



**LOW CARBON LIVING
CRC**

RP 2021 Greening Suburban Travel

Interim Report on (sub) urban travel demand analysis



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Greening Suburban Travel

Current situation and trends in (sub) urban travel demand analysis

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Background

From the end of World War Two, the use of public transport in Australian cities declined as the automobile industry grew and car ownership increased rapidly. Over time the car has evolved beyond being a means of transportation into being a subject of interest and a cherished part of their lifestyle for many people (Bureau of Infrastructure Transport and Regional Economics 2013). In Australia, the car population is growing faster than the human population, and more than 90 per cent

of Australians live in a household with access to a car. Traffic congestion has become a major problem, particularly in urban areas: Figure 1 shows that congestion levels are increasing by 2 to 4 per cent annually. Due to this congestion, private vehicle users are spending more time on roads. Bus patronage is generally weak around the country, to some extent because of the growing levels of congestion. Efforts must be made to shift at least a small percentages of car trip users to public transport to address this problem. This report's objective is to analyse and understand the current travel demand.

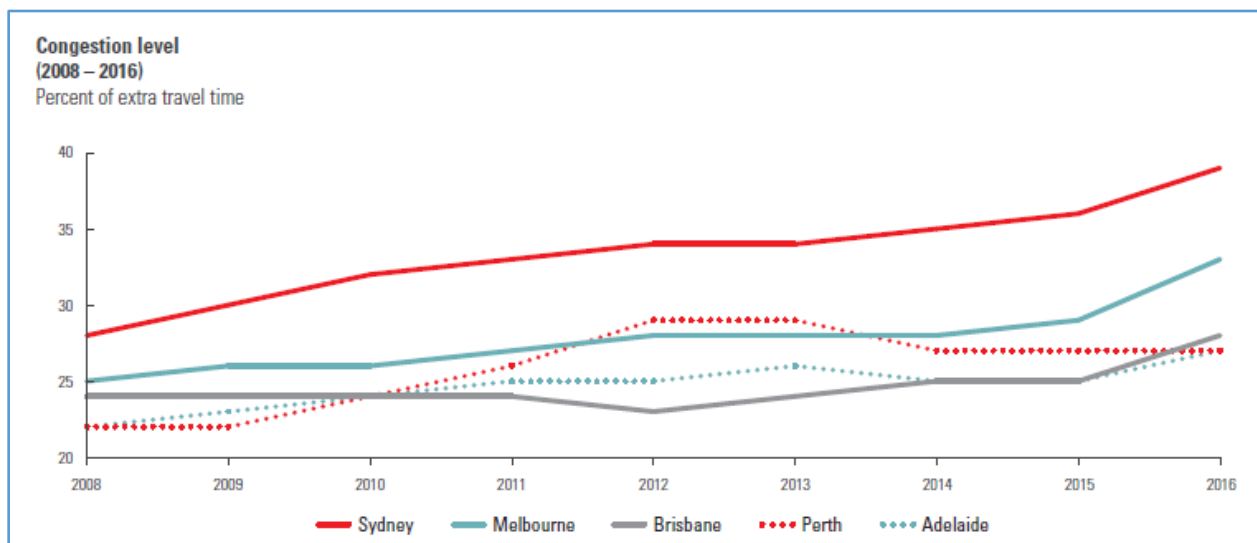


Figure 1: Congestion levels in key Australian metropolitan cities (TTF & LEK Consulting, 2018)

Given the low patronage of public transport, it is difficult to justify service improvements, and it is only natural that government agencies tend to reduce rather than enhance public transport services. This exacerbates people's shift to driving as public transport became less and less convenient or, indeed, available. Recently efforts have been made to stop this cycle as the social and environmental ramifications of cars, and their contribution to air pollution are now increasingly evident. Moves are now taking place for society to be less automobile-dependent and to seek the advantages of being fit or active by undertaking, for instance, regular walking, which will cut mortality by about 20%.

The majority of Australians believe that we should be doing more to reduce our environmental impact. However, In Australia, 72.4% of all kilometers driven in the 12 months to October 2014 were in privately owned passenger vehicles (ABS 2015) ,with an average fuel efficiency of 10.7 L/100km. With an average of bus fuel efficiency of 28.8L/100 km, there is a net fuel saving if only three people who would normally drive ride the bus instead. Rail vehicles (trains and trams) are not only faster than buses but more efficient too, due to the low friction of steel wheels on a steel rail. Transport NSW (2017) reported that greenhouse gas emissions per passenger kilometre for rail transport is up to five times less than that of car transport. Walking and cycling are even better for the environment as they require a much narrower paved surface than cars and there is no fuel combustion.

Why do only about 12% of people choose to commute by public transport or active transport (walking or cycling)? The answer is that our

beliefs do not necessarily determine our actions (Heberlein 2012). If informing people is not the answer, how can their behaviour be influenced? Several methods have been tried, ranging from large network changes like those in Portland Oregon, where the community has a high-frequency grid for bus routes (Walker 2015), to small temporary changes like giving habitual drivers in Kyoto a free one-month bus pass to try and instil a new habit (Fujii & Kitamura 2003). In both cases, some success has been noted but only to a small degree. Can we reduce people's car dependence by making driving more difficult or expensive? In isolation, this is not possible, given the political or economic repercussions that would ensue, but combining it with improved public transport could offer a significant gain in public transport patronage (Wegener 1996).

For instance, in Stockholm, Sweden, a congestion charge was introduced in conjunction with public transport service improvements (Heberlein 2012). While there was an initial reluctance to change, this was overcome because the improved public transport services could accommodate the trips previously undertaken in cars. Cities in different countries vary substantially in many ways: in physical form, size, function and collective attitude. People's attitudes have to be changed to recognise the importance of doing things differently before changes can actually occur. In the example above, the congestion tax was more or less accepted by the people since Swedish people are generally understanding of the need for the public good, and it has been demonstrated that their tax money flows back to them in the form of government services. Would the same be true in Australia? Where Australian passengers are concerned, needing to change

how they undertake their journey is a considerable problem, especially for commuters. In Adelaide, South Australia, public transport has less than 10% of the share of work-related trips, and of these only 29% require a vehicle change. In London, 44% of all underground journeys require a transfer (Guo & Wilson 2011), so clearly, something is different. Most often the difference is cited as density, given that London is far bigger than Adelaide and indeed all other Australian cities.

Density may well have an impact, but it does not seem to be the governing factor in cities around the world with similar sizes and densities as Melbourne, which has a significantly higher share of public transport than other Australian urban centres. This is because users are attracted to using high-quality services. For instance, In Vancouver, development strategy prioritised public transport and other service improvements very early, recognising that changes in urban density and form are slow processes, but that people can take advantage of improved transport immediately (PTUA 2016). Some efforts have been made to explain the explosion of car travel in recent decades but while a lot is known about the differences between private and public vehicle travel, what exactly do people mean by convenience? It is possible people are referring to faster travel, greater flexibility, or higher service frequency (for example, anytime departure). Several years ago, a Brisbane-based study (Buys & Miller 2011) found that a combination of these physical factors and several psychological ones were required to describe convenience. However, due to the nature of this particular study, it was impossible to quantify how much

impact these individual factors had on people's choices of travel mode.

Perception of the options offered by public transport is of great importance; but what drives it? Transit maps play a large part in selling a network to new users. It is known that these maps are distorted for the sake of simplicity. Problems with this approach were only discovered recently when passengers in London were observed taking less than ideal trips because they looked better on the schematic map which many travellers use to navigate (Guo 2011). In all Australian cities attempts have been made to improve schematic maps, but many of them are still not user-friendly. This is predominantly because cities' suburban areas are now so huge that fitting it all on a single schematic is at worst unfeasible and at best very challenging.

Other studies have indicated that reliability and punctuality have a great impact (Metro 2016; Nankervis 2016) on the willingness to use public transport. A small deviation from perfection can generate an angry response, indicating that day-to-day variability in travel time has a great impact on people's perceptions of a public transport service. For example, in Adelaide, all transit modes were operating above 91% in terms of punctuality. It seems people put great faith in printed material in general, with transit maps and timetables considered public transport gospel. In contrast, providing travel time information to drivers is a much newer concept with Google Maps making this possible from 2007 onwards (CrackBerry 2007). As well, Addinsight, which is a system providing Adelaide drivers with information on their phones and via roadside

signs at strategic locations, came online in early 2016. This information is fairly variable, and drivers are not as likely to have a strong attachment to an exact time of arrival.

Walking is a socially inclusive and carbon-neutral form of transport with great benefits to the individual's mental and physical health (Arup 2016). What it lacks, however, is speed. To overcome, this walking can be combined with fast, reliable public transport. In the context of car vs public transport choice, some research from the Netherlands (van Exel & Rietveld 2010) suggests that if a public transit trip has a total door-to-door travel time of 1.5 times more than driving, it begins to appeal to potential passengers and offers some competition. Is this applicable in the Australian context? The evidence says yes, in that if you go below a unity ratio, in other words where public transport is actually quicker, the results are astounding: a good example being Adelaide's O-Bahn busway. Similarly, the southern rail corridor in Perth, Western Australia, with trains travelling at 130km/h, has vastly exceeded all expectations (McIntosh, Newman & Glazebrook 2013).

Currently, Australia has the highest congestion costs in the world (Arup 2016) given the suburban nature of our cities; this is a difficult but hugely important issue that needs to be addressed. The literature often fails to address improvements to the suburban form, instead implying that suburbs are the enemy and need to become denser. In the Australian context, where the tendency is for new outer suburbs to be created rather than to build apartment blocks, it is important to address this. Our suburbs are not going to disappear. Although younger generations have less desire to be car-

dependent (Arup 2016), they still moving into fringe suburbs on previous greenfield sites. Walking and cycling play a huge role in the most successful cities; for example, Paris has a 48% walking mode share (Arup 2016), and this contributes to its appeal as both a tourist destination and a place to live. In a suburban context walking and cycling alone are not going to be the structural fixes they are in dense cities like those of Europe. The low density in Australia results in longer trip distances, and it is unreasonable to argue that these trips can be undertaken by the slower modes of walking and cycling. However, these and others can be used as complementary modes, enlarging the catchment areas of public transport nodes. In this way, existing nodes and their surrounding suburban developments could be geared towards achieving similar goals of sustainability and social inclusion as transit-oriented developments.

Literature review

Accessibility and transfers

Much research has been published on public transport accessibility (Malekzadeh 2015; McIntosh, Trubka & Newman 2014), although only a very few papers focus on transit as a provider of accessibility, as opposed to a service to be accessed (Yigitcanlar et al. 2007). Of those papers that address network patterns, the grid network layout (Chien & Schonfeld 1997; Walker 2012) is a popular choice as it provides the highest access to all neighbouring nodes with a minimum number of transfers. Even so, it requires passengers to make transfers to get from any point of origin to a destination. There is a deal

of research into passenger preference, and the case study by Guo and Wilson (2011) suggests that a better understanding of transfer behaviour and improvements to the transfer experience could significantly benefit public transport systems. This research suggests that there are sections of the travelling public who are more deterred by transfers than others, namely those commuting to work/school. Transfer waiting time is such a deterrent that it has been modelled at twice the time cost of travel time in Brisbane (Yigitcanlar et al. 2007). Potential users can have conflicting aims, such as the desire to get somewhere (accessibility) and the desire to do so in one vehicle. A grid network helps to resolve the accessibility issue by requiring few transfers, but when does a few become too many? One study of the Brisbane area suggested a high reluctance for passengers to choose trips requiring even one transfer (Malekzadeh 2015).

Network maps

How does the network map affect people's perceptions? Adelaide has a clear schematic map of its rail (train, tram) lines with reasonable geographic integrity made possible because it has only a few quite straight rail lines. Adelaide has a large number of high-frequency bus corridors (Go-Zones), and although a schematic map has

been available since 2012, it has not been updated or republished since then. In Adelaide a complete network map is available, but this is presented entirely geographically and is very cluttered, and tracing a proposed route is almost impossible. There is scope to improve this situation: for instance, perhaps frequency could be denoted by thickness, as has been done in Portland's maps (Walker 2015).

Melbourne, the capital of Victoria, has separate maps for each mode (bus, train and tram), and the train and tram maps are quite schematic with little geographic integrity. Interestingly, Melbourne's tram and smart bus networks incorporate both grid and radial elements on the same routes. Most prominently there are tram lines starting downtown and forming a high-frequency corridor heading south-east before splitting and turning due north at regular intervals to form grid elements. For example, routes 16 and 72 (highlighted with red and green in Figure 2) exhibit this configuration. This is perhaps an attempt to solve issues of connectivity without requiring transfers to get to the CBD. Adelaide has similar links on its bus network, although the cross-town sections very often have lower frequencies and operational hours than the downtown ones.



Figure 2 Map of Tram routes in Melbourne's South East.

Network improvements

Earlier research (Heberlein 2012) suggests that complementary changes have a much greater effect when made together. Various

methods have been suggested to improve public transport ridership and reduce the CO₂ emissions from a mobile population. As expected, these work best when they applied together: it is not enough to provide a better

public transport service, nor will congestion charging drivers more lead to systematic change.

Unlike Stockholm which does impose a congestion charge, Adelaide has a very low suburban density, and many people blame this on the low utilisation of public transport within the suburban region (Mannix, 2013). In such areas, public transport options are added only after the housing developments are completed and the residents are used to driving everywhere: it is hard to change their behaviour once the habit has been formed. Conversely, as noted by the Melbourne Public Transport Users Association, Vancouver provides public transport services before housing developments actually begin (PTUA 2016). This allows prospective residents to weigh up all transport options before committing.

While it may be tempting to build our way out of a problem, there is some evidence that this is not the best option (Mees 2014). The recent Victorian Regional Rail Link project and the upcoming Melbourne metro are huge construction projects in dollar terms, but focusing on the CBD will not provide systematic behaviour change. Instead, we must make better use of the existing infrastructure. Any large-scale solution such as increasing urban density or constructing new transport corridors is slow to implement, and improving access to, and upgrading, existing facilities might be a more effective way to achieve sustainability goals in the shortest timeframe.

For new services that are required, Bus rapid transit is well balanced for a city the size of those in Australia. This mode has medium to high capacity, reasonable route flexibility, and good speed. Where it has been implemented already, in Brisbane and Adelaide, the results have been very encouraging. In Adelaide, it was noted that there was a very firm boundary outside which bus use was low. The O-Bahn services expanded this boundary to the north-east from its otherwise generally circular form, as shown in Figure 3.

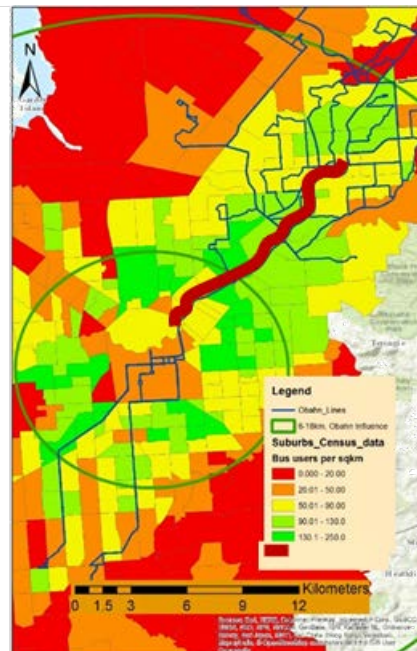


Figure 3 O-Bahn influence

Further, existing freeways could also be used between interchanges to create inexpensive high-speed transport corridors. One such potential corridor that stands out in the

Adelaide suburbs is the Port River Expressway, highlighted in orange in Figure 4. It links Mawson Lakes, a major educational and transport hub in the north, with Port Adelaide – a recreation and commercial hub that is currently being reinvigorated – to the west.

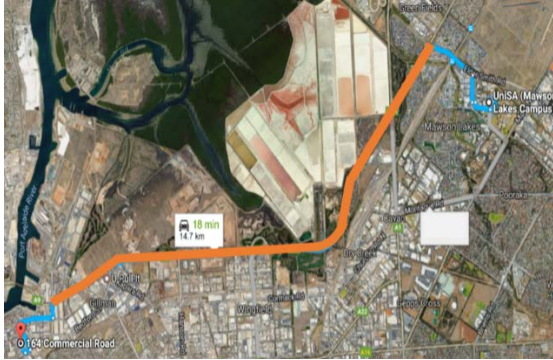


Figure 4 Adelaide's Port River Expressway

Case studies

Perth Transit Oriented Developments (TODS)



Figure 5 and Figure 6: A train on the Perth–Mandurah line and Subiaco Oval

Subiaco

- Traditional TOD
- Major Sports Ground (providing demand for off-peak services)

Mandurah line

- ✓ High frequency all day every day
- ✓ Good interconnectivity

- ✓ Exposure to road users
- ✓ Medium-high speed
- ✓ Exceeded all expectations

This southern rail corridor of Perth, with trains travelling at 130km/h predominantly down the median of a freeway, has been a great success (McIntosh, Newman & Glazebrook 2013). This rail corridor utilises distances of around 2–3 km between stations and several different development patterns to achieve its success. This rail corridor uses its position within a very car-dominated environment as an advantage. The inner stations are built within a freeway that limits pedestrian access but allows for efficient bus and car connections. The outer stations make use of bus connections and park-and-ride facilities built on the outskirts of the served community. This results in a speedy service to Perth, but more than this, the stations have the capacity to be upgraded towards conventional transit oriented developments (TODs) as the stations become hubs in their own right (Curtis 2008; McIntosh, Trubka & Newman 2014). Perth already has some experience with conventional TODs, particularly with the successes of Subiaco in the inner west (Figures 5 and 6). However, this style of development has not diverted as many trips as its catchment is much smaller (Mees 2014).

Tonsley Rail Services, Southern Adelaide

It is time public transport agencies realised the answer to falling patronage is not rationalisation but improvement so that more people are more

likely to use their services. An example of this is the Tonsley railway service in Southern Adelaide. This short branch, pictured in Figure 7, was originally built to serve a car-making factory. Earlier a low service frequency was provided as the vast majority of the traffic consisted of shifts arriving and or departing from at the factory at regular intervals. However, the low frequencies are still with us today, regardless of the line's proximity to major destinations such as Flinders University. Where the line finally ends, at a point where three major routes to the city for both cars

and buses converge, there is a huge volume of traffic and buses. While it might be presumed this would attract large passenger numbers, in reality, the opposite is true.

While the adjacent section of South Road is one of the busiest in Adelaide, Tonsley Station is one of the quietest, and this is due to its low service provision. When the line was closed entirely for adjacent upgrades, residents in the area were promised on reopening there would be a service available to them every 15 minutes. When the line eventually reopened, this was scaled back to 30 minutes across the day. Although this was an improvement over the previous hourly service throughout the interpeak period (defined as weekdays between 9 am and 3 pm in Adelaide) and certainly an improvement on no trains at all for the two previous years, it was a marked decline in the number of services in the peak periods, when trains used to run every 20 minutes. Use of this service is not going to increase unless the service improves significantly.

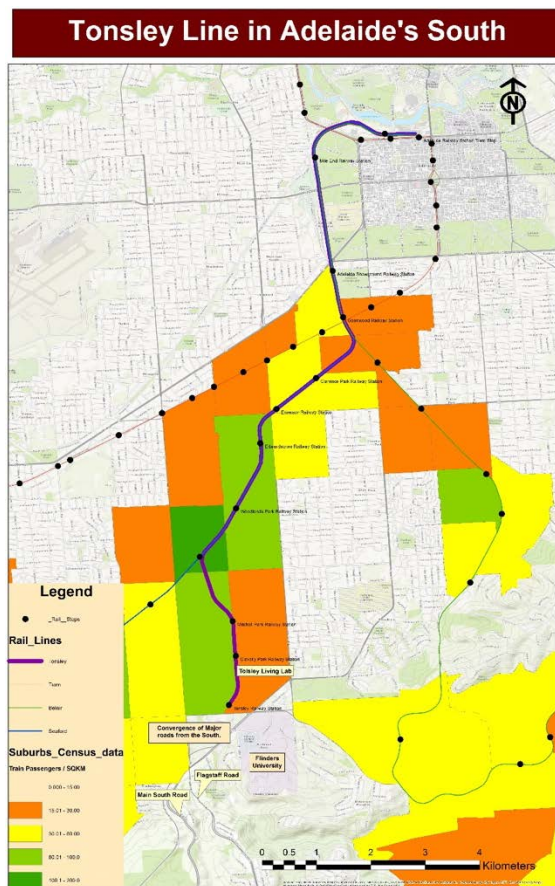


Figure 7 Map of Adelaide's Tonsley Line

Gaps

Service Visibility

There has been little research on the role visibility plays in attracting passengers to public transport. This is something that is hard to quantify but is nonetheless worth investigating. For example, running down the centre median, the Mandurah line in Perth is highly visible as shown in Figure 7 and it is easy to assume that some drivers, overtaken by a train, have decided to switch modes based on this experience. More commonly drivers are forced to wait for passing trains and may lament their choice; perhaps this is why trains are sexy, and buses are not. Can we model this mathematically? In recent times cities have been replacing bus lines with light rail. It is known that this increases the land value of adjacent properties due to the permanence of these routes (Du & Mulley 2012). Does it have a similar effect on patronage?

The following questions are identified after extensive literature review:

- How do we address the contradiction between potential passengers' desire to reach a destination and their aversion to transferring?

- How does service frequency affect this behaviour?
- Will improving the transferring experience help:
 - frequency improvements?
 - station upgrades?
 - improved interchange design?
- What is the effect of transfer coordination? What if receiving vehicles are also feeding vehicles (e.g., routes 722 and 733 services in Adelaide's south?)
- Can we create a flexible network that changes throughout the day so commuters do not need to transfer but other users may do so?
 - This has been tried in Adelaide's southern suburbs to some extent with peak hour buses running directly to the CBD rather than terminating at their usual suburban interchanges. What is the effect of this?

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