy of different transport modes

Mode	Operating characteristics	Indicative construction cost ($M per km)[ab]	Typical capacity, per direction[c]
Intercity/trunk			
Metro rail	■ Medium station spacing ■ Usually all stops but can also operate express ■ High frequency, no timetable ■ Minimum seats to maximise capacity ■ Own right of way	270	Up to 40,000 people per hour
Heavy (suburban) rail	■ Longer station spacing ■ Mix of express and all-stop services ■ High to low frequency ■ Operate to timetable ■ Maximises seats for longer journeys ■ Own right of way	60	Up to 24,000 people per hour
Intercity/trunk, intermediate/suburban			
Bus Rapid Transit	■ Medium stop spacing ■ Usually express ■ High to medium frequency ■ Usually own right of way but can share some corridor with cars	35	Up to 11,000 people per hour
Light rail	■ Medium stop spacing ■ Usually all stops but can also operate express ■ High to medium frequency ■ Usually own right of way but can share some corridor with cars	120	Up to 6,750 people per hour
Intermediate/suburban, local			
Bus	■ Medium to short stop spacing ■ Usually all stops but can also operate express ■ High to low frequency ■ Generally shared corridor with cars	NA[d]	Up to 6,000 people per hour
Tram	■ Short stop spacing ■ Usually all stops but can also operate express ■ High to low frequency ■ Generally shared corridor with cars	30	Up to 4,000 people per hour

Mode	Operating characteristics	Indicative construction cost ($M per km)[ab]	Typical capacity, per direction[c]
Emerging modes			
On-demand bus	■ Medium to short stop spacing ■ Usually all stops but can also operate express ■ High to low frequency ■ Generally shared corridor with cars	NA[d]	Up to 30 people per vehicle 1,500–1,800 vehicles per lane, per hour
Ride share and carpool	■ Short to long travel distances ■ Journey time dependent on stopping pattern ■ Flexible, demand-responsive frequency ■ Shared corridor with cars	NA[d]	Up to 4 people per vehicle 1,500–1,800 vehicles per lane, per hour
Car share	■ Short to long travel distances ■ Flexible, demand-responsive frequency ■ Shared corridor with cars ■ Constrained by parking availability	NA[d]	Up to 5 people per vehicle 1,500–1,800 vehicles per lane, per hour
E-bike share	■ Short to medium travel distances ■ Flexible frequency ■ Shared corridor with cars and dedicated bike lanes	NA[d]	1,500 bikes per dedicated lane, per hour
Bike share	■ Short travel distances ■ Flexible frequency ■ Shared corridor with cars and dedicated bike lanes	NA[d]	1,500 bikes per dedicated lane, per hour

a. Costs are indicative only and derived using weighted averages from previous projects in Australia. There is very significant variation between individual projects. The context of each project will require different engineering responses, such as tunnelling, movement of utilities, etc.

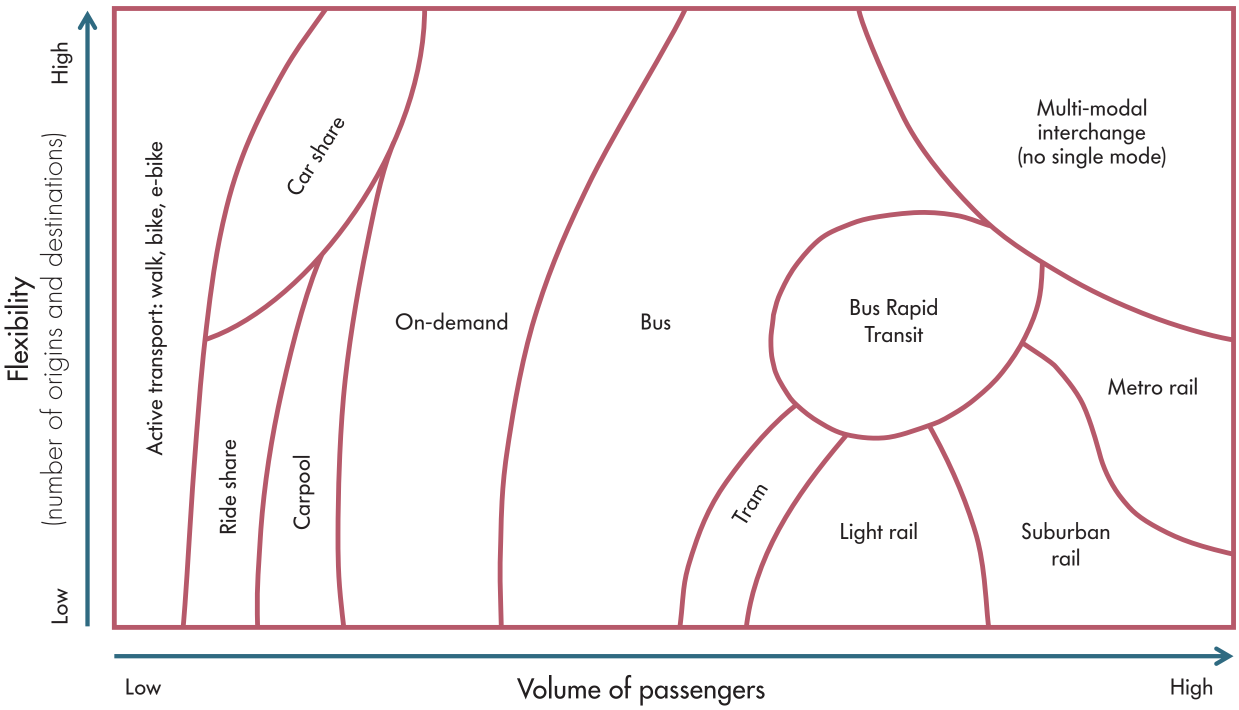
*b. The table does not include operating costs (see **Chapter 1** for discussion and data on operating costs by major operator).*

c. Capacities are indicative only and are subject to significant variation. They are designed to align with Australian experience and in some instances vary significantly to overseas capacities.

d. We have not identified indicative construction costs for transport modes that are assumed to use existing roads that are shared with private cars. There are associated infrastructure costs with these modes that are not included in the table, such as bus stops and shelters, segregated bike lanes and docking systems.

Source: Infrastructure Australia research[52]

Figure 24: Indicative characteristics of public transport modes for network design



Integrating the service hierarchy should allow for greater frequencies and service levels

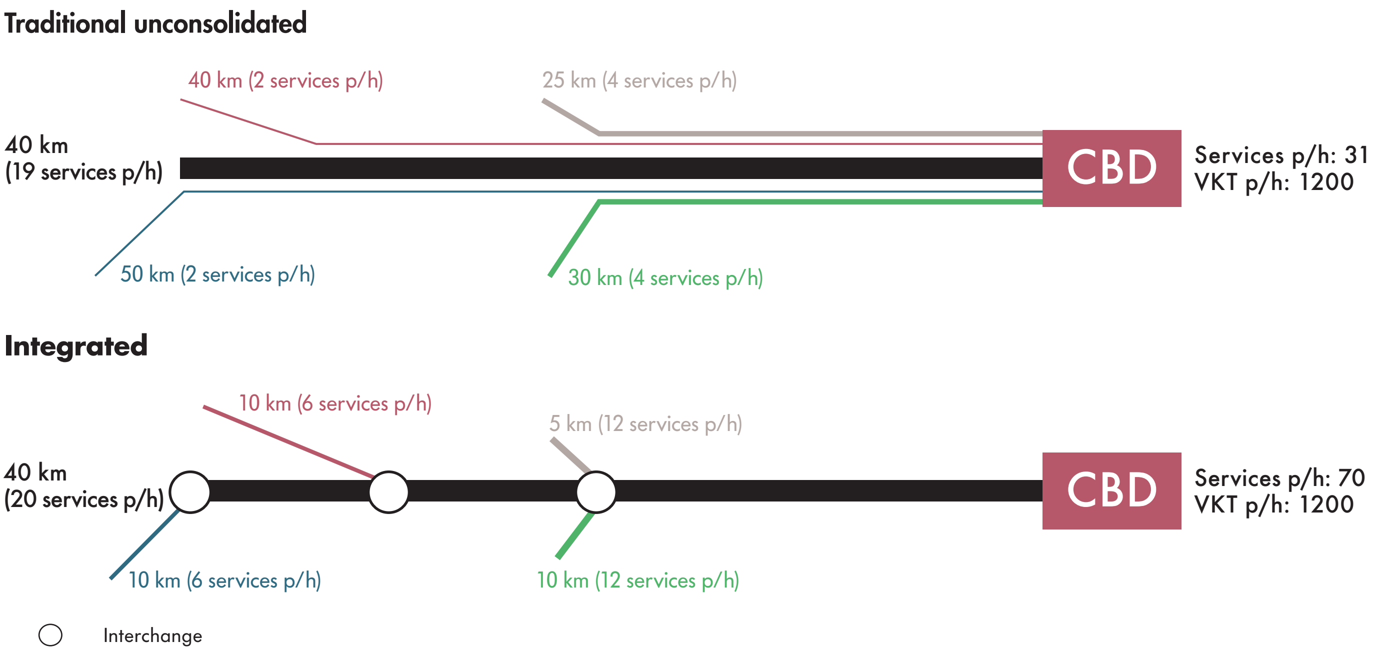
Once the service hierarchy is defined, it is important to ensure services are coordinated so that individual routes form a coherent network. Passengers should be able to transfer easily between individual services, and different modes should seamlessly form part of a single journey.

A key pitfall to avoid when planning public transport is developing individual routes incrementally and not integrated with the network. This results in routes that operate in isolation, carrying passengers from the suburbs to key centres but often duplicating each other in the process. A lack of integrated planning can lead to poor use of the public transport fleet, where vehicles/carriages are used on multiple routes on a single corridor, therefore splitting the travel market and travelling unnecessarily long distances. Service levels and frequencies typically decline under such conditions, particularly on feeder networks.

Figure 25 shows how coordinated planning can result in an integrated network, where frequencies and the number of services increase substantially, but the actual vehicle kilometres travelled remains constant. In other words, service levels improve but the key drivers of costs – the size of the fleet, hours of labour and wear and tear to vehicles – remain roughly the same. The 'unconsolidated' route structure shown in this figure is a network where each individual route travels from the suburbs into the CBD. For large parts of the journey, the routes compete with each other for passengers and, because they are travelling such long distances, frequencies are relatively low. In contrast, the 'integrated' structure shows a network where feeder routes interchange with the main, high-capacity trunk line. These feeder routes travel much shorter distances and therefore the number of services run and frequencies can increase substantially. The greater fleet availability has also allowed an additional service to be added to the black trunk route.

This is a simplified diagram, and it assumes that capacity exists along the trunk route for interchanging. It also assumes demand along the feeder routes justifies the increase in services. However, if the routes are well planned, increased frequency should result in more ridership and potentially allow for an expansion of the network.

Figure 25: Characteristics of integrated and unconsolidated transport networks



Note: *This figure assumes that each route in the unconsolidated network takes one hour to complete a one-way journey. Services in the integrated network are then redistributed based on time saved from feeder routes. This diagram is conceptual only and designed to illustrate the benefits of integrating networks. There will be a range of considerations on real networks, such as capacity of trunk infrastructure, the type of infrastructure available (rail, light rail or bus), costs of constructing interchanges.*

Note: *VKT means vehicle kilometres travelled and p/h means per hour (one way).*

Integration can expand the reach and flexibility of the network

Integrating services can help to increase the number of origins and destinations that a network reaches. This is particularly important in the context of Australian public transport networks, which are typically radial and designed to transport people in and out of employment centres, particularly the CBD. The limitation of radial networks is they are inflexible. They are specifically designed for a weekday commute, meaning other trips, such as for leisure, school or sport are more likely to be done by car. Work-related travel is a minority of all trips, meaning public transport serves only a small part of the travel market (**Figure 26** shows that 26% of trips in Melbourne are for work purposes). This contributes to rates of car ownership remaining high. The decision to purchase and own a car encourages its use for irregular journeys, continuing a trend away from public transport choice.

The issue is particularly pronounced in low-density outer suburbs that sit at the extremities of the network. When they are serviced by public transport, it is typically by a route that carries them to the CBD. This means it can be difficult for residents to catch public transport to smaller local employment centres, or for purposes other than work.

Flexibility in the transport network has important considerations for equity. When networks are focused primarily on serving large, mostly white-collar employment centres, they tend to ignore the needs of workers from the suburbs or people who are not necessarily travelling for work. Inflexible networks may therefore have a disproportionate impact on people who are on lower incomes, such as part-time workers, stay-at-home parents or pensioners. The policy challenge for governments is to make public transport a more practical choice for a wider number of journeys by increasing its flexibility.

One of the simplest and most cost-effective ways to do this is by encouraging people to interchange between services. In Australia, this is likely to involve running orbital routes, which interchange with largely radial trunk lines. Each interchange represents an opportunity for a passenger to change their direction of travel and opens a greater diversity of potential destinations. This is the principle by which metro networks around the world operate. This approach requires governments to acknowledge that individual routes are inherently limited and cannot possibly serve every origin and destination.

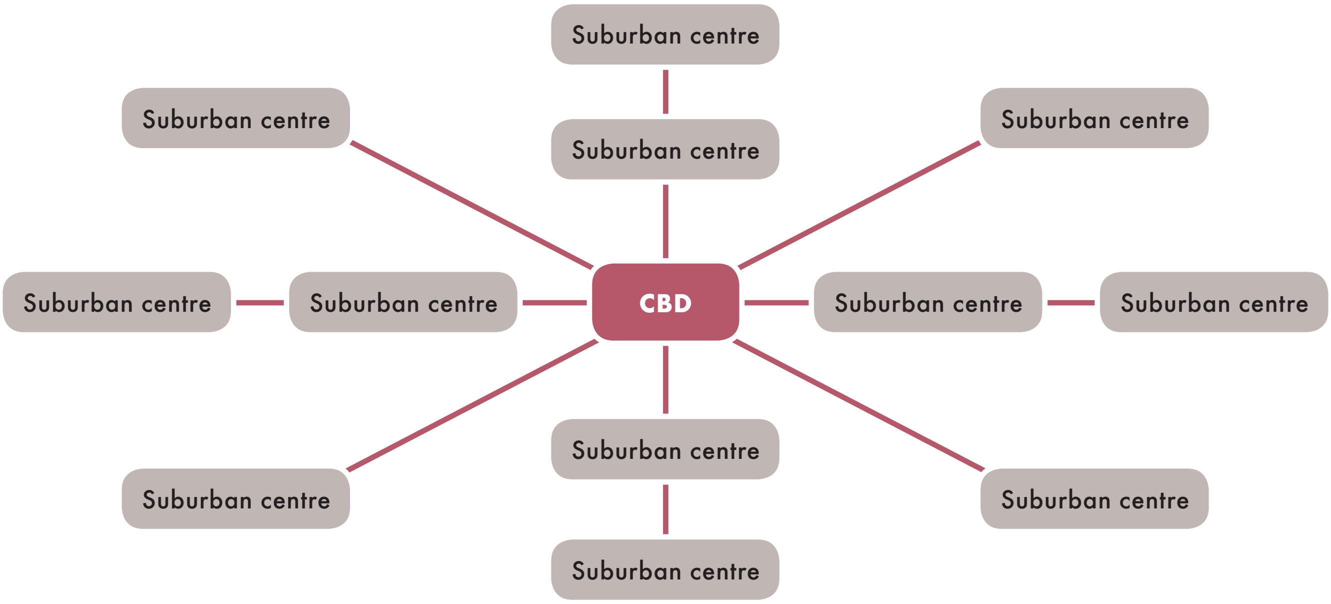
This concept is illustrated in **Figure 27**, which compares radial and non-radial ('grid') networks. The radial network allows limited potential destinations for passengers, with each centre individually connected to the CBD. The non-radial (that is, grid) network is based on the concept of interchanging. It means some passengers will have a less direct route to the CBD, however the network services a far broader range of destinations.

Figure 26: Purpose of weekday trips in Melbourne, 2014–16

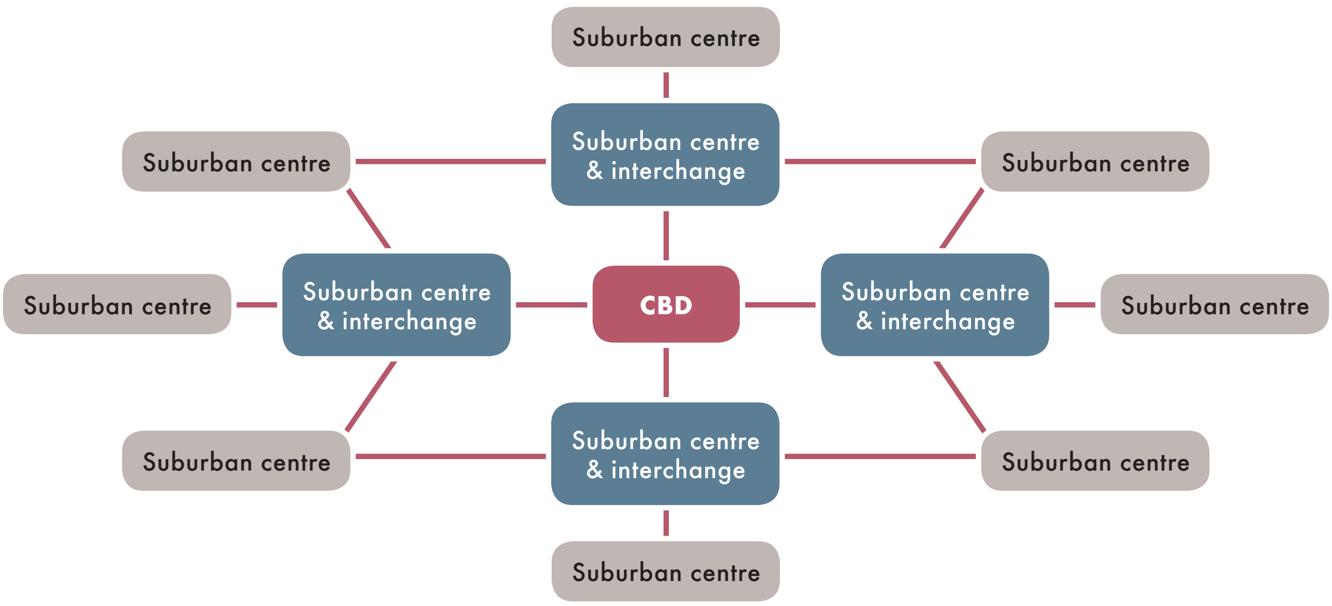
Source: Transport for Victoria (2016)[53]

Figure 27: Radial and non-radial networks

Radial



Non radial (i.e. grid)



Multi-modal integration is key in the Australian context

Cities in Australia do not have a high density of railway lines in the outer suburbs, and the costs of building numerous new, non-radial lines in low-density environments can be prohibitive (see **Chapter 1**). If Australian cities are to better integrate their networks, they will need to focus on cross-modal solutions that integrate different forms of transport.

This would likely result in more expensive infrastructure (such as heavy rail) serving as high-capacity trunk routes and cheaper, more flexible modes, such as buses, serving as feeder and secondary routes. The flexibility of buses is particularly helpful in scaling transport services to demand levels in lower-density areas, and responding quickly to increases in ridership as a result of new developments or service improvements. For example, if a particular bus route becomes popular, governments could respond by increasing frequencies, introducing higher-capacity vehicles, and adding new bus lanes in a significantly shorter period and at a fraction of the cost compared to other types of infrastructure. Equally, bus operators in low-demand areas could be given the freedom to operate smaller, cheaper and more environmentally friendly vehicles, provided they meet agreed service standards.

In our major cities, outer suburban bus networks are usually privately operated, under contract to a state government. These governments are responsible for ensuring contracts are designed in a way that ensures integration with other transport modes and sufficient service levels.

There is no ‘correct’ way to contract public transport services, as it will depend on context. However, the key is for governments, acting on behalf of taxpayers and passengers, to be clear about their desired outcomes and that they are built into the contract.

When integration with other services and modes is a priority, a contract may include minimum service levels and network designs, performance and patronage incentives as well as penalties. Focusing on multi-modal integration is consistent with international best practice. In French cities, network and service integration is often a major focus of network management. In cities such as Lyon, to support integration, a single operator is contracted to design and run the entire public transport network within an urban area. The operator is partially remunerated based on the number of passengers that use the network, which incentivises them to ensure services match the community’s need and to market them accordingly.

There has been a growing focus on multi-modal integration in Australia through network design and service contracting. In Newcastle, the New South Wales Government has followed the French model and contracted a single operator to run the city’s public transport network, with a focus on integration (see **Box 1)**.

Box 1: Multi-modal integration in Australia

Newcastle Transport

Public transport in Newcastle has undergone a significant overhaul in recent years. Making a national first, the New South Wales Government contracted a single operator, Keolis Downer, to manage and operate most of the city’s multi-modal public transport network.

The 10-year contract began in July 2017 and includes responsibility for planning and operating the city’s buses, ferries and, from 2019, a light railway. The purpose of bundling all the services under one contract was to ensure multi-modal integration, giving people seamless, coordinated door-to-door journeys.

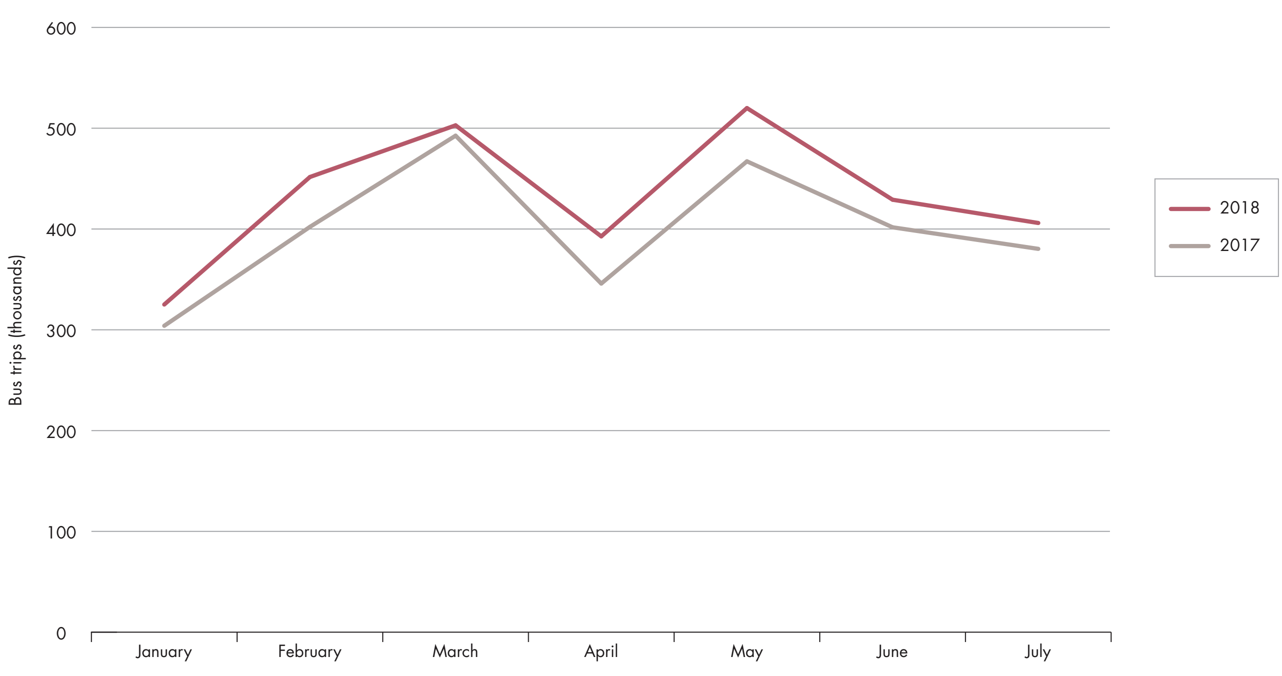
The new network has a clear hierarchy of services, with the future light rail line and high capacity bus lines forming the backbone of the system, and local buses, ferries, and smaller on-demand services integrating with the frequent trunk lines. This redesign of the system is amongst the most significant in the city since the removal of trams in the 1950s.

To facilitate this, a major transport interchange is under construction at Wickham that will allow passengers to interchange between the existing heavy rail line, buses, and the forthcoming light rail.

The New South Wales Government has designed the contract to encourage better performance, by including incentives to grow patronage on the network.

It is, of course, too early to assess the success of the initiative. However, the early signs have been positive, with monthly bus patronage for the Newcastle contract area increasing since the introduction of Newcastle’s new timetable in early 2018 (see **Figure 28**). This is particularly encouraging given the light rail and final network design are not yet operational.

Figure 28: Monthly bus patronage between January and July, Newcastle contract area, 2017–2018



Note: The Newcastle contract area is now operated by Keolis Downer. There are some public transport operations which are not included in the contract, such as the heavy rail service.

Source: Transport for NSW (2018)[54]

In our largest cities, the focus on multi-modal integration is equally important. Already there are numerous examples of where coordination and integration of services has become a significant focus for governments:

- In 2011 and 2012, Transport for NSW and Public Transport Victoria were established. This brought to Australia the 'Transport for London' model of a single organisation overseeing all aspects of public transport. Other states have followed suit, most recently with the newly elected South Australian Government committed to establishing South Australian Public Transport Authority (SAPTA). SAPTA intends to establish transport planning guidelines and a network hierarchy to ensure buses are fully integrated with the railway and tram networks.[55]
- In 2007, the Mandurah line in Perth was completed. The project came with an overhaul of the bus network in Perth's south, and the integration between buses and trains was a priority for the Western Australian Government. This was particularly important because Perth's very low residential density makes walking access to stations impractical for many. Perth now has significantly higher levels of access to rail stations by bus than any other Australian city.[56]
- In 2016, the Queensland Government opened the Redcliffe Peninsula line. The new railway was accompanied by a redesign of the bus network to ensure it integrated with train services. The redesign included 17 bus routes servicing new stations as well as an expansion of the network to cover growing residential areas.[57]

Box 2: Integration is crucial for long distance commutes from satellite centres

NSW Central Coast case study

Residents in satellite centres, located beyond the main city boundary, face unique public transport challenges compared to their capital city neighbours.

One such centre is Gosford in New South Wales. Located between Sydney and Newcastle, it is the main centre of the NSW Central Coast. The ABS has classified this region as part of the Greater Sydney capital city area and it forms part of the outer-Sydney sector in the analysis presented in **Chapter 2**. The Central Coast is considered part of Sydney's labour market – of the Central Coast's 267,300 employed persons, 10% work in Sydney.[58]

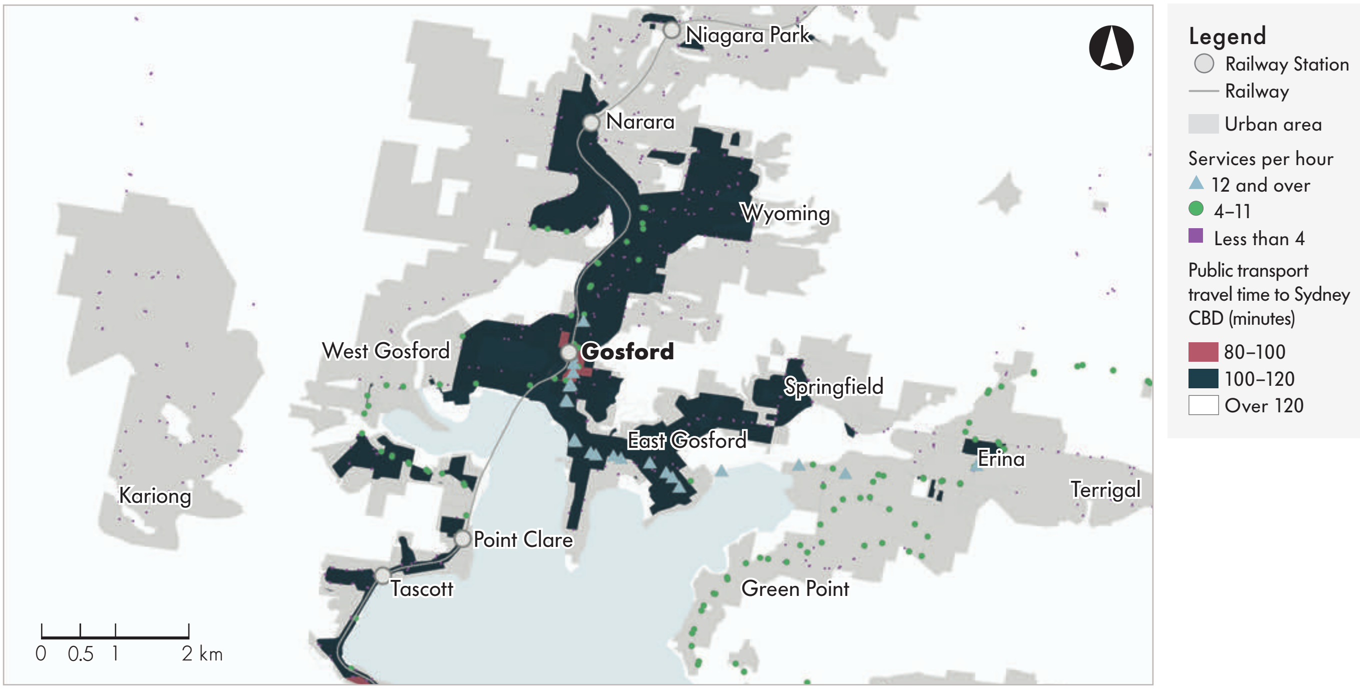
Public transport access and service quality are vital for enabling workers living in the Central Coast to access the vast job market in Sydney. The primary public transport service to Sydney is the intercity Newcastle to Sydney rail line, with Gosford and Woy Woy being major stations on the Central Coast. The region is low density and very spread out, meaning feeder bus services to the stations on this line from surrounding areas, as well as car parking, are vital for improving access to the rail network.

Figure 29 shows that travel times to the Sydney CBD from Gosford and Woy Woy are predictably shortest in the immediate areas surrounding the train stations (80 to 100 minutes). Travel times under 120 minutes also align with areas where there are medium- to high-frequency bus services that connect to the railway. Outside of the medium- to high-frequency bus network, travel times increase to over 120 minutes. This illustrates the important role that feeder buses can have in extending the reach of the public transport network and reducing travel times for users.

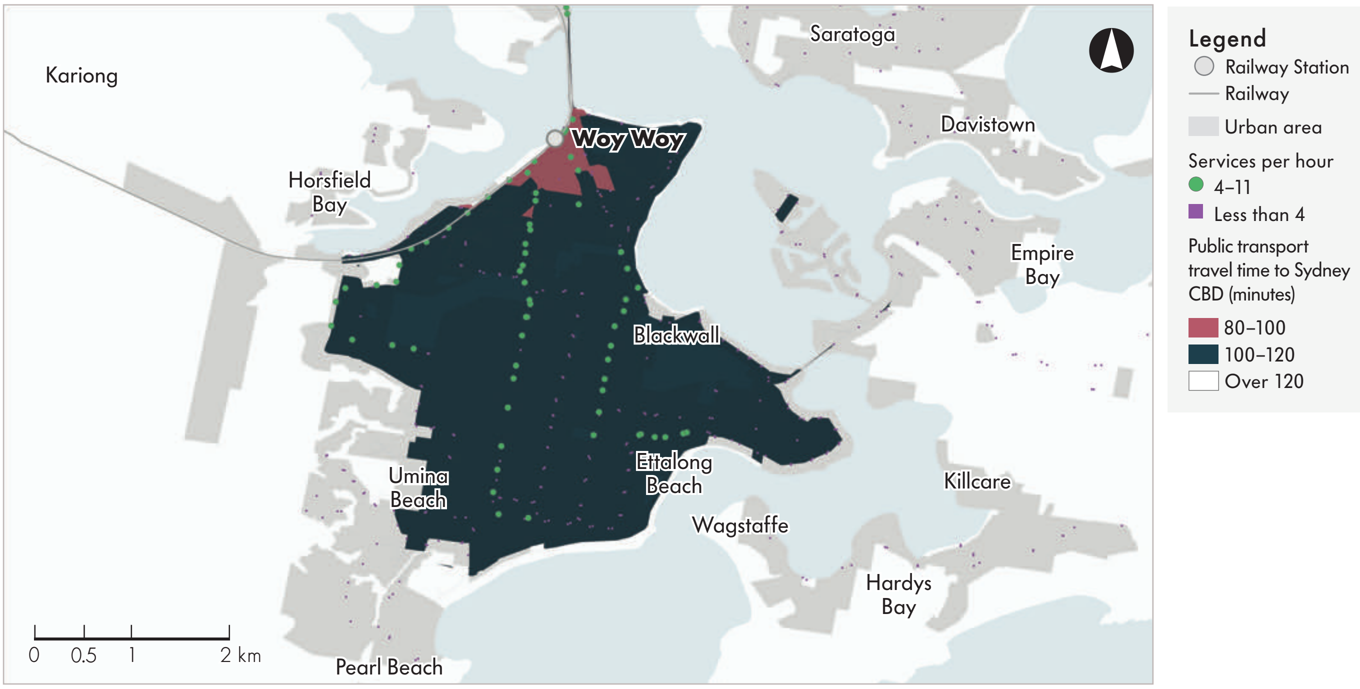
Nevertheless, despite the positive effect of these feeder services, people who live near Gosford and Woy Woy railway stations will still face travel times to Sydney CBD of 100 minutes and over. Significant capital investments are beyond the scope of this paper, however it is important to note upgrades to the Newcastle–Sydney–Wollongong railways are listed as a Priority Initiative on the *Infrastructure Priority List,* the consensus list of nationally significant infrastructure investments.[59]

Figure 29: Public transport journey times to Sydney CBD and feeder bus services, Gosford and Woy Woy, 2017

Gosford



Woy Woy



Source: Based on GTA Consultants (2017)[60]

Designing an ideal network to attract users

In order to attract more users, public transport networks must get the basics right of taking people where they want to go. While this simple concept is universally adopted by transport agencies, rapid population growth, land use changes, or shifting industry hubs are too infrequently catalysts for transport network changes.

In some of the outer urban areas in major Australian capital cities, 'ground-up' public transport network redesign has not been undertaken for over two decades – potentially double the average period of continuous occupancy of a property, even in established suburbs.[61]

Transport network planning must be sufficiently flexible to respond to changing community characteristics to allow the establishment of public transport use as a pattern of behaviour. Traditionally, transport network planning has involved incremental modification of existing services. Where these services currently attract low levels of patronage, it is unlikely that incremental enhancements will drive significant take-up.

Recent improvements, however, in the availability of travel data, including from telecommunications devices, and the rise of on-demand and ride share, has provided a catalyst for more holistic review of network design. To support improved transport service, transport agencies, communities and operators must work in partnership to transform networks to better cater to community needs. There is a potential role for private operators to engage more directly in this process as part of periodic tendering for operational contracts. However, the final approval authority should rest with transport agencies, especially to ensure that outcomes are in the best interest of the community.

Typically, best-practice network design for low-density urban areas would include:

- designing strategic policy objectives to be supported through the network design
- identifying the locations of trip-generating facilities, such as employment centres, entertainment precincts, and education and health facilities
- surveying the community to determine preferences and desires for the future transport network
- designing a simple network structure that is easy for the community to learn and remember
- establishing trunk line services and ensuring adequate frequency to support attractive interchange and turn-up-and-go services
- trunk line routes that are as direct and fast as possible
- designing feeder services, defining their role within the broader network through a purpose (such as servicing a railhead or employment centre) or an economic use (such as servicing a coastal tourist service or shopping hub)
- designing low-frequency services, such as on-demand, ride share, active transport and private car access
- supporting integration through timetable design and fare integration, including of on-demand last mile services, which could be provided by third parties in a competitive market
- providing booking and payment platforms, as well as supporting the development of third-party booking and payment offers to support emerging models, such as subscription
- designing, procuring and delivering infrastructure and rolling stock
- trialling services, continually assessing feedback, and adjusting services (particularly low-frequency services) to meet demand
- launching network and periodically monitoring, de-scoping poorly utilised services, and consolidating popular services.

Recommendation 1:

While progress is being made in most jurisdictions, state and territory governments should prioritise the seamless integration of transport networks for users by coordinating service planning, timetabling, fare policy, digital tools and operations.

Governments should work in partnership with transport agencies, operators and communities to:

- maintain an efficient transport hierarchy through maximising service frequencies on trunk routes and encouraging interchange for first-and-last mile connections
- incorporate flexibility in planning and contracts to allow them to monitor and respond to poorly utilised services
- ensure the integration and coordination of services are undertaken with an understanding of customers' needs and perspective
- undertake periodic holistic redesigns of public transport networks to match changing land use patterns and consumer preferences.

Embrace innovation and new modes

Where people are demanding better transport, try on-demand

On-demand or demand-responsive transport services have existed amongst world-class public transport networks for more than 70 years. In addition to developed countries in Europe, Asia and North America, they also operate in emerging networks in Latin America, Africa and Southeast Asia, and are not new to Australia (**Box 3** describes long running on-demand services in regional South Australia). Many entertainment and hospitality venues have also featured similar services within suburban Australia, from local clubs to education institutions and community transport.

While use of traditional on-demand transport services, such as taxis, has traditionally been limited in Australian cities (often due to cost) the advent of Uber, Lyft and their counterparts has led to rapid growth in consumer acceptance of on-demand services. The growing popularity of on-demand transport is part of a trend of increasing personalisation of services through the application of technology. It should be expected that the popularity and use of on-demand services will continue to become more attractive as communications technology improves.

Significant change in community acceptance of on-demand modes, as well as improvements in booking and route optimisation technology, provide an opportunity for governments to consider opportunities to incorporate these services into a city's integrated transport network. In particular, the change in public appeal of on-demand services and reduced costs associated with their uptake provides an opportunity to expand these services as the basis for public transport in outer urban settings.

On-demand transport is ideal for low-density, low-demand areas, as journeys are optimised between locations to reduce travel times and operating costs. This approach differs to the traditional model of public transport, which often has a high cost to governments in outer urban areas, where bus services run to set routes and timetables and rely on people being within walking distance of stops.

By contrast, on-demand transport means operators can respond to demand, providing a tailored door-to-door/door-to-interchange service. On-demand transport could potentially be provided at lower costs than traditional public transport in areas where demand is too low to justify fixed route services. For instance, capital requirements for public transport infrastructure, such as stops, can be reduced. Operators can also run smaller vehicles that are deployed when demand is sufficient, meaning they could be more cost efficient than traditional modes of delivery.

However, on-demand services often require greater promotion, through advertising and high-quality passenger interfaces (such as smartphone booking apps), which can increase costs in these areas. Various operating models of on-demand transport are summarised in **Table 5**.

As services grow in popularity, regular patterns for journeys may be established and vehicle size may increase. This may require the establishment of timetabled services. When this occurs, vehicles offering on-demand services can be repurposed to allow the establishment of new routes elsewhere.

In many Australian jurisdictions, trials are underway that combine on-demand services with smartphone apps and real-time information. For example, the New South Wales Government is currently trialling on-demand transport services, where people can book a vehicle (usually a bus or van) to pick them up from their home and take them to one of the transport hubs or centres that are included in the trial. Fares are generally comparable with public transport fares and services can be booked online, via apps, or over the phone.[62] Another trial has been undertaken in the ACT with Transport for Canberra partnering with Uber to take passengers from bus stops to their homes (see **Box 4**).

Trials to expand the application of on-demand public transport in outer urban areas are important and should aim to address one of the key challenges in providing public transport in low-density areas – the first and last few kilometres between people's homes and the public transport network.

By their very nature, such services would be designed to service low-demand areas and will subsequently need to be adjusted in time to ensure they are viable. Some trials will inevitably have mixed results and identify important lessons for government. Although there is significant potential for on-demand transport to flourish and address the public transport shortfall in outer urban areas, there have also been plenty of examples where flexible routes have not been adequately patronised and subsequently not commercial.

The stubborn nature of shifting user behaviour to new transport modes in areas with high levels of car ownership must be considered in planning the deployment of on-demand services. On-demand transport exists in a highly competitive market competing against the incumbent car, and new modes such as ride and car share. In order to support access to public transport in low-density regions, new modes must be widely promoted over a sustained period. Consideration should also be given to integration of on-demand services with broader network fare policies, systems, and timetables.

New models of travel are a certainty, however the most effective method of delivery will vary. Care should be taken by governments and the community not to abandon reform.

Box 3: On-demand transport is not new to Australia

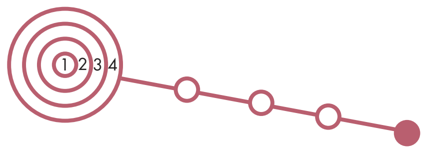
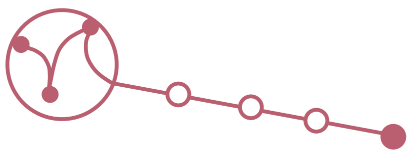
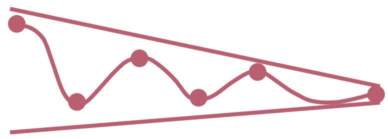
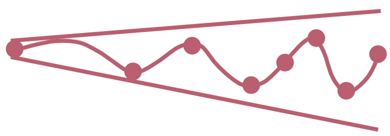
South Australian regional bus contracts

Regional and outback South Australia has been a quiet Australian pioneer of demand-responsive transport. Dial-a-ride services have been provided in many townships for more than a decade, and service key locations, including health and social services, and commercial precincts.

Dial-a-Ride services operate under a range of business models and have demonstrated capability to operate with a commercial return, without government subsidy. Fares for these services can carry a premium on less flexible timetabled, fixed-route public transport, however they offer an alternative to car ownership for people in low-density areas.

For instance, Murray Bridge Dial-a-Ride operates pre-booked, or 'Hail-a-Ride', services within the township area of Murray Bridge. The service provides pick-up and set-down from specific locations at set times with an hourly frequency, with full fare on these services priced around $11.60. The Barossa Dial-a-Ride service operates with one-hour notice door-to-door between Angaston, Nuriootpa and Tanundra, with full fare on these services priced around $6.00.

Table 5: Summary of various on-demand operating models

Operating model	Route variability	Stop location flexibility	Use	Example	Illustration
Demand responsive	High. Fast route between confirmed pick-up and setdown locations.	Fixed to flexible	Low density, intra-urban	Dial-a-ride, e.g. LinkSA	
Capacity responsive	High	Flexible	Low density, intra-urban or inter-urban	Carpool, e.g. Liftango or Uberpool	
Local pick-up	High	Flexible	Various	Carpool, e.g. Liftango or Uberpool	
Single destination	Moderate. Various pick-ups within predefined boundary, single destination.	Origin flexible, destination fixed	Servicing to a trunk line or trip generator	On-demand bus, e.g. Bridj or Keoride	
Single origin	Moderate. Single origin, destinations within predefined boundary.	Origin fixed, destination flexible	Servicing from a trunk line or from a trip generator	On-demand bus, e.g. Bridj or Keoride	

Box 4: Ridesharing trial

ACT Government partnership with Uber

The Australian Capital Territory was the first jurisdiction in Australia to regulate ride sharing and, having observed trends elsewhere, did so before ride sharing had become established in Canberra. By incorporating a pro-active, outcomes-based approach to regulation, the ACT Government embraced technological developments and market change.

In multiple summer trials over 2016 to 2018, and during some major events, Transport for Canberra partnered with Uber to extend the reach of Canberra's late-night bus service. Late-night transport often suffers from the same challenges as public transport in lower-density suburbs, where low ridership and dispersed travel patterns mean the services are often inefficient and very expensive to deliver.

Transport for Canberra and Uber jointly subsidised a $10 discount on Uber rides that were taken between bus stops and the surrounding suburbs. The purpose of the trial was to provide an affordable way of accessing the public transport network by servicing the first and last few kilometres between homes and the local bus interchange.

Figure 30 shows origins (orange dots) and destinations (blue dots) of Uber trips during the trial. The trips are largely concentrated between major bus interchanges at Gungahlin, Belconnen, Civic, Woden and Tuggeranong.

Figure 30: Origin and destination of Uber trips during the Bus+Uber trial

Image source: Uber and the ACT Government

The rise of connected and automated vehicles

While on-demand transport has the potential to improve the quality of services in outer urban areas, the rise of connected and automated vehicles provides an opportunity to reduce operating costs. The most significant operating cost for a bus service is the driver. Commercial deployment of automated bus technology has the potential to significantly reduce the cost of providing bus services, the heavy lifter of outer urban public transport. The cost of the driver currently accounts for about three-quarters of the cost of an Uber trip and around half of the operating cost of a bus.

While autonomous vehicles may seem futuristic to many in the community, automated vehicle technology is already on Australian roads in both light and heavy vehicles. Most Australian jurisdictions are currently trialling automated (level 4) shuttles from a variety of manufacturers. These trials include highly automated vehicles travelling on public roads and private precincts, mixing with pedestrians and human operated vehicles. Governments should leverage trials to provide the opportunity for communities to interact with autonomous technology and build familiarity.

There is still a series of regulatory, safety, and technological hurdles to overcome ahead of widespread adoption of automated vehicles on our roads. However, vehicle manufacturers forecast increased availability of new automated taxis and buses over the next few years and widespread commercial availability of highly autonomous vehicles within the next decade.

While there is increasing confidence in the arrival of autonomous technology, the impact automated vehicles will have on our public transport networks is less certain and will depend on our pricing and regulatory settings. If we plan well, they could complement our public transport networks. Automated vehicles offer the potential to provide low-cost services to first-and-last-mile journeys, particularly in outer urban settings. However, their low cost, convenience, and the flexibility for passengers to undertake other tasks while travelling could result in these modes competing with public transport, thereby undermining the potential benefits they offer.

The arrival of connected and autonomous vehicles should be considered when planning urban environments, especially streetscapes and parking, as well as for major transport projects.

Unlike fully-autonomous vehicles, connected vehicle technology is commercially available today and provides opportunities to enhance user experience and transport service planning and operation. The development of connected applications, such as updates on real-time parking availability, traffic signal prioritisation or journey routing, offer significant consumer benefits without the high cost of major infrastructure investment. There are many ways technologies could combine to shape our future transport networks. The key for governments is to be outcome-oriented, open to innovation and to embrace change. The adoption of intelligent transport systems may add up-front costs to projects, however, where well planned, they offer significant benefits into the future.

Recommendation 2:

Australian governments should embrace new transport modes, such as on-demand services, which are well suited to low-density areas.

Governments should:

- work in partnership with the private sector to understand potential network impacts, business models and operating requirements of new modes and technologies, such as demand-responsive services, in-market competition or automated vehicles
- develop coordinated whole-of-government implementation and communication strategies to support the adoption of connected and automated vehicles, including the use of pilots and trials.

Encouraging people to interchange is crucial to servicing lower-density areas

Encouraging people to interchange is crucial to a successful public transport network. However, Australian commuters have historically been reluctant to interchange. This is because poor-quality interchange options can result in long and frustrating waiting periods between services. Poorly designed interchanges can also result in wasted time walking between services and can be particularly difficult for those with limited mobility or during unpleasant weather. The reluctance to change services can be due to numerous factors, such as uncertainty about reliability, the effort required in transferring, the likelihood of missing out on a seat, or the quality of facilities at the interchange point.[63] These difficulties in interchanging are well reflected during the transport planning process **(see Box 5)**.

Another key disincentive to interchanging is when the fare structure penalises service changes. Fare penalties have been common in Australia, particularly for changes between modes, although this is less of a problem now with most authorities undertaking structural fare reforms associated with the introduction of electronic ticketing. However, governments should not simply remove interchange penalties, but strive to go further and put in place incentives within fare structures to encourage the most efficient use of the transport network.

New South Wales is the last jurisdiction without full integration of traditional modes, however all jurisdictions should also consider integration of emerging modes.

Box 5: Interchanging is penalised in transport planning

The difficulty in interchanging is reflected in the Australian Transport Assessment and Planning (ATAP) guidelines, which include a ‘transfer penalty’ for project business cases to reflect the inconvenience associated with changing services. This penalty is generally over and above the additional time that a transfer will add to a trip (although sometimes there is cross-over with walking and waiting time calculations).

ATAP considers waiting time to be worth 1.4 times the value of travel time,[64] while UK guidelines have it at 2.5 times the value of travel time.[65] This is a reflection of people’s preference to be on their service moving towards their destination instead of waiting on the platform.

Waiting times should be minimised through high frequencies, coordinated timetables and active network management

Perhaps the most important disincentive for transferring is that it inevitably means time spent waiting for the next service. Waiting for a service adds to passengers' trip times and can cause frustration and anxiety, particularly if services are unreliable. As a result, it is generally assumed that passengers will try to avoid making transfers.[66]

Recently, waiting periods have been reduced through improved customer information and real-time apps, meaning passengers are now more likely to coordinate their trips with the timetable. However, waiting for transfers can still be more difficult to coordinate for passengers because it is largely reliant on whether the timing of the initial and connecting services are aligned.

Several options are available to transport planners and operators to minimise negative passenger perception of delays during transfers:

1. **Timed transfers.** The timetables of routes can be aligned so that passengers are able to transfer between services easily. This is a common approach in regional and outer urban areas where service frequencies are low. This strategy generally chooses some key interchanges and ensures that at each location, services from across the region simultaneously converge and then simultaneously leave a few minutes later. This allows passengers to arrive at an interchange and choose from a large variety of services to which they can transfer. The approach is widely used in European transport networks, particularly for railways in Germany, the Netherlands and Switzerland.[67] However, timed transfers only work when networks are running to schedule.
2. **High frequencies.** Urban transport networks can become too complicated to coordinate services. This is particularly the case where demand is sufficient for higher frequencies, meaning there could be hundreds of services arriving at interchanges within a short timeframe. The key to reducing waiting time in these networks is to maximise frequency so that passengers never have to wait long while transferring. This is the basic principle of metro systems around the world, where each route will generally run a service every few minutes. However, high frequencies are also achievable with cheaper infrastructure, such as buses. If demand is sufficient, high-frequency bus services can connect railways with local demand centres (such as universities or shopping malls), therefore expanding the reach of the network and ensuring passengers do not have to wait long (see **Box 6** for an example from Melbourne). In the outer urban context, this level of frequency may not always be justified, particularly for local feeder services. When this is the case, a hybrid approach can be taken, where trunk routes are high frequency and the arrival/departure of local and suburban services are coordinated with each other. This means passengers have the option of transferring to high-frequency trunk services or local services that are timed to allow for easy transfers.
3. **Bookable connecting services.** While it is impractical for major trunk services to wait for the arrival of passengers, smaller more flexible first-and-last-mile services offer the opportunity to delay departures to ensure passenger connections can occur. The use of bookable services, with real-time travel information, can ensure that passengers can join a waiting service for the final 'to-the-front-door' leg of a journey. This avoids the need to use a car to travel to a transport interchange. The emergence of 'car-as-a-service' or car-share services has introduced the potential for a connecting service to include a self-driven vehicle. These types of bookable services are already popular at many airports.
4. **Bookable seats.** Passengers can be reluctant to interchange to a parallel express service or another mode if it means giving up a seat. Passengers with limited mobility, travelling with dependants or with luggage often place the highest value on a seat. The certainty of a seat when travelling can mean the difference between leaving the car at home or continuing a journey on a feeder service rather than interchanging to a trunk route.
5. **Comfortable waiting areas.** In addition to comfortable journeys, customers value comfortable waiting areas. Exposure to extreme weather, including wet, heat or wind, can be a significant deterrent to interchanging. In addition, safety and personal security at stops is also a significant consideration for some passengers, particularly those who are vulnerable.
6. **Active network management.** Active management of the network by operators to reduce delays is critical to ensure customer confidence in interchanging. This involves minimising the disruption from both planned and unplanned incidents. When public transport networks experience delays, the greatest problems manifest at interchanges. By understanding passengers' door-to-door journeys (where their final destination is, instead of simply where they will get off their current bus or train), passenger volumes can be managed to ensure that interchanges are not overloaded. This could be done through network operators proactively responding to the behaviour of the network then, for example, immediately deploying bus services to train stations at full capacity, and directing passengers arriving at these stations onto these buses. If these passengers' intended destinations are known, they could be directed to take these services before they arrive at the station. By proactively managing the network beyond simply reacting to individual events as they arise, and by managing passengers on a journey basis instead of a trip basis, issues on the public transport network could resolve quickly.

Box 6: High-frequency, connecting buses are an effective way to expand the reach of the network

Melbourne's 401 and 601 bus routes

Melbourne is not normally associated with buses. Its famous tram network and extensive railway system are generally the focus of public transport stories in the Victorian capital. However, Melbourne has numerous highly successful bus routes that help to connect railway stations to key centres, and therefore expand the reach of the network through interchanging. Two of its most successful routes are the 401 and 601 bus services, which connect North Melbourne Station with the Parkville medical and university precinct, and Huntingdale Station with Monash University (Clayton Campus), respectively. Both services run at high frequencies (every 3 to 4 minutes in the peak) and are two of the more popular bus routes in Melbourne, together carrying about 7,000 passengers each weekday.[68]

Public transport fare structures should ensure passengers are not penalised for transferring

Public transport fares have historically been calculated differently depending on the mode of transport. This can make sense from an administrative perspective, as transport modes will have different costs to government for delivering a service. For example, the cost to government of a 10 km trip on a train will not be the same as that same trip on a bus. A key performance indicator for transport operators is cost recovery from fares, so it has been administratively easier to apply differential structures. There has also been a lack of integration in governance across different operators, meaning some operators have been reluctant to share fare box revenue, instead attempting to operate their network in competition with other modes.

Charging different fares for transport modes discourages people from transferring between services. This is because most fares will include a 'flagfall' component just to access the network, meaning transferring between modes will result in passengers paying a flagfall fee with each transfer. The result is that passengers who transfer services will likely pay more, even when it is the most efficient way to travel.

Fare integration has become a less significant issue since the 2000s. This is partially because jurisdictions have increasingly moved towards 'gross-cost' public transport service contracts. Historically, contracts were awarded to operators on the basis that they will set their own fare structures in order to raise revenue. Now that governments retain all revenue risk, there is no longer an institutional incentive for differential pricing.[69]

In addition, the roll out of electronic ticketing presented an opportunity for governments to reform their fare structures to ensure integration between modes. Melbourne, Perth and South East Queensland all migrated to full fare integration before the roll out of their electronic ticketing systems. This means passengers pay the same amount to get from point A to B, regardless of transport mode.

Sydney's electronic ticketing roll out was arguably the most complicated of the Australian cities because of the differences between modes and their distance-based charging. The New South Wales Government has made progress towards fare integration with the recent introduction of a rebate when passengers change modes. However, full fare integration is yet to be achieved.[70]

Additionally, as new transport modes arrive, integration of fare structures for these modes need to be integrated with overarching electronic ticket systems in order to ensure the network is most attractive to users.

Well-planned interchanges encourage people to transfer between services

The physical quality of an interchange can have a significant impact on the time it takes a passenger to change services as well as the traveller's experience. The 'transfer penalty' is generally higher for interchanges between modes (such as from buses to trains) than within modes (for example, train to train). This is because physically co-locating different modes of transport is difficult. For example, a transfer from one train to another may simply involve crossing the platform or walking to a different platform within the same station. A transfer from a bus to train, however, may involve paying at different gates, crossing roads and longer walking times.

Infrastructure providers should focus on ensuring interchanges are well designed in order to minimise the time and effort it takes to change services. This means ensuring that customer's experience is the priority, which, at a minimum, includes the following principles:

- Comply with the *Disability Standards for Accessible Public Transport 2010*.
- Where possible, keep all transfers 'at grade' (avoid making passengers climb stairs or escalators) and avoid road crossings.
- Minimise the walking distance between services, such as through platform-to-platform and multi-modal platform interchanges (for example, co-locating bus and tram platforms).

- Ensure passengers are protected from the weather while walking between services, coming to and from car parks, and while waiting.
- Ensure appropriate lighting and security features so that passengers feel safe using public transport. Safety concerns are a significant impediment to using public transport, particularly for vulnerable groups, so it is critical that operators and transport authorities work closely with police to ensure safety is a priority both at interchanges and during transit.
- Provide easily accessible information for passengers, including real-time service information and wayfinding.

Box 7 presents an example of a high-quality interchange in Brisbane that applies some of these principles.

The design of an interchange can significantly affect the extent to which passengers view transfers as an impediment. Research in New Zealand and the United Kingdom indicates that the ‘transfer penalty’ applied when assessing business cases can vary from five minutes for a simple transfer to 14 minutes for a complicated interchange.[71]

Box 7: High-quality interchanges

Cultural Centre Station, Brisbane

Classic public transport models look at feeder buses supporting trunk rail services. The Brisbane public transport network is more complex, due to the provision of separated busway infrastructure. Brisbane’s busway infrastructure provides fast, direct and frequent services from major suburban catchments to central locations in the CBD, and most of the major patronage generators outside the CBD. The bus network provides important trunk routes complementing the rail network, and the distinctive stations provide a transfer. They provide a sense of permanence and visibility normally associated with railway stations, and the passing lanes allow a mix of stopping and express services.

The Cultural Centre Busway Station is the third busiest public transport station in Brisbane and the most intensive interchange location in relation to the number of passenger transfers in the public transport network. The success of Cultural Centre Station can be attributed to a number of factors including seamless same-platform transfers, high frequencies (with around four buses every minute in the morning peak), and integration with a range of routes. In particular, the integration of southern, northern, eastern and western routes at this location allows passengers to access services to a broad range of locations with minimal transfer inconvenience.

Image source: Transport for Brisbane

Governments generally have design guidelines for new transport facilities and interchanges.[72] The key is to ensure existing facilities are also upgraded. There is an opportunity to undertake these upgrades a part of each government's broader accessibility improvements to their respective networks.

State and territory governments are currently upgrading their transport networks to ensure they are compliant with the *Disability Standards for Accessible Public Transport 2010*. These standards are part of the *Disability Discrimination Act 1992* and require most public transport facilities to be fully accessible for those with limited mobility by 2022 (2032 for some operators).[73] For interchanges, governments should aim to exceed the minimum requirements set out in the legislation and ensure all passengers have comfortable, time-efficient transfers.

Sufficient support and training for staff by operators will also be important in ensuring assistance is provided at stops and interchanges, particularly for less mobile passengers. Although infrastructure is being progressively upgraded to try to ensure passengers can be independent, assistance from staff can make a very real difference in people's experience and whether they are willing to catch public transport (see **Box 8**).

Finally, governments should consider co-locating value-add services at interchanges. These range from simple businesses, such as cafes or food outlets, to timesaving services such as 'click-and-collect' groceries or delivery collection. These services can significantly improve the interchange experience for frequent travellers. They can also reduce the need for passengers to drive in order to access a service before or after their public transport journey, especially as they may otherwise choose to drive the entirety of their journey out of convenience. Conversely, service operators can potentially capitalise on very high amounts of foot traffic, generating new revenue streams for public transport operators.

Recommendation 3:

State and territory governments should implement a coordinated policy approach to encourage interchanging within an integrated transport network by:

- minimising passenger waiting times by coordinating services at interchanges, such as through timetable integration, timed transfers, high-service frequencies and active network management
- providing passengers with the ability to reduce their waiting times through booking connections, including using on-demand transport
- reviewing fare policies and structures including removing interchange fare penalties and introducing incentives
- prioritising the customer experience when designing transport interchanges, such as by minimising physical obstacles, providing real-time service and wayfinding information, and co-locating value-adding services at interchanges.

Box 8: The importance of well-trained staff

Customer feedback to Transport for NSW

"We are from Orange and our 13-year-old son is a power wheelchair user. Initially nervous about using the train system … when we arrived at North Ryde an attendant approached us and assisted with ticket purchase and then directed us to the correct platform where another attendant put us on the train with a ramp. When we arrived at Town Hall there was another attendant. This service was consistent throughout all stations. It made travelling with a wheelchair so easy. Well done on improving accessibility on your service … it was fantastic that staff were very responsive and professional … a credit to the organisation."

Source: Transport for NSW (2017)[74]

Public transport needs to be integrated with private, active and emerging transport modes

Public transport does not operate in isolation. If governments are to prioritise the user experience, it is important to recognise many people will find it more convenient to access the public transport network by car. This is particularly the case in the outer suburbs, where low densities mean people often have to travel longer distances to railway stations or bus stops. In these environments, easy access to the network can often mean the difference between people using public transport for part of their journey, or choosing to drive the whole way.

It is therefore important to ensure major stops and stations are accessible by other modes of transport, including cars, bicycles, on-demand transport and feeder public transport routes. In doing so, governments will need to make strategic decisions about the best use of land. Some areas may be suitable for residential and employment densification, with a greater emphasis on walking and cycling access. Others, however, will require a greater focus on feeder public transport services and private vehicles. The important point is there is no universal 'right' answer, and the best access mode will depend on context.

Outer urban interchanges, stations and stops should allow for easy access by cars

In most Australian cities, the majority of outer urban residents do not have access to high-quality public transport within reasonable walking distance. Although there are numerous measures governments can take to improve the quality and reach of the public transport network, the reality is that private vehicles will continue to be the dominant mode of transport, particularly in low-density environments, for the foreseeable future. Cars offer far greater flexibility, convenience and travel time for the majority of trips, which is why they generally average between 80% and 95% mode share in Australian cities.[75]

However, mode share statistics can be misleading because they imply a simplistic and false conflict between public and private transport. People generally use the most time and cost effective modes to travel between their origins and destinations. Private and public transport are just sub-sections of the transport network and most people frequently switch between them.

Ensuring that people can access key public transport hubs by car broadens the reach of the network substantially and makes public transport a more viable option for people who do not live nearby a station or stop. There are two main strategies for ensuring ease of access for car users: car parking and drop-off facilities.

Car parking at interchanges can help provide easy and safe transfers for public transport passengers, but is best provided on a case-by-case basis. In higher-density locations, where it is reasonable to assume most people can walk, cycle or catch an interconnecting service, providing car parks may be an inefficient use of land and generate congestion. However, in lower-density, outer suburban areas, where there are fewer people living near the transport network, sufficient

car parking capacity can be important for improving the attractiveness of public transport in regions where private vehicle use is dominant.

Commuter car parks are popular in most cities in Australia, particularly Perth. However, capacity is often low, and they often fill-up and overflow onto nearby streets. There is great potential for incentivising public transport use through providing additional car parking and the prioritisation of parking for commuters. Governments and transport operators should consider policies to introduce charges to commuter carparks that disincentivise the use of these carparks by non-commuters.

An example of such a scheme was trialled in 2018 by Transport for NSW. Dedicated park-and-ride facilities were provided at selected train stations throughout Sydney, with each offering 18 hours of free parking for anyone who completed a trip with an Opal card. At Ashfield, the first trial station, over 6,000 customers made use of the scheme in the first month, showing that there is an appetite for such services.[76] All governments should consider integration of carpark payment into electronic ticketing systems, discounts for commuters, and booking systems to prioritise parking for commuters and carpoolers.

Like car parking, drop-off (or 'kiss and ride') facilities allow passengers to access the network easily via private vehicle. These are designated zones where public transport users can be dropped off by friends and family. These zones do not have large requirements for land, and they save passengers from the added stress of having to look for parking. Governments should ensure that these facilities are readily available at public transport stations and stops, and encourage their use ahead of parking. They should make them as easy to use as possible, by locating them as close as possible to the station/stop, providing level (flat) access, and providing weather protection.

Governments should prioritise buses and on-demand transport near major interchanges

Congestion around major transport interchanges can be significant, and is compounded at peak hour on both the surrounding roads and within the transport interchange. Supporting transport services, such as feeder buses or on-demand modes, share the road network with private vehicles, and are susceptible to delays and subsequently missed connections. Poor timeliness encourages passengers to drive to their interchange instead of using feeder services, which in turn contributes to congestion levels.

Governments should proactively ensure that supporting transport services, such as buses and on-demand, are able to arrive quickly and reliably at major transport interchanges and are prioritised over private vehicles and commuter car parks when allocating space at interchanges. This will improve the experience for passengers, as they will have more predictable arrival and waiting times. Governments should consider reserving lanes and roads for buses and on-demand transport, either for the full day or during peak periods, and prioritising the movement of these services at traffic lights. Where possible, on-demand services should also have designated waiting areas to improve reliability and prevent congestion around stations. The success of these services depends on them being reliable and competitive with private vehicles, otherwise passengers will lose confidence and choose not to use them.

Journeys continue beyond bus stops and train stations to the front door – walking and cycling is key

Whether on foot, on two wheels or four, public transport passengers must bridge the first and last mile to their destinations. Walking and cycling are environmentally friendly and healthy ways to access the public transport network, and also amongst the cheapest to accommodate and should therefore be embraced.

Walking is the most popular way to access railway stations and bus stops in the inner and middle suburbs, but can be more difficult in the outer suburbs due to longer distances. Nevertheless, governments can help encourage walking access by ensuring good-quality paths, signage and lighting around public transport.

Cycling can enable people to cover longer distances relatively quickly, so it can be a useful mode of transport in lower-density areas. However, people are often discouraged from cycling because they feel unsafe riding on roads, and there are limited storage options for their bikes.[77] These issues can be at least partially overcome through better planning and well-designed public transport facilities.

Most local, state and territory governments have identified strategic cycling networks. These networks are normally a combination of segregated cycleways, cycle lanes and quieter roads that cyclists are encouraged to use. Public transport access points, particularly larger stations and interchanges, should act as focal points for bicycle networks. These networks should prioritise the safety of cyclists, including full separation from motor vehicles where necessary. To ensure continuity of cycling networks, local governments may also consider working together to develop larger regional networks with assistance from other levels of government.

Transport operators often provide bike-storage facilities at stations and interchanges. These can vary in quality, from a simple bike rack near the station to enclosed and covered cages with shower facilities. Ideally, storage will include protection from the weather, maximise security but be easy to access, be located as close as possible to the transport station or stop, and be offered for a discount to commuters as part of integrated ticketing arrangements.

Some jurisdictions also provide bike storage on their public transport vehicles. For example, in the ACT, ACTION buses often have bike racks on their front, allowing passengers to transport their bikes with them.

Furthermore, governments should support, and consider providing, on-demand bike services (such as e-bikes and bike share) at stations. This will allow passengers who do not own a bike, or are unable to bring their bike on public transport, to extend how far they can travel once they end their public transport trip. Ultimately, empowering passengers through providing information and options when they need them increases the catchment of the public transport network and improves its attractiveness.

Recommendation 4:

State, territory and local governments should improve the physical integration of the public transport network with private, active and emerging transport modes by:

- prioritising access for public transport, including dedicated drop-off and waiting areas for buses and on-demand modes near interchanges
- improving access for private transport to interchanges, including providing additional car parking where appropriate, drop-off facilities, as well as bike storage
- providing car-share, e-bike and bike-share facilities at major interchanges to support a broader range of end-journeys
- integrating active transport, including walking and cycling, through dedicated infrastructure, improved lighting and all-weather protection.

Governments should embrace change, data and technological innovation in the transport sector

The transport sector is in a state of rapid transition. Over the past decade, the way people consume transport has rapidly changed. Communications technologies have enabled access to real-time transport information, planning routes, and booking services. In addition, the emergence of car share and deregulation of ride share and point-to-point transport, such as Uber, has proven a significant market disruption. The pace of change will likely get quicker, with connected and electric vehicles now selling in Australia or available through sharing platforms, and trials of automated vehicles underway.

Future changes to the sector, and their impact on the way people travel, can be difficult to anticipate because they are largely dependent on the pace of technological change, regulatory settings and the way transport is priced. Nevertheless, in order to plan for the future needs of Australian cities, governments must anticipate future scenarios, plan to accommodate technological change and be open to its emergence.

One of the few certainties is change itself, which is why Infrastructure Australia recommended in the *Future Cities: Planning for our growing population* paper that governments adopt an outcome-focused approach to regulation that encourages the private sector to innovate, provided there is no harm to the community.

Australia's governments have historically been slow to respond to innovation and emerging services such as Uber and dockless bike-share schemes, either delaying their inevitable arrival or taking a hands-off approach that has lead to sub-optimal outcomes for the community. However, this is now changing, and governments are increasingly working with emerging operators to understand their business models and operational requirements. Governments should explore opportunities to partner with the private sector to plan for and trial new modes, models and communication tools (see **Box 9**).

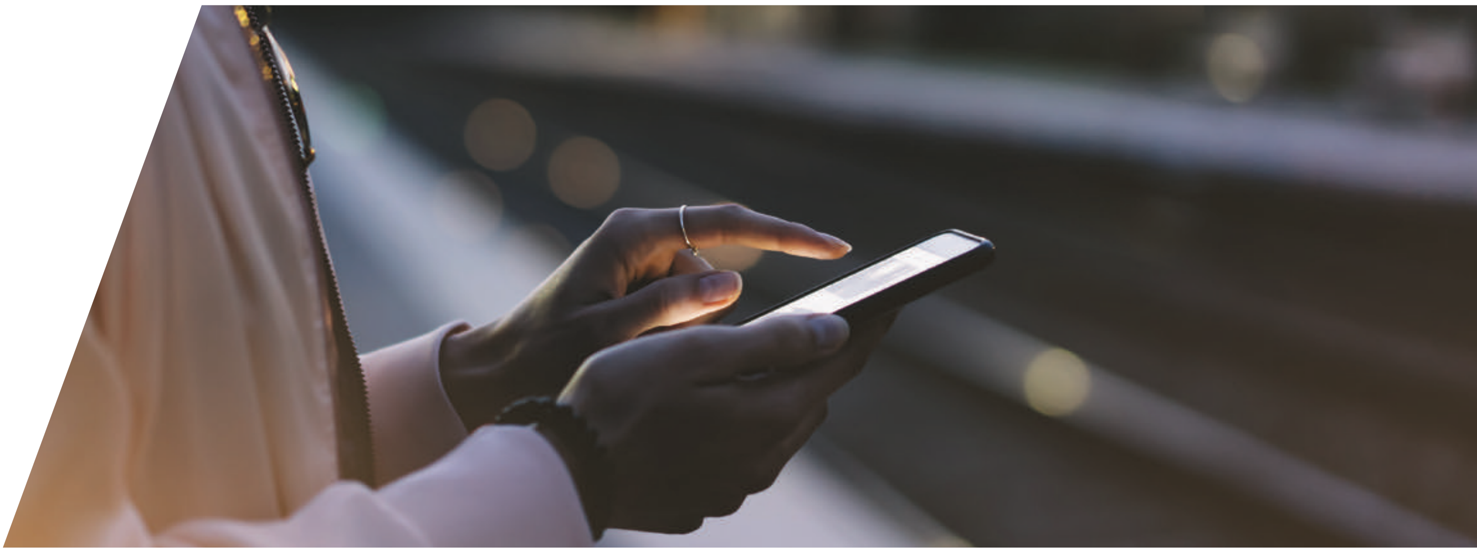
Governments must embrace open data and explore partnerships to deliver new applications

The emergence of integrated ticketing systems, connected vehicle technology and real-time traffic information has led to the creation of new sources of data that can inform transport planning, real-time journey planning and route optimisation.

Recently, transport operators have been able to combine real-time travel time data with other data, such as public transport crowding, scheduling, stop or station accessibility, and traffic, in order to provide consumers with an insight into travel times and potential delays, as well as comfort. The provision of passenger information can be a significant influence on mode choice, particularly for those who highly value access to seating, such as those with limited mobility or who travel with children.

Governments should collect, store, regularly review and proactively release datasets for use in the planning of transport services. This data should be provided to industry participants – such as local government, transport operators or planners – who could apply it in the planning, operation and innovation of transport delivery. Ideally, the data should be provided on easily accessible, open data websites. This encourages innovation by maximising the number of people who are able to access the information and ensuring third-party providers are not limited by the task of having to individually apply to government for access to information.

Governments should also seek opportunities to collaborate with third-party innovators and transport journey planners in order to facilitate an end-to-end customer journey experience (that is, planning, booking, and ticketing) through third-party applications. This approach can accelerate consumer acceptance and support acceptance of public transport by visitors to a city.



Beyond open data, open platforms are critical to support service innovation

In order for end-to-end customer journey experiences to be facilitated through third-party applications, government ticketing platforms must be open to access by third-party applications.

As closed systems, established integrated ticketing systems do not allow third-party service providers to leverage the ticketing system to expand their present suite of transport services. These barriers should be proactively removed, and government should allow third-party providers to develop direct relationships with transport users. In effect, this approach will allow governments to move from being at the centre of the transport network to being the facilitator of others, expanding choice and supporting the development of new ticketing products. Central to this will be the need to operate open systems that facilitate transactions between third parties.

For instance, the delivery of the Opal ticketing system in New South Wales has provided a common ticketing platform for customers and service providers of major public transport modes. Opal consists of three key functions: ticketing (predominantly by smartcard), access controls (for example, ticket boom gates), and a back-end system to support payment processing. Under an ideal open platform state, ticketing and access systems would be open to competition by third-party providers. The back-end system would additionally be able to accommodate the fare and ticketing hierarchies of private providers.

The first steps have been taken towards open platforms in New South Wales. For instance, ticketing on some private transport operations has recently been facilitated using the government smartcard. Contactless ticketing using third-party credit cards has also been introduced on government ferry and light rail services. Additionally, ticket processing can occur through some third-party devices, such as some EFTPOS machines.

Despite some successes, progress towards open access has been slow in all Australian jurisdictions. A patchwork of progress has allowed open access on some modes or using some devices. To accelerate progress, clear milestones for the provision of open access to third-party ticketing providers, such as journey planning applications, should be a priority.

A short-term priority should be to ensure that third-party transport providers, who may provide an essential link within door-to-door journeys in outer urban areas, have access to integrated transport ticketing systems. This may include emerging and established transport modes, such as on-demand services, car parking at interchanges, private buses and point-to-point transport operators (such as Uber and taxis).

Box 9: Government must be open to innovation

From copyright infringement to partnerships in New South Wales

While the role of big data and open platforms is increasingly accepted, this has not always been the case.

During 2009, the New South Wales Government rail operator, RailCorp, threatened a series of app developers (Grofsoft, Metro Sydney and Transit Sydney) with copyright infringement following the use of timetable information in journey planner smartphone apps.

It was not until 2012 that the New South Wales Government dropped its opposition to the work of these app developers and even eventually established partnerships for the development of additional functionality for their apps.

This experience, during the emergence of commercial applications of big data to transport, is one of the clearest examples of how opposition to open data philosophies can delay the adoption of additional functionality and applications for transport users. However, it is not unique.

Transport for NSW has since formed a series of partnerships with third-party developers, including notably the Future Transport Digital Accelerator.

Open data and systems are the stepping-stones to new subscriptions models, such as Mobility-as-a-Service

It will be important for governments to implement open systems and open data distribution in order to foster innovation and accommodate the introduction of subscription based transport models.

Presently, customers are required to transact with government ticketing systems, such as Myki in Victoria, in order to access public transport services. These closed systems provide only limited access to third-party service providers to allow payment on private transport services, such as franchise transport operators. This approach isolates other third-party transport services and therefore limits the reach of public transport systems. In outer urban areas, this can increase resistance to public transport use due to the complexity and cost associated with maintaining various tickets.

Governments should plan to allow third-party service providers to access their systems and data. Governments can then move from being at the centre of the transport network to acting as the facilitator of interactions between private transport providers and users, therefore helping to reduce the cost of providing these services.

The open access to payment systems and provision of data to facilitate journey planning are the key technology enablers of subscription models for transport, such as Mobility-as-a-Service (MaaS). The central premise of MaaS is to put the user at the centre of transport and mobility options. The transport market is fragmenting and becoming more complex, with a growing number of options for users to choose from. MaaS aims to use real-time information about modes, routes and services to help travellers get from their origin to destination using whichever mode, or combination of modes, is most effective and efficient.

The world's first MaaS solution, Whim, was established in Helsinki, Finland, in 2016.[78] Customers access Whim through their smartphone and use it as an interface to plan and pay for all modes of public and private transportation, whether it be train, taxi, bus, car share or bike share. Australian governments have acknowledged MaaS's potential – for example, the Queensland Government, which recently established a MaaS project management office.

Australia already has a range of apps and real-time information available for different transport modes, from public transport to private vehicles. MaaS aims to consolidate this information into a single interface, along with payment, personal preferences, and mobility requirements. To deliver this service, booking, electronic ticketing, and payment services must be integrated, and a diverse range of agents would need to cooperate. As these platforms evolve and incorporate greater services, service providers and operators will need to ensure that their operations, real-time data and scheduling information are seamlessly interoperable with these third-party services.

The benefits of MaaS could also extend to operators and service providers by offering improved user and demand information. This could allow them to tap into unmet demand and more efficiently allocate rolling stock, vehicles, and staff. The impacts of MaaS could be accelerated and multiplied when coupled with other emerging technologies, particularly automated vehicles. In time, on-demand transport and MaaS could potentially combine with automated vehicles to produce innovative feeder services for the trunk public transport system.

Recommendation 5:

Australian governments should openly embrace technological innovation in transport, working with third-party operators to improve the user experience.

Governments need to:

- adopt an outcomes-based regulatory approach
- improve open data distribution to facilitate third parties providing complementary services such as timetable information and integrated ticketing
- leverage open data and systems to support new subscription models for transport, such as Mobility-as-a-Service.

Effective land use and planning can help to generate demand for public transport and improve outer suburban accessibility

Low and dispersed demand for public transport in outer urban areas can make transport planning challenging and investments in outer urban networks difficult to justify, as discussed in **Chapter 1**. Integrated land use and transport planning can help to consolidate demand around transport nodes through increasing the density of housing, employment and social infrastructure and therefore drive increased patronage.

However, simply increasing densities alone is not a sufficient policy solution.

Locations for increased density must be strategically selected. Increasing density adjacent to railway stations, bus stops and transport interchanges ensures the value of existing infrastructure investment is maximised. Where increases in residential and employment densities occur, there will need to be proportionate improvements in service levels. In addition, any growth in service levels should be consistent with underlying infrastructure. For example, new residential subdivisions should include a hierarchy of roads that ensure the needs of public transport, such as buses, are taken into account.

Strategically planning density so that the urban form is integrated with transport services will ensure public transport is the most attractive option for users. This includes ensuring accessible and useable stops and stations, as well as ensuring services travel to the destinations that people need to reach.

Residential and mixed-use densities should be incrementally increased around existing stations and interchanges

The rationale for increasing densities around public transport is relatively simple – by placing housing, employment and social infrastructure near public transport, services become more accessible to more people, resulting in increased patronage.

Although the rationale is simple, the implementation can be complicated. Communities can understandably be concerned about increasing densities, and regularly raise concerns about the impact new developments will have on local traffic, parking, demand for services, the character of their suburb, and property prices.[79]

It is not enough for governments to simply re-zone land around interchanges for higher densities. Careful strategic planning at both a metropolitan and local level is required to deliver high-quality density that is supported by the range of economic and social infrastructure needed to make a place 'work'. Developments around transport nodes need to ensure that community concerns are addressed through genuine community consultation. Perhaps most importantly, a whole of government, place-based approach to planning is required, where state and local government services, such as transport, education and health, are coordinated and enhanced to be commensurate with increased housing and demand. This approach also needs to ensure the history and character of the local community is respected and retained.

Governments increasingly recognise the importance of coordinated responses when aligning infrastructure and growth. The Greater Sydney Commission, for example, has developed Growth Infrastructure Compacts, which identify areas of significant growth and then coordinate government agencies, industry and the community in developing a response. In Melbourne, the Victorian Government created the Office of Suburban Development to increase collaboration across government agencies and sectors to improve outcomes for communities. It developed six Metropolitan Partnerships, which bring together leaders from government, business and the community to develop regional plans for jobs, services and infrastructure.

These are positive developments, but aligning infrastructure and housing is a complex challenge for government. Infrastructure Australia will outline the common barriers to good planning and sequencing practices in a forthcoming research paper. The paper will also identify ways government can improve its planning, funding and governance frameworks to better cater for growth.

Recommendation 6:

Australian governments should undertake integrated land use and transport planning to examine opportunities for employment and residential densification at key sites adjacent to public transport.

Governments should:

- identify appropriate sites adjacent to trunk transport infrastructure to support densification
- develop corresponding metropolitan and local strategic plans to reflect potential for densification, including adequately assessing the capacity of existing social and economic infrastructure
- ensure that increases in density also reflect local character and amenity and are commensurate with improvements to local infrastructure and services
- establish implementation strategies and institutions with the right governance, funding and authority to ensure the planned infrastructure enhancements occur alongside densification
- for transport projects, explore the feasibility of value capture mechanisms.

Developing new suburban employment centres is a desirable yet challenging solution

Developing suburban employment centres can help to take jobs closer to where people live. In the context of outer urban public transport, it can also help to develop centres of demand, to which planners can direct higher-capacity public transport routes. In this report, this approach is treated as distinct from incremental increases in density, because it usually involves a concerted effort for a steep change in the density of employment in a specific location.

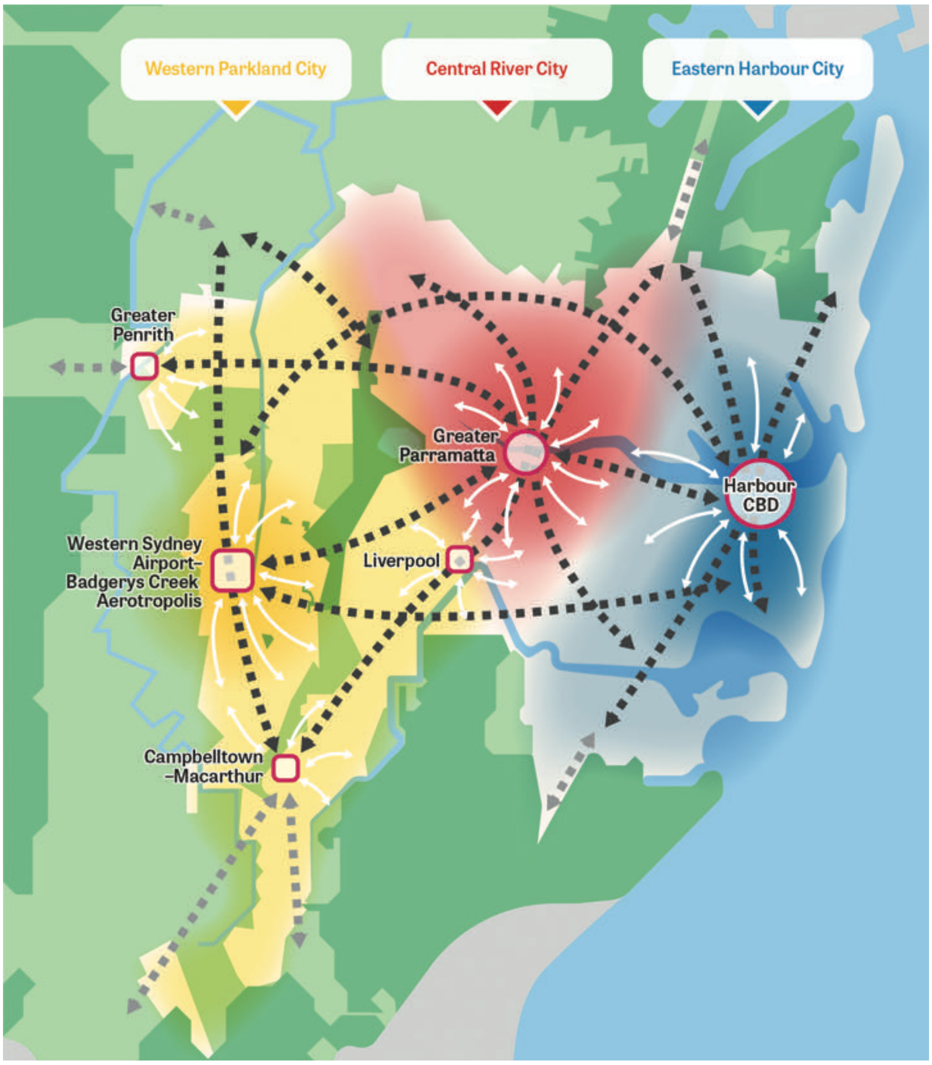
Developing and significantly enhancing suburban employment centres is a common strategy for governments. Almost all metropolitan strategies have some variation of employment consolidation in identified centres. These policies often have been pursued for extended periods and will usually involve attempts to encourage employers from similar industries to locate in a specialised employment centre.

In Melbourne, for example, state government policies to develop employment clusters, or 'activity centres', can be traced back to the 1980s.[80] The current version of Plan Melbourne identifies National Employment and Innovation Clusters, which are a small number of high-technology, knowledge-intensive activity centres that form the basis of polycentric city clusters.[81]

Perhaps the most ambitious example is the Greater Sydney Commission's Three Cities Plan. The strategy aims to build on the strength of Sydney CBD and Parramatta as its 'Eastern' and 'Central Cities', respectively. However, they also plan to develop a new 'Western City', which will have at its heart the forthcoming Western Sydney Airport as its main employment centre. **Figure 31** shows the strategy's three employment centres.

The development of a new airport and its associated freight, services and logistics industries is a rare opportunity. Backed by very significant government investment, it is projected to create 48,000 jobs by 2041, and this airport precinct is likely to substantially change employment patterns in Sydney.[82]

Figure 31: The Three Cities Plan, Greater Sydney Commission



Moving jobs closer to people can improve liveability, productivity and the efficiency of transport networks

The consolidation of employment into suburban centres can have numerous benefits. On average, people will live within 35 minutes of their workplace (see **Box 10**). This means that an over-reliance on single centres, such as CBDs, can place significant restrictions on people's ability to choose where they live. Additionally, the finite transport infrastructure servicing these centres can struggle to meet demand during peak periods. Developing well-planned suburban employment centres may therefore provide numerous benefits to a city, such as:

1. **Improving access to jobs.** The key economic advantage of cities is accessibility. They provide easy access to a broad range of skilled labour for employers, while also allowing access to jobs for people. A healthy labour market will maximise accessibility and therefore efficiently match people's skills with jobs.
2. **Improving spatial equity.** When a city is overly reliant on a single, high-skilled centre such as a CBD, it can lead to significant increases in land values within 35 minutes of that centre. This means inner-city areas become unaffordable to lower socio-economic groups, and further restricts people's freedom of movement. Developing high-skilled jobs in suburban centres can also help to distribute higher-income residents more evenly across a city.
3. **Improving access to amenities.** Well-planned centres are not only about employment. They also include important social infrastructure, amenities and access to leisure activities.
4. **Improving the efficiency of public transport systems.** Developing centres along existing public transport networks can help to improve the efficiency of their operations. Mono-centric cities that are supported by radial networks will suffer from 'peaking'. This means there can be heavy one-way demand in the peaks, but very few passengers heading in the opposite direction or outside of peak periods. A more efficient use of infrastructure, and one that supports further investment, would be to have passengers travelling in both directions throughout the day. Suburban centres can help to concentrate demand for public transport outside of the city centre.

Such benefits have made developing suburban employment centres a widely adopted policy solution for governments. However, these policies have limitations. They often follow rather than create investment, have relatively little impact on transport patterns at the scale of the city, and can encourage urban sprawl. It is therefore important that governments have a clear and transparent policy framework for their development.

Developing suburban employment centres is not a silver bullet – governments must be clear about their policy goals

Although suburban employment centres can deliver significant benefits in accessibility and liveability, governments will need to decide their viability on a case-by-case basis. The first step in this process is to be clear about the policy reasons for establishing new employment centres.

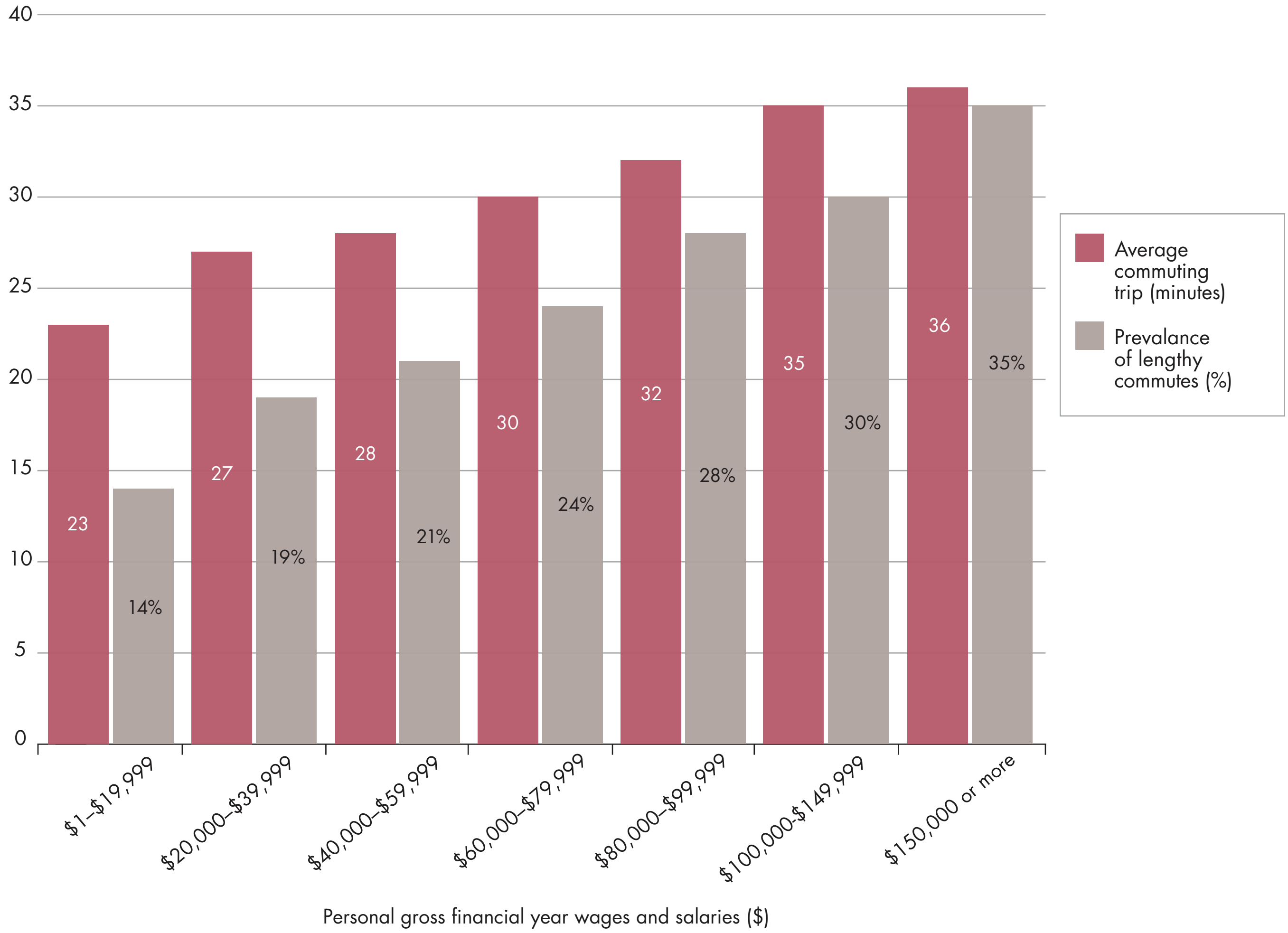
People choose where to live and work based on a complicated mix of factors such as social ties, housing markets, family structure, education, income, transport and other individual lifestyle preferences. Creating suburban employment centres may help to achieve a geographic balance between jobs and housing, but this is not an end in itself because there is no guarantee that people will choose to work at their local employment centre.

In other words, the complexity of people's personal preferences can serve to undermine well-intentioned policy goals. For example, there are some important goals that the development of new suburban employment centres are unlikely to assist with:

1. **New employment centres are unlikely to improve travel times for lower socio-economic groups.** A common misnomer is that people from lower socio-economic backgrounds are forced to travel longer distances to work because of higher land values closer to the city centre. By this logic, creating suburban employment centres would help to address disadvantage by lowering commute times. However, a recent study by the Bureau of Infrastructure, Transport and Regional Economics (BITRE) shows that average commute times increase with incomes.[83] This is because people on lower incomes are more likely to work in local centres, while higher-paid workers are more likely to travel significant distances to the CBD or other 'high-value' employment centres (see **Figure 32**).
2. **New centres are unlikely to significantly reduce average journey to work times.** Average commute times generally increase with the size of a city until they reach a maximum of about 35 minutes each way – a 70 minute round trip (see **Box 9**). This trend is generally consistent across advanced economies and reflects the fact that people choose to live within a certain travel-time 'budget' of their work. Once that budget is exceeded, they will generally move house or change jobs. Equally, if new transport infrastructure is built or jobs are moved closer to people, it frees workers to move further away, a pattern which was perhaps best illustrated with the urban sprawl associated with the widespread adoption of cars from the 1950s.

Transport and planning outcomes can often be counter-intuitive. Governments therefore need to have a clear understanding about why they are encouraging new suburban centres. This starts with a clear definition of what the problem is and how this policy solution will address it. High-level assertions about equity and economic development should not form the basis of government policy. Goals need to be clearly defined, measurable and frequently assessed.

Figure 32: Average commuting trip time and prevalence of lengthy commutes by income, Australian capital cities, 2016



Note: Lengthy commutes are defined as one-way trips of 45 minutes or more.

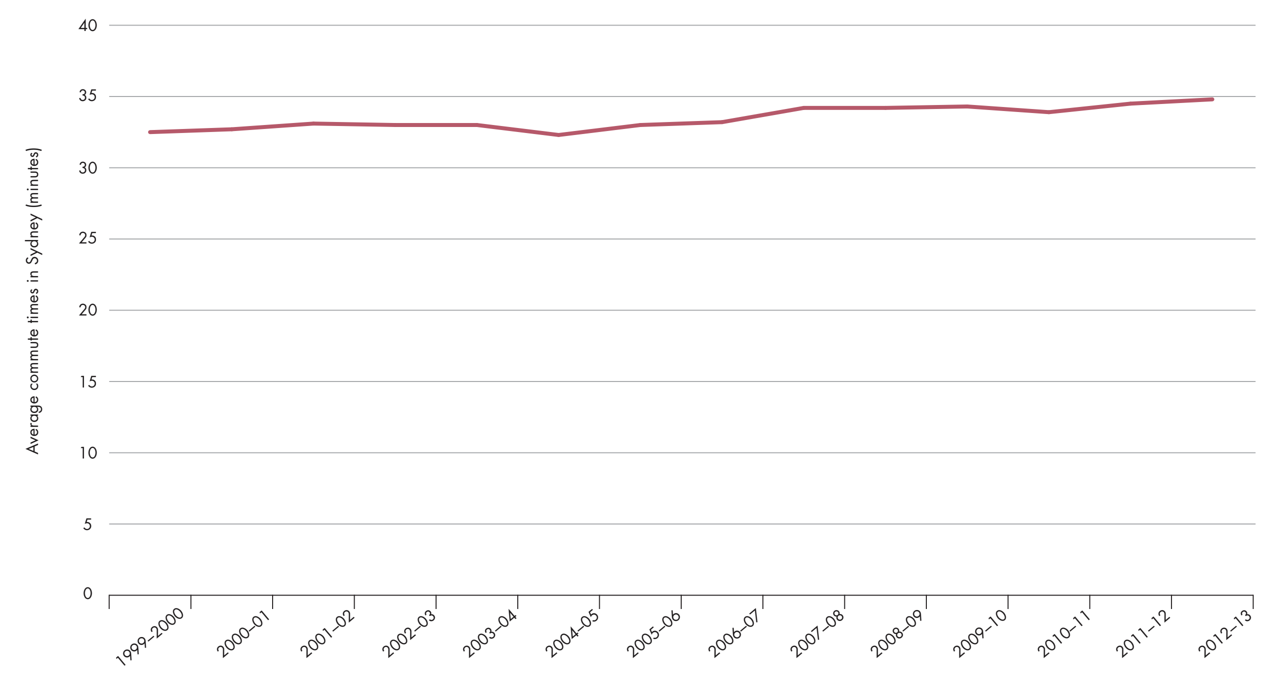
Source: Bureau of Infrastructure, Transport and Regional Economics (2016)[84]

Box 10: Commute times and the size of cities – Marchetti's constant

Cesare Marchetti was an Italian physicist who studied journey times and argued that for repeat and consistent journeys – such as commuting to work – people will have a 'budget' of about 1 hour and ten minutes each day (35 minutes per direction). After that, the perceived cost of the journey rises steeply, and so becomes rare quite quickly. This is supported by extensive evidence both in Australia and overseas, which shows average commute times will generally increase as a city grows, but will plateau once it reaches about 35 minutes. Commute times do not continue to grow as a city gets bigger, because once a certain travel 'budget' is reached, people will either move house or change jobs to lessen their commute to an acceptable level.

Sydney is a good example of this trend. It is Australia's largest city and has the longest average commute times. However, after reaching about 33 minutes at the start of the century, there has not been further significant increases (see **Figure 33**). It is important to note these are average times only, and there is significant variability depending on the mode. Continuing the Sydney example, the dominant mode of transport is cars and there is very little variation in average car commute times across the Sydney Greater Metropolitan Area (about 25–27 minutes). However, for public transport, average commute times vary significantly, from about 46 minutes in inner Sydney to 77 minutes in the outer suburbs.

Figure 33: Average commuting trip time, Sydney, 1999–2013



Source: Bureau of Infrastructure, Transport and Regional Economics (2016)[85]

Attracting jobs to new suburban centres is a significant policy challenge

In most cases, suburban employment centres will not have the same scale or degree of government expenditure as Sydney's 'Western City'. With smaller centres in particular, attracting employers can be difficult because it often runs against prevailing market conditions.

In recent decades, the focus of our urban economies has shifted away from manufacturing and towards more knowledge-intensive and service sectors. Employers in these sectors tend to centralise, usually at high densities, in CBDs and specialist centres.[86] This is because service sector and high-skill jobs are more likely to benefit from being physically near each other. They will often provide services and markets for each other as well as compete for high-skilled labour and resources. Locating in city centres also means these businesses will benefit from Australia's radial public transport networks, which provide access to each city's labour force. An opportunity for outer urban public transport is to better link specialist centres.

The benefits for businesses of being near each other is called 'agglomeration economies', and can be so significant that businesses are willing to pay the high rents associated with being based in the city centre. Moving employers away from CBDs and attracting them to smaller suburban centres can therefore be challenging, particularly if the move will mean they forgo the benefits of agglomeration.

It is also important to remember that despite the recent growth in inner-city jobs, the vast majority of jobs in every city remains outside the CBD. In Melbourne, for example, about 33% of jobs are in Inner Melbourne (the CBD and inner city), while the rest are distributed fairly evenly across the rest of the city.[87] There are various reasons an employer may choose to base itself outside of a major centre. For example, a lot of 'population-serving jobs', which range from doctors and teachers to service station and supermarket workers, are necessarily based in areas that serve population catchments. In other words, they benefit more from being close to people than to other businesses.

In addition, some industries, such as manufacturing, transport or logistics, often require large amounts of land and therefore base themselves where this is available and relatively cheap. Finally, the high rents in major centres are often unaffordable for employees, particularly for smaller businesses.

Consolidating these dispersed jobs in suburban centres can be even more difficult than attracting the jobs that are based in the inner city. Policymakers therefore face significant challenges when trying to develop suburban centres and, as a result, progress is often slow.

Despite the challenges, there are examples where the development of new centres has been successful. These normally require one or a combination of the following:

1. **Good public transport links to employment centres.** This helps to improve access to the labour market for employers,replicating one of the key benefits of being based in the CBD.
2. **Good public transport services within employment centres.** Low-density employment centres, spanning large areas, require internal transport connections to allow workers to travel from the public transport node to their place of work. Developers are often required to provide this service. Other options include ride-sharing, such as Co-Hop in Sydney's Macquarie Park, and corporate buses.
3. **Specialisation in specific, targeted sectors.** Focusing on specific sectors helps generate agglomeration economies for businesses. Suburban centres will inevitably be smaller than the CBD, so may need to focus more narrowly on specific industries rather than relying on the scale of activity and business relationships that occurs in the city centre (see **Box 11**).
4. **Strategic location and use of land.** Successful employment centres are usually located in areas that suit the specific needs of the particular industry. For example, trade and industrial centres are more likely to be established in areas away from residential land use and near key freight networks.
5. **Active role for government.** Some employment centres develop organically, with minimal interference from government. However, if government decides it would like a specific location to become an employment centre, it should be prepared to take an active role in establishing the right conditions to attract employers. This can include a broad range of measures, such as providing infrastructure, amenities, appropriate zoning, and providing fiscal incentives for tenants (which should always be subject to a robust business case).

Recommendation 7:

Australian governments should support the development and growth of suburban and outer urban employment centres to improve job accessibility.

In planning for new centres, governments should:

- be clear and transparent about their role and policy objectives – milestones for growth should be clearly defined, measurable, and frequently assessed
- identify the appropriate sectors to target and specific roles for government and partners, including the development of specialised knowledge precincts
- identify the supporting infrastructure requirements, particularly transport to and within employment centres.

Box 11: Universities and hospitals can act as knowledge job anchors outside of CBDs

The role of universities in attracting businesses from CBDs has been a focus for urban planners and governments over recent years, and with good reason.

Macquarie University in Sydney, Griffith University on the Gold Coast, and Wollongong University in New South Wales, among others, have successfully developed highly skilled workforces and attracting business from established CBDs.

The success of these universities in attracting employment has been complemented by the availability of high-quality public transport services to their precincts, access to lifestyle services (such as hospitality and retail), the availability of land for commercial development, and the potential for local residential development.

Acceleration in the growth of knowledge jobs around each of these universities has occurred following the establishment of medical faculties, particularly teaching hospitals. The Fiona Stanley-Murdoch Health and Knowledge Precinct, located 12 km from the Perth CBD, is expected to grow to 1,200 dwellings for 2,400 residents, employment for 35,000, as well as 45,000 m^2 of health, retail and commercial space. The precinct is served by a bus and rail interchange.

Conclusion

Our cities are growing rapidly, and so the delivery of efficient and effective public transport networks is critical. Most governments are responding to the challenge of growth with significant public transport investments. Billions of dollars are being spent, with all levels of government acknowledging the importance of public transport networks to the health and productivity of our cities.

However, the outer suburbs of our cities have demonstrably poorer public transport than the inner and middle ring suburbs. Public transport in outer urban areas is typically characterised by lower service frequencies, lower levels of accessibility, and longer travel times.

The case for improving public transport in outer urban areas is clear, however the solution is not always straight forward. Traditionally, governments have relied on increases to passenger numbers to support a strong business case for further investment in infrastructure or additional services. This has rightly led to public transport investment being centred on corridors where there is most demand.

However, this approach means lower-density outer urban areas have received less public transport investment. Public transport is often an uncompetitive option in these areas, and private vehicles are usually the preferred choice.

In the absence of high-quality public transport options in the outer suburbs, a cycle of policy challenges develops for governments. Due to lower service levels, accessibility and entrenched car use, there is often lower levels of ridership on existing public transport services. This in turn leads to lower cost recovery for governments, meaning it is more expensive for them to operate services in the outer suburbs. Investment in new infrastructure or service upgrades then becomes harder to justify, which reinforces poorer service levels and low ridership.

This paper has focused on measures that can help to break this cycle. Governments need to ensure public transport operates as a coordinated network, rather than as a series of individual routes. Through smart network design and encouraging interchanging, we can expand the reach of our networks, meaning they are more useful for passengers and operate more cost effectively for government.

It is also critical to ensure public transport networks are accessible by private vehicles and active transport, such as walking and cycling. Lower urban densities mean people are less likely to live near public transport stops and stations. That means the ‘first and last mile’ of people’s trips, from their home to the stop or station, is critical.

To be competitive in low-density environments there needs to be a focus on making it as easy as possible to access public transport.

Public transport networks do not exist in isolation, but form part of complicated urban fabrics. They therefore need to be integrated with land use. It is important that land around existing transport infrastructure, stops, and interchanges is used efficiently. This may mean increases in residential and employment densities at strategic locations – provided developments are sensitive to the needs of the local community.

There is also a case for governments to attract more jobs to centres in the outer suburbs. In doing so, governments need to be clear and transparent about their goals and will normally have to play an active role in developing new centres. Developing suburban employment centres is a challenging policy space and has a mixed history in Australia. However, if it’s done well, it could help to re-balance our cities, improving accessibility in the outer suburbs and also justifying further public transport investment in these areas.

New technology, greater availability of data and the emergence of new trends in shared consumption also offer the opportunity to improve accessibility in low-density settings. Ride-share and on-demand services can be particularly effective in catering for passengers who live or work in areas of low ridership. These services are more flexible than traditional public transport, with the rolling stock and service levels scaled to match demand.

Governments have a broad range of policy options available to them for improving public transport in lower-density outer suburbs. As our cities grow and expand, governments will need to look at all options to ensure future generations have access to the jobs and the crucial services they require.

Appendix – Methodology

Public transport network analysis

Geographical data

The sector and capital city boundaries were taken from the Australian Bureau of Statistics's (ABS) Australian Statistical Geography Standard (ASGS). The ASGS comprises a hierarchy of geographical structures. The structures used for this analysis were:

- 2016 Greater Capital City Statistical Area (GCCSA): the socio-economic extent of the capital city
- 2016 Statistical Area Level 2 (SA2): a large suburb or a collection of small suburbs, with populations ranging from 3,000 to 25,000
- 2016 Mesh Blocks: the smallest geographic region in the ASGS, with most residential Mesh Blocks containing approximately 30–60 dwellings.

Each capital city boundary was taken directly from the GCCSA structures. Then, each sector was established by allocating SA2 geographies within these GCCSAs as 'inner', 'middle' or 'outer'. As a small number of SA2s were geographically large, they were split between sectors – for example, Fremantle SA2 was allocated to Inner Perth, but also contained Rottnest Island, which was split and allocated to Outer Perth.

While GCCSAs are geographically extensive, large parts of the outer sectors have very low or no population (such as national parks). In assessing the performance of our public transport networks, most of our metrics are weighted by population. This means the metrics for the outer sectors more closely reflect the experiences of people who live in established suburbs rather than peri-urban or rural residents.

Population data

Population figures were calculated using the ABS Estimated Resident Population (ERP) for each SA2 as of 30 June 2016.

Public transport network data

The public transport network datasets (bus, tram/light rail, ferry, and train services) for each city were extracted from the General Transit Feed Specification (GTFS) data that was available for the timetables that were in effect between April and June 2017.

This was performed by GTA Consultants.

Infrastructure Australia acknowledges that jurisdictions have since changed and upgraded timetables.

Public transport service frequency

Public transport service frequencies were calculated by GTA Consultants using 'BetterBusBuffers', an add-in tool to Esri ArcGIS.[88]

This was performed for the timetables that were in effect between April and June 2017. The date ranges vary for each state and the GTFS is managed slightly differently with the data and date ranges from each state transport agency. The weekday analysis was conducted for a Wednesday and the weekend for a Sunday. AM peak period was set to 8 am to 9 am, while off-peak was set to 11 am to 12 pm.

This tool counted the number of services that visited each stop/station during the selected time window. Stops/stations with 12 services or greater (travelling in at least one direction) were designated as 'high' frequency, four to 11 services was designated as 'medium' frequency, and four services or fewer as 'low' frequency.

It is important to note these definitions were developed for this study only and jurisdictions have their own internal definitions regarding service frequency. Infrastructure Australia does not intend for these results to be compared to each state's own standards.

Walking access to public transport

Walking access to public transport was initially calculated by GTA Consultants using 2011 population data, then updated by Infrastructure Australia using 2016 population data.

All public transport stops with 'medium' or 'high' frequency during weekday AM peak were selected. Walking catchments around each stop were generated, with a radius of 800m for heavy rail stations and 400m for all other stops.

Any ABS 2016 Mesh Blocks that intersected with any of these catchments were designated as being within walking distance. The percentage of people within walking distance was calculated at SA2 level by dividing the sum of 'Mesh Block Counts' (Mesh Blocks within walking distance within the SA2), by the sum of 'Mesh Block Counts' of all Mesh Blocks within the SA2. The number of people within walking distance was calculated by multiplying this percentage by the population of the SA2, taken from the ABS ERP as of 30 June 2016.

Infrastructure Australia acknowledges there are limitations to this analysis, which result in an overestimation of the percentage of people within walking distance. This is due to:

- using geometric distance to calculate catchments, which do not take into account road network and topographical constraints
- counting whole Mesh Blocks, which means that individual dwellings that are beyond walking distance, but are in a Mesh Block that is partially within walking distance, are included in the calculation.

Additionally, Infrastructure Australia acknowledges that 'Mesh Block Counts' are an imperfect measure of population, as they do not capture people who were not counted in the Census. As such, they were only used to calculate the percentage of people within walking distance, which was then multiplied by the ABS ERP for each city sector to produce a more accurate measure of people within walking distance.

Despite these acknowledged limitations, the analysis is sufficient to identify high-level patterns within and between cities with the aim of making policy recommendations. Infrastructure Australia does not intend for these results to be compared to each state's own standards.

Travel times

Travel time contour mapping was conducted by GTA Consultants using Route360,[89] an online service that uses Google Maps API. This was performed for a range of destinations for each city, using timetables that were in effect between April and June 2017. This used the GTFS data in-built within Google Maps to calculate the indicative public transport journey times during weekday AM peak.

ABS 2016 Census of Population and Housing analysis

Distance to work

Distance travelled to work data were extracted from ABS TableBuilder Pro, using the following parameters:

- Counting employed persons (aged 15 years and over).
- Custom geography for Place of Work (for example, 'Inner Sydney', 'Outer Perth', 'Middle Brisbane').
- Custom geography for Place of Usual Residence (for example, 'Inner Sydney', 'Outer Perth', 'Middle Brisbane').
- Distance to Work (DTWP) – 4 Digit Level (for example, '1 km to less than 1.5 km', '11 km to less than 12 km', '27 km to less than 28 km').

The custom geographies were configured by uploading a table containing mapping of SA2s to inner, middle and outer sectors to ABS TableBuilder.

The DTWP variable is a new variable introduced in the 2016 Census.[90] This is a measurement of the distance travelled between a person's Mesh Block of Usual Residence and Mesh Block of Place of Work. The 4 Digit Level is the most disaggregated level of detail published by the ABS.

Public transport mode share

Journey to work data were extracted from ABS TableBuilder Pro, using the following parameters:

- Counting employed persons (aged 15 years and over).
- Custom geography for Place of Work (for example, 'Inner Sydney', 'Outer Perth', 'Middle Brisbane').
- Custom geography for Place of Usual Residence (for example, 'Inner Sydney', 'Outer Perth', 'Middle Brisbane').
- Method of Travel to Work (MTWP) – (for example, 'Train', 'Car – as driver', 'Walked only').

The custom geographies were configured by uploading a table containing mapping of SA2s to inner, middle and outer sectors to ABS TableBuilder.

The MTWP variable records up to three methods of travel to work on the day of the Census. In our analysis, we do not assign a hierarchy of modes, so one mode does not take precedence over another. For instance, employed persons who drove their car to their local train station in order to ride a train will be counted in both the Public Transport mode share and the Private Vehicle mode share. This differs from most other analyses, which only count this in the Public Transport mode share.

Car ownership

Household car ownership data were extracted from ABS General Community Profile DataPack table G20 at SA2 level, and was aggregated to sector geography.

ABS 2015–16 Household Expenditure Survey analysis

Household expenditure data were acquired from ABS through a custom data request using the following parameters:

- Mean weekly household expenditure.
- Custom geography (e.g. 'Inner Sydney', 'Outer Perth', 'Middle Brisbane').
- Selected ABS household expenditure categories.

The following ABS cost categories were used to generate the average weekly household expenditure on operating vehicles and their proportions relative to the total weekly household expenditure:

- Motor vehicle fuel, lubricants and additives.
- Vehicle parts, servicing and crash repairs.
- Parking fees.
- Road tolls.
- Total goods and services expenditure.

Table 6 shows cost estimates and relative standard errors, as reported by ABS, for each expenditure category used in the analysis.

Infrastructure Australia acknowledges that a small number of survey estimates in these cost categories had standard errors between 25% to 50% and should be used with caution. However, the largest single factor in vehicle operating costs (motor vehicle fuel, lubricants and additives) consistently carried small standard errors. The second largest factor (vehicle parts, servicing and crash repairs), has larger standard errors, but only four estimates with standard errors in the 25% to 50% range. Overall, these figures do not distort the analysis undertaken.

Table 6: Estimated average weekly household expenditure and relative standard errors by expenditure category and by sector, all five cities, 2015–16

		TGSE		MVFLA		VPSCR		PF		RT	
		Estimate ($)	RSE (%)	Estimate ($)	RSE (%)	Estimate ($)	RSE (%)	Estimate ($)	RSE (%)	Estimate ($)	RSE (%)
Syd.	Inn	2,127.4	11	25.7	12	29.6	**42**	4.9	**38**	4.2	**33**
	Mid	1,526.2	6	41.5	7	27.0	16	2.2	17	2.5	**31**
	Out	1,580.3	4	51.1	5	25.9	13	2.3	14	4.6	18
Mel.	Inn	1,591.4	6	25.7	10	21.0	**44**	5.0	**33**	2.5	24
	Mid	1,542.8	4	41.6	5	32.7	13	4.3	13	1.8	23
	Out	1,373.1	3	53.1	4	31.1	18	3.6	14	3.5	15
Bris.	Inn	1,672.3	7	33.7	13	26.3	**37**	7.5	**31**	3.1	**48**
	Mid	1,507.5	4	45.4	8	26.0	18	3.8	20	2.8	24
	Out	1,343.7	5	56.2	9	21.8	15	2.3	23	3.4	**33**
Ade.	Inn	1,348.2	7	32.5	11	19.2	24	4.2	**37**	0.0	–
	Mid	1,248.4	5	33.1	5	19.1	22	3.5	19	0.0	–
	Out	1,266.1	5	44.0	6	31.1	18	3.7	**29**	0.0	–
Per.	Inn	1,576.2	9	39.4	10	26.9	**48**	3.4	**29**	0.0	–
	Mid	1,269.1	4	37.1	8	23.7	24	3.8	18	0.0	–
	Out	1,461.3	4	52.3	6	40.3	19	2.7	23	0.0	–

Note: Relative Standard Errors (RSEs) over 25% are bolded. TGSE – Total goods and services expenditure (excludes expenditure derived from non-cash benefits from employer provided vehicles and car parks), MVFLA – Motor vehicle fuel, lubricants and additives, VPSCR – Vehicle parts, servicing and crash repairs, PF – Parking fees, RT – Road tolls.

Source: Australian Bureau of Statistics (2017)[91]

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Outer Urban Public Transport

Improving accessibility in lower-density areas

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Infrastructure Australia
Level 21, 126 Phillip St
Sydney NSW 2000 Australia
T +61 2 8114 1900
E mail@infrastructureaustralia.gov.au
W infrastructureaustralia.gov.au