

CHAPTER 21

DOES PERTH'S GROWING WEALTH LEAD TO BETTER PUBLIC TRANSPORT ACCESSIBILITY?

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INTRODUCTION

Metropolitan planning strategies and planning policy for Greater Perth (herein abbreviated to Perth) have long recorded aspirations for the development of an urban form capable of supporting good accessibility by public transport (Curtis, 2012; Legacy, Curtis & Neuman, 2014). There has also been continuing community support for investment in public transport as an alternative to private car travel (Department for Planning and Infrastructure, 2003; Western Australian Planning Commission (WAPC), 2004), with the most recent survey placing an efficient public transport system as the number one priority for the future for 89 per cent of respondents (Committee for Perth, 2015). These are sound policies for tackling traffic congestion. Indeed, all Australian cities grapple with ongoing concerns about traffic congestion. Infrastructure Australia (2015) predicted that, without investment in new transport capacity and demand management, car travel times will increase by at least 20 per cent in the most congested corridors between 2011 and 2031. Infrastructure Australia is the most recent organisation to argue for expansions to public transport infrastructure as one response to congestion. In this chapter we query the extent to which Perth has, or can in the future, provide for accessibility by public transport as a realistic alternative to private car travel to meet residents' daily activity needs. We ask to what extent Perth has considered and

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Timeline	Plans and Proposals
1881	Fremantle to Perth to Midland railway opened (Fremantle section serving inner west suburbs; Midland section serving eastern suburbs)
1889	Perth to Armadale railway line opened (serving south eastern suburbs)
1899	First electric tram opens in Perth (Fremantle in 1905)
1955	'Plan for the Metropolitan Region Perth and Fremantle' (1955) proposed two new suburban rail lines (never implemented)
1958	Last electric tram closes in Perth (Fremantle in 1952)
1967	'Rationalisation of Urban Public Transport' Plan published – focus on 'efficiency' and, in particular, proposing rail closures in favour of buses
1979	'Urban Public Transport for Perth: Rail and Bus Policy' published promoting rail line closure and replacement with buses Fremantle to Perth section closed in 1979 to make way for a new arterial road (never built)
1983	Fremantle to Perth section reopened
1991	Existing railway lines electrified
1992	Perth to Joondalup railway line opened (serving northern suburbs)
1998	'Better Public Transport: Ten Year Plan for Perth' promotes public transport as an alternative for car users – mainly focussed on bus-based initiatives
1998/1999	Circle Bus Route opened – southern suburbs in 1998, extending to remainder of orbital route in 1999
1998	'Transform WA' published, announcing State government investment intentions – while purporting to be promoting public transport, most investment was for road infrastructure including the duplication of the Narrows Bridge
2004/2005	Northern rail line extended to Clarkson, Thornlie spur (from Armadale line) opened as part of New MetroRail Project
2007	Perth to Mandurah railway line opened (serving southwestern suburbs with ten new stations (with up to eight further intermediate stations to be added in the future)
2008	Proposal to extend northern suburbs line northwards – subject to planning study Proposal to extend Perth to Mandurah line to Bunbury (110 kilometres) – subject to planning study
2011	'Public Transport for Perth in 2031: Mapping out the Future for Perth's Public Transport Network' published – proposes new light rail routes, a rail link to the airport and an extension of the northern suburbs railway to Yanchep with new stations
2012	Two planning studies commence: i) for MAX light rail corridor to run from Mirrabooka through Perth then splitting to QEII Medical Centre and the Causeway and ii) for the airport railway link
2013	MAX light rail corridor project deferred for three years by State government following withdrawal of Federal funding support for urban public transport projects

*Table 1: Perth Public Transport Planning: A chronology
(Adapted from Newman, 2001; Curtis, 2008).*

invested in public transport to keep pace with growth and as a means of positioning the city as a global, liveable city. Has Perth capitalised on boom-time periods to deliver this public good?

We carry out this task using a mix of data: by mapping public transport infrastructure change over time; by examining census data on public transport use; by analysing the public transport accessibility of the system using our Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS) tool over the recent seven-year period; and also using this tool to project future scenarios for public transport accessibility.

THE PAST: A CHEQUERED HISTORY OF INVESTMENT IN PUBLIC TRANSPORT

The beginning of the twentieth century is an appropriate starting point for these questions. During its first boom – the Gold Rush of the 1880s – Perth invested in its first passenger railways (Table 1) from Fremantle through Perth to Midland, and from Perth to Armadale. This occurred on the back of suburban development stimulated by the boom and was followed by the introduction of a tram network before World War I (Bureau of Infrastructure, Transport and Regional Economics, 2014).

Rail, trams and buses supported a steady increase in public-transport patronage right up until World War II (Figure 1). From that point, with the proliferation of the car, public transport patronage declined until the 1980s and did not reach the pre-war peak (in absolute figures) again until after 2005. On the basis of patronage figures, it would seem that the boom-facilitated, pre-automobile era investments in public transport suited the city's accessibility needs at the time well (although we are yet to assess this historically using the SNAMUTS tool).

The post-World War II period was characterised by a muted approach to public transport planning. The improvement of public transport accessibility as an alternative to car use was not a prominent policy objective. Instead public transport was relegated to providing a social welfare safety net and attempting to meet peak-hour job commuting (Curtis & Low, 2012). The push-pull battle between a bus-based system versus a rail-based

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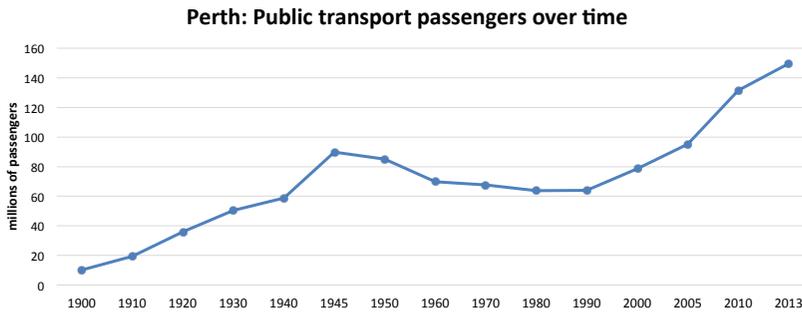


Figure 1: Perth: Public transport passengers over time (BITRE, 2014).

system (evidenced in Table 1) seemed to be fought over cost rather than accessibility. For a small window there was an attempt by the then public-transport agency in Perth to see its role in competing with the car. In the late 1960s the agency argued that parking restrictions in the Perth CBD would ‘allow public transport to operate more efficiently and provide more attractive services’ (MTT, 1969; p. 5 – cited in Curtis & Low, 2012). This multimodal approach to transport planning was short-lived in Perth.

Since 1976 the Australian Census has recorded the method of travel to work. In Perth, private vehicle commuting has dominated with upwards of 80 per cent of all journeys to work being undertaken by car. Public transport takes around 10 per cent of the mode share and walking and cycling around 5 per cent (the remainder of the share being by mixed modes). Only since the beginning of this century is there a discernible trend for public transport to make modest mode share gains against the car (Figure 2).

At the beginning of the twenty-first century, Australian cities are burdened by the growing economic costs of traffic congestion. These costs have been quantified as reaching \$13.7 billion in 2015 collectively in Australia’s six largest cities and is forecast to almost quadruple by 2031 to \$53.3 billion (Infrastructure Australia, 2015). Yet there continues to be unequal expenditure on transport, with

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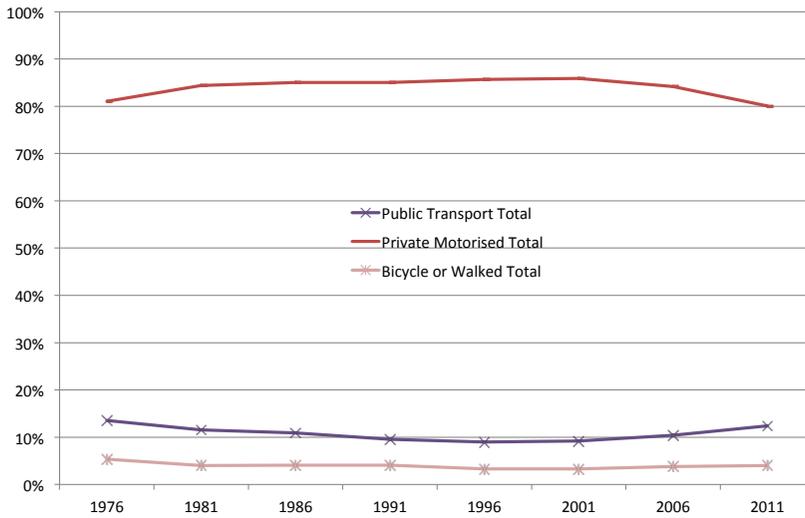


Figure 2: Greater Perth – Method of Travel to Work (ABS Census data, 1976–2011).

roads favoured over public transport. This approach contradicts international research evidence concluding that it would not be possible to satisfy the demand for car-based travel by building roads in urban areas (Department for Transport, 1994) and, further, that road capacity reduction, where it has occurred, has led to up to 32 per cent reduction in car-based travel (Cairns, Hass-Klau & Goodwin, 1998). The imbalance in expenditure is evident, for example BITRE (2011) reported that in 2008/09 \$11.3 billion was spent on road construction and only \$3.3 billion on rail construction. In the first decade of the twenty-first century only thirty-one public transport projects were completed in Australia at a total cost of \$10 billion. These projects were dominated by heavy rail (Martin, 2011). The reality has been that the Australian Federal government has only ever been sporadically involved in urban public transport, with activity during the 1970s, 1990s and again in 2009–10 when a budget of \$4.62 billion was set for urban public transport projects through Infrastructure Australia. By April 2013 the then Liberal opposition leader (later prime minister)

Tony Abbott made the policy position of the incoming government clear:

Now the Commonwealth government has a long history of funding roads. We have no history of funding urban rail and I think it's important that we stick to our knitting, and the Commonwealth's knitting when it comes to funding infrastructure is roads. (Carey & Gordon, 2013)

Despite mounting economic evidence that public transport accessibility is an important consideration in the transport mix, federal government interest in investment in this mode appears at a twenty-five-year low, and the capacity of state governments to bridge this gap remains limited (in the Howard era Western Australia was the biggest spending state government on public transport infrastructure, supporting this through sale of other public assets). This lack of federal support is of particular concern given the recent upturn in ridership and the associated pressures on public transport systems that were configured long ago for modest levels of patronage.

PRESENT DAY ACCESSIBILITY BY PUBLIC TRANSPORT: 2007–2014

Recent growth in public transport ridership overall, and of public transport's mode shift for the journey to work, coincided with substantial investment in public transport infrastructure and services (Table 1), which have seen a greater penetration of public transport across the Perth metropolitan area. Living near to a railway station does make a difference to mode choice (Figure 3). A higher proportion of workers residing in suburbs in Perth that have a train station within 800 metres of the suburb boundary use public transport for their journey to work – 15.3 per cent compared to 10.3 per cent for workers residing in suburbs without a train station within 800 metres of the suburb boundary (ABS,

2011). Additional public transport patronage statistics are provided in chapter 22. But just how accessible is metropolitan Perth by public transport? Figure 3 also shows that a high proportion of workers drive to work. Only for residents in the metropolitan centre does the mode share by car fall significantly. Do these mode-share patterns coincide with the levels of accessibility provided by public transport? We turn to our accessibility tool to examine these questions.

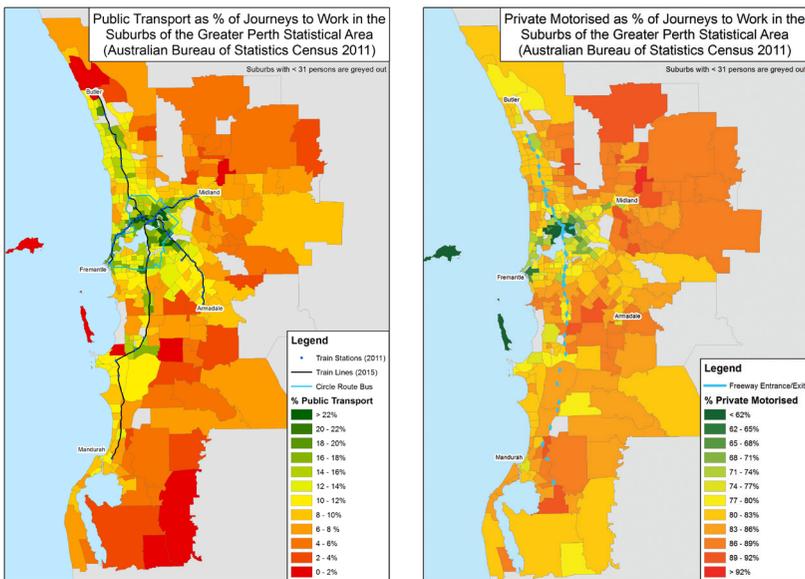


Figure 3: Proportion of employees who use public transport (left) and car (right) for the journey to work by suburb (ABS, 2011).

The Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS) tool assesses the performance of public-transport networks in their settlement context using a suite of eight indicators that illuminate different aspects of spatial accessibility. It is beyond the scope of this chapter to describe the rationale, evolution and methodology of each indicator in detail; interested readers are advised to consult Curtis and Scheurer (2010 and 2016) and the project website (www.snamuts.com) for further reference.

The analysis is based on network and service data derived from public domain timetables and route information in Perth. Land-use data relies on the ABS census. Residential data is analysed at the level of mesh blocks and aggregated to determine the population size within walkable activity node catchments (see below). Job data is derived from the Department for Planning's transport model (STEM). For the 2007 and 2009 study years, in the absence of ABS census data, both residential and employment figures were calculated by adding 20 per cent (2007) or 60 per cent (2009) of the 2006–2011 change increment to the 2006 figures. For the 2011 and 2014 study years, unmodified 2011 census figures were used since newer projections for residential and employment trends will not be available until the 2016 census. Given the substantial growth rate of metropolitan Perth, the activity node catchment sizes for 2014 used in the SNAMUTS analysis thus contain a measure of understatement.

The SNAMUTS assessment refers to a matrix of activity centres, derived from strategic-planning documents such as Directions 2031 (WAPC, 2010), the structure of the public transport network and site observation. The concentrations of origins and destinations are most relevant to urban movement and accessibility. In 2007 sixty-seven such nodes were identified in metropolitan Perth and by 2014, network expansion had increased their number to eighty-six. A minimum service standard is applied in order to focus our analysis on those elements of the public transport system that allow for both planned and spontaneous trip-making and thus offer the greatest competitiveness with the car. This standard is defined as minimum 20-minute intervals during the weekday inter-peak period and minimum 30-minute intervals during the day on Saturdays and Sundays.

The eight core SNAMUTS indicators revolve around inquiries of:

- the operational input required to provide service on the network at the defined minimum standard (service intensity);

- the ease of movement provided by the structure of network and service levels (closeness centrality);
- the transfer intensity resulting from the structure of the network (degree centrality);
- the percentage of metropolitan residents and jobs with walking-distance access to public transport at the defined minimum standard (network coverage);
- the percentage of metropolitan residents and jobs that can be accessed by way of an average 30-minute kerb-to-kerb public transport journey (contour catchment);
- the distribution of travel opportunities generated by the interplay of public transport and settlement structure over network elements and places of activity (betweenness centrality);
- the suitability of network elements to service existing concentrations of travel opportunities and to absorb potential future growth (resilience);
- the position of activity nodes within a network that allow for flexible, autonomous user movement and attraction of land-uses dependent on good public-transport access (network connectivity).

Following, we will present and briefly discuss the evolution of network results for Perth on each of these indicators in biannual intervals over the 2007–2014 period.

Service Intensity

The service intensity index captures the number of public transport vehicles or train sets in simultaneous revenue service at the SNAMUTS minimum service standard (see above). This number nearly doubled between 2007 and 2014 and grew by more than half relative to population (Table 2). This was the result of the opening of the Mandurah rail line and associated bus network improvements at the end of 2007, as well as

a gradual program of service frequency increases on bus routes throughout Perth. Some inflation of these figures may also have occurred as a result of buses being subject to growing traffic congestion, which increases their travel time while impacting negatively on passengers as well as operational needs. Overall, however, Perth has significantly boosted its public transport supply during the recent boom period.

Perth SNAMUTS 23R	2007	2009	2011	2014
Service intensity (total) (rail/bus)	152 21/131	174 26/148	217 26/192	281 26/255
Service intensity (per 100,000 inhabitants)	9.8	10.6	12.6	16.2*

*Table 2: Service intensity in Perth, 2007–2014, in vehicles/train sets in simultaneous revenue service on routes meeting the SNAMUTS minimum service standard. * 2014 figure based on 2011 census data*

Closeness Centrality

The closeness indicator is based on a spatial separation or travel impediment measure composed of travel time and service frequency, as proxies for the ease with which a passenger can move around the city on public transport. Lower figures indicate greater ease of movement. On average, this measure deteriorated slightly following the expansion of the system to the south with the opening of the Mandurah rail line and its bus feeders in late 2007 (Table 3). However, this is primarily due to the peripheral location (relative to the rest of the metropolitan area) of many of the new train stations and their bus feeder catchments. These circumstances invariably translate into high (poor) closeness values for seven out of the ten activity nodes that were added to the network.

Another factor that had a negative effect on ease of movement during the 2007–09 period was a service frequency cut (as part of the Barnett government’s objective to cut public sector spending by 3 per cent) during the weekday inter-peak period on the

Joondalup (and Mandurah) train lines from 7.5 minutes to 15 minutes, which, despite strong patronage increases, had not yet been fully reversed by 2014.

Perth SNAMUTS 23R	2007	2009	2011	2014
Closeness centrality (average per node)	58.5	60.3	60.0	60.1

Table 3: Closeness centrality in Perth, 2007–2014, with lower values indicating greater average ease of movement.

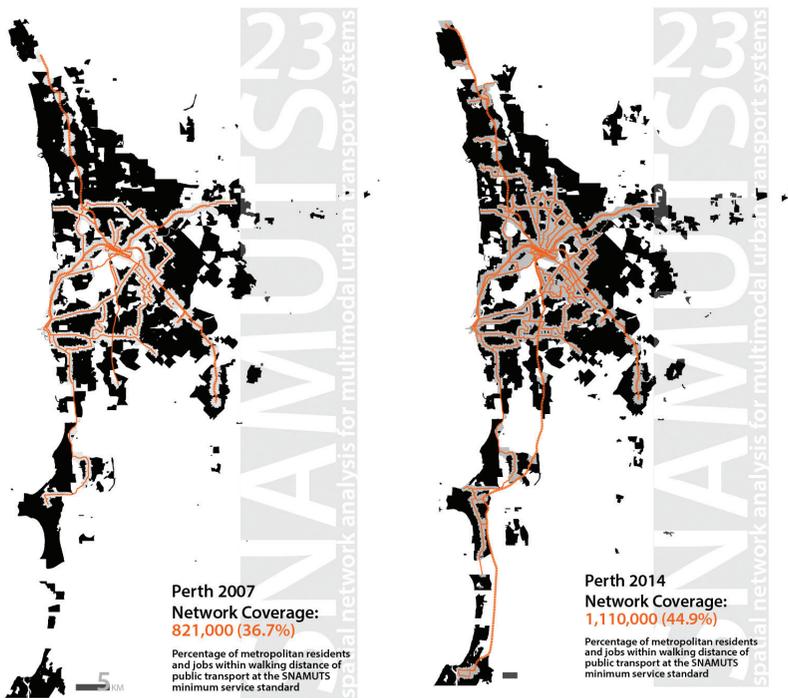


Figure 4: Network Coverage 2007–2014.

Degree Centrality

The degree centrality index measures the reliance of the network on transfers between public transport services on different routes to make journeys on the network. Lower figures indicate lower

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Perth SNAMUTS 23R	2007	2009	2011	2014
Network coverage (total) (percentage of activities)	821,000 36.7%	933,000 39.6%	1,027,000 41.5%	1,110,000 44.9%*

*Table 5: Network coverage in Perth, 2007–2014, in percentage of all metropolitan residents and jobs. * 2014 figure based on 2011 census data.*

transfer intensity. On average across Perth, this measure reduced tangibly with the opening of the Mandurah rail line (Table 4). While this rail line was designed around the conversion of several previously radial bus lines into transfer-dependent feeders and the addition of several new ones of a similar type, greater network coherence was achieved across the metropolitan area by the practice of offering transfer-free rail services between the Joondalup and Mandurah lines and by supplying a train station to the main CBD bus terminus at Elizabeth Quay.

Perth SNAMUTS 23R	2007	2009	2011	2014
Degree centrality (average per node)	1.05	1.01	1.00	1.02

Table 4: Degree centrality in Perth, 2007–2014, with lower values indicating lower average transfer intensity.

Network Coverage

Network coverage measures the percentage of metropolitan residents and jobs within walking distance (roughly 800 metres around rail stations and 400 metres along bus and tram corridors) of one or more public transport routes that meet the minimum service standard. Network growth through new lines and frequency improvements on existing lines between 2007 and 2014 has produced a steady expansion in the number of residents and jobs they can access within walking distance from their origins and destinations (Table 5). However, the majority of activities, including more than two-thirds of residents, remain outside this standard even in 2014 (Figure 4).

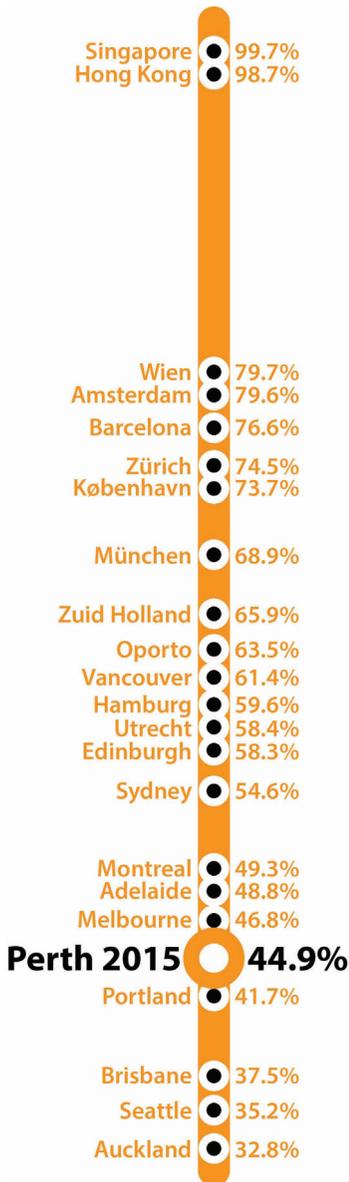


Figure 5: Network coverage: Perth and comparison cities.

In an international context, only Brisbane, Auckland and the US cities assessed by the SNAMUTS tool provide an even lower level of network coverage than Perth (Figure 5). Since this indicator incorporates land-use as well as transport network parameters, it shows that Perth's legacy of low-density, dispersed settlement has proved harder to service by public transport within walking distance of origins and destinations. Despite a twenty-five-year strategy for Transit-Oriented Development (TOD), the uptake of TOD has been very slow and has only gained momentum in this decade (Curtis, 2012).

Thirty-minute Contour Catchments

The contour catchment index captures the number of residents and jobs that can be reached within a public transport journey of thirty minutes or less from each activity node. On average, this measure increased steadily in absolute terms between 2007 and 2014, but less steadily when population growth is taken into account (Table 6). The shift from 2007 to 2009 can be attributed to the additional

travel opportunities generated by the Mandurah (Figure 6a and 6b) rail line and associated bus network improvements, despite the negative effect of additional peripheral nodes and their inherently small thirty-minute contour catchments on the average result.

Perth SNAMUTS 23R	2007	2009	2011	2014
Contour catchment (average per node)	225,000 10.0%	250,000 10.6%	262,000 10.6%	270,000 10.9%*

*Table 6: Average catchment of a thirty-minute public transport travel time contour in Perth, 2007–2014. * 2014 figure based on 2011 census data*

Betweenness Centrality

This indicator measures the presence of public transport travel opportunities across the network and in different network elements, modes or geographical areas. Global betweenness, a proxy for the ability of the network to connect concentrations of land-uses well, surprisingly shows a small decline between 2007 and 2011 – the Mandurah rail line’s initial positive impact on these figures were neutralised when its service frequency was reduced eighteen months after opening (Table 7). After 2011, a package of bus network improvements reversed the trend, mostly by establishing ‘turn-up-and-go’ service levels on key inner urban routes and by contributing to a more multi-directional network. It remains to be seen to what extent the effects of urban intensification along some of these same corridors, as well as at rail stations along the Mandurah line and others, will further boost the global betweenness figure when detailed land-use figures become available in future census years.

The opening of the Mandurah line resulted in a relative shift of travel opportunities from bus to rail, though the subsequent expansion of the minimum-service bus network in the absence of further rail extensions (with the exception of the peripheral extension from Clarkson to Butler in 2014) almost reversed this effect in 2014. The shift to an integrated, trunk-and-feeder network

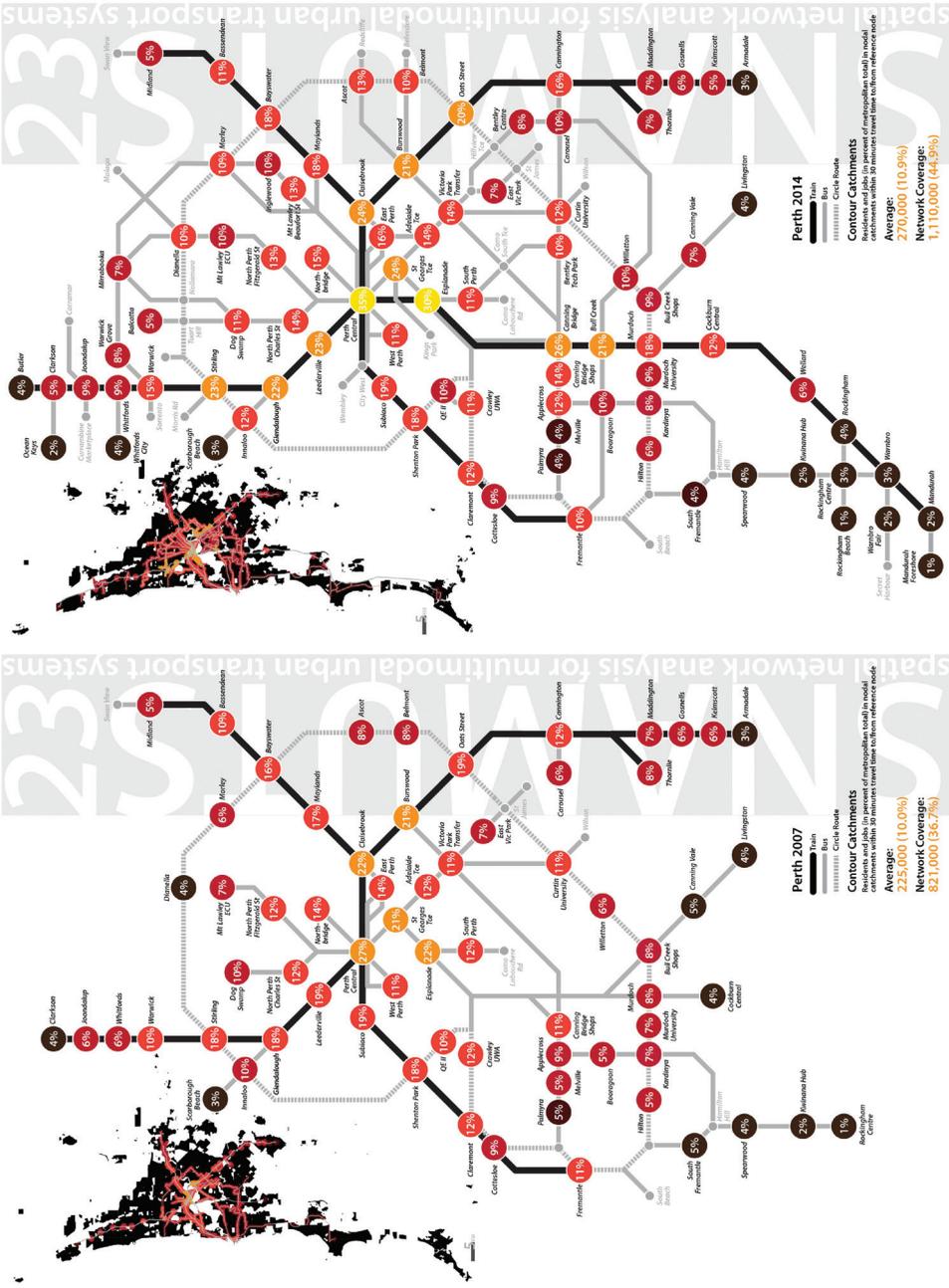


Figure 6: Contour Catchments a) 2007, b) 2014

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design in Perth's south, as the Mandurah line was opened, resulted in a boost to travel opportunities away from the CBD area, a trend that has since continued with bus network improvements, albeit at a slower pace.

Perth SNAMUTS 23R	2007	2009	2011	2014
Global betweenness (per million residents and jobs)	246	243	240	258*
Segmental betweenness (rail/bus)	41.2%/58.8%	50.8%/49.2%	46.4%/53.6%	43.5%/56.5%*
Segmental betweenness (CBD segments)	44.5%	40.5%	40.1%	38.9%*

Table 7: Global betweenness and segmental betweenness by mode and within the CBD area in Perth, 2007–2014. * 2014 figures based on 2011 census data.

Resilience

Network resilience measures the suitability of the network (or of specific network elements) to mobilise public transport mode share and to absorb future increases in patronage. With the opening of the Mandurah rail line in late 2007, a boost in resilience was achieved across the city, in the bus sector (where some lines under pressure were replaced by rail) and in the CBD area (Table 8). However, since 2009 this trend has reversed, with resilience shortfalls building particularly in the CBD area (the tentatively optimistic figures for 2014 are likely to show a further deterioration here once population and job growth since 2011 is taken into account). Clearly, Perth is facing a significant challenge in maintaining its public transport system to be in a position to serve the mobility needs of a growing population, without ongoing significant improvements to the network, infrastructure and service levels.

Perth SNAMUTS 23R	2007	2009	2011	2014
Network resilience (total/rail/bus)	+9.0 +18.4/+7.4	+11.7 +17.2/+10.7	+10.8 +15.9/+10.1	+12.6* +15.7/+12.2
Segmental resilience (CBD segments)	+5.7	+11.7	+7.5	+7.9*

Table 8: Network, modal and CBD resilience of Perth's public transport, 2007–2014, with higher figures indicating greater resilience. * 2014 figures based on 2011 census data

Nodal Connectivity

The nodal connectivity index depicts the capacity of nodes to facilitate frequent movement in a multitude of directions, facilitating user flexibility in moving between places of activity on public transport as well as determining the attractiveness of network hubs for land-uses that depend on public transport access. This measure improved between 2007 and 2014 (Table 9). However, the number of public transport ‘accessibility hotspots’, where residents or businesses can expect to live or operate comfortably without the need for a car, remains small and limited to the CBD area.

Perth SNAMUTS 23R	2007	2009	2011	2014
Nodal connectivity (total/average per node)	944 14	1,291 17	1,503 18	1,841 21

Table 9: Nodal connectivity in Perth 2007–2014.

Efficiency Change

The efficiency change index captures the improvement – or deterioration – in public transport accessibility (ease of movement relative to the distribution of activities) over time. Between 2007 and 2014, global efficiency went up by 27.4 per cent across all parts of the network (Table 10), though to varying extent (Figure 7). The highest rates of improvement occurred in the inner and middle southern suburbs – the wider catchment of the Mandurah

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line – as well as in the mid-northern suburbs where a number of bus routes were lifted to the minimum service standard. The lowest rate of improvement can be found on stations along the Joondalup line, which had a better daytime service frequency in 2007 than it has today.

Perth SNAMUTS 23R	2009	2011	2014
Global efficiency change (over 2007)	+9.5%	+18.9%	+27.4%
Global efficiency change (over 2009)		+8.5%	+16.3%
Global efficiency change (over 2011)			+7.1%

Table 10: Global efficiency change in Perth, 2007–2014.

Throughout the three analytical steps from 2007 to 2009 to 2011 to 2014, the rate of efficiency improvement seems to slow slightly. This could be indicative of a pattern of diminishing returns – many of the bus improvements of the recent past constituted ‘low-hanging fruit’ for enhancing network accessibility. Future measures to further boost the network’s performance may need more complex interventions and possibly more complex decision-making processes.

LOOKING TO THE FUTURE – WHAT WILL IT TAKE TO ACHIEVE WORLD-CLASS PUBLIC TRANSPORT ACCESSIBILITY?

The SNAMUTS tool has been applied repeatedly in collaborations with Perth stakeholders to investigate strategic directions in urban development and the role and character of integrated land-use and transport planning in metropolitan Perth. In an early exercise around alternative macro-urban growth scenarios as input to the Directions 2031 metropolitan strategy (Curtis & Scheurer, 2009, 2010), our attention was directed to the superiority, in accessibility terms, of

peripheral greenfield land, even where such expansion occurs in a transit-oriented form. Another project assessed a range of planned public transport network and service improvements and concluded with the need to overcome a widespread vein of thought that seeks to strengthen public transport purely by extrapolating from current patterns of spatial demand (Curtis, Scheurer & Burke, 2013). This is particularly relevant in Perth and other Australian cities where public transport networks are traditionally configured in a radial shape and where these radial lines are increasingly vulnerable to congestion as patronage grows. Effective planning of a more multi-directional and robust network requires a layer of accessibility-related inquiry that traditional transport models are often not suited to deliver.

In our most recent work for the City of Perth, we analysed a 2050 scenario focussed primarily on the optimisation of public transport accessibility for those residing within 5 kilometres of the Perth CBD. The aspiration was to ensure all residents enjoyed high levels of autonomous mobility or the ability to rely on public transport for one's movement needs in a similar way to the private car (Dowling & Kent, 2013). The scenario included a number of improvements to Perth's public transport network that reflect those that are currently or are likely to be committed to by the state government. These include rail extensions (from Butler to Yanchep in the north, Bayswater to High Wycombe in the east and Thornlie to Cockburn Central – creating the start of a potential orbital link in the south). It also includes three branches of light rail centred on central Perth (to QEII, Mirrabooka and Victoria Park), as well as improvements to rail and bus service frequencies. From these potential projects, further network development followed an iterative process with the main foci being:

- network shape – the creation of a full spider web-shaped network within the area bounded by the Circle Route;
- increased service frequencies;

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Perth SNAMUTS 23R	2007	2014	2050
Service intensity (total rail/light rail/bus)	152 21/-/131	281 26/-/255	509 79/70/360
Service intensity (per 100,000 inhabitants)	9.8	16.2*	14.6
Closeness centrality (average per node)	58.5	60.1	40.8
Degree centrality (average per node)	1.05	1.02	0.96
Network coverage (total percentage of activities)	821,000 36.7%	1,110,000 44.9%*	2,886,000 58.9%
Contour catchment (average per node)	225,000 10.0%	270,000 10.9%*	914,000 18.7%
Global betweenness (per million residents and jobs)	246	258*	375
Segmental betweenness (rail/light rail/bus)	41.2%/-/58.8%	43.5%/-/56.5%*	58.7%/22.6%/18.7%
Segmental betweenness (CBD segments)	44.5%	38.9%*	30.1%
Network resilience (total rail/light rail/bus)	+9.0 +18.4/-/+7.4	+12.6* +15.7/-/+12.2	+12.4 +7.9/+17.1/+12.5
Segmental resilience (CBD segments)	+5.7	+7.9*	+7.7
Connectivity (total average per node)	944 14	1,841 21	13,798 128

*Table 11: Overview of SNAMUTS indicator results in Perth, 2007, 2014 (actual performance) and 2050 (aspirational performance). * 2014 figures based on 2011 census data.*

- modal upgrades from bus to light rail where bus services did not provide optimal accessibility or suffered from poor resilience; and
- assumptions for population growth and land-use including a greater extent of urban growth around activity centres that are accessible by public transport (ranging from sixty residents and thirty jobs per hectare to 120 residents and sixty jobs per hectare).

This is just one example of a 2050 scenario and is used only for demonstration purposes – there is no suggestion that it would be adopted by government. The outcomes can be summarised as follows (Table 11). Ease of movement improves to the extent that Perth (average closeness: 40.8) exceeds that of present-day Vancouver (42.1), whose inhabitants currently make

nearly twice as many annual public transport trips as those of Perth (Curtis & Scheurer, 2016). The spiderweb-shaped structure of the network reduces transfer intensity, making more destinations accessible with fewer transfers. From a network coverage perspective, nearly 60 per cent of metropolitan residents and jobs in Perth exist within walking distance of public transport, which is almost on par with Vancouver today (61.4 per cent). Significantly, four-fifths of this increase in network coverage can be attributed to land-use intensification around public transport (an assumption to the scenario was that 83 per cent of metropolitan growth between 2031 and 2050 would occur around rail infrastructure), rather than the geographical expansion of the network.

The presence of public transport for making connections between places of activity (global betweenness) is also improved to Vancouver levels (367) and travel opportunities redistributed to higher-capacity modes that are best suited to absorb them. The deployment of vehicles relative to population (service intensity) and the resilience of the network are roughly maintained at 2014 levels, despite an expected doubling of Perth's population and employment until 2050. Resilience, however, deteriorates disproportionately on the heavy rail system, suggesting that the assumption made in this scenario to not expand Perth's highest-performance public transport mode beyond the projects already discussed for the period until 2031 may not be a viable long-term policy direction, despite the rollout of an expansive light rail network. Critically, the 2050 projection results in a tremendous increase in network flexibility (nodal connectivity), suggesting that the scenario will offer good conditions for public transport-oriented lifestyles and business operations at least in Perth's inner suburbs and key middle suburban hubs.

DISCUSSION AND CONCLUSION

In this chapter we have used accessibility analysis to demonstrate that while Perth has invested in a public transport network, it has not been of a sufficient standard to compete with the car and offers less than half of the population reasonable accessibility by this mode. Since the turn of the century, both investment in public transport and intensification of development are succeeding in improving accessibility on most assessment indicators (the latter to a lesser degree since TODs are only now becoming established and occupied). Improvements to accessibility have been achieved as a result of investment in a rail megaproject (the Perth to Mandurah railway) as well as the rollout of significant service improvements for buses, though these are operationally resource-intensive. Despite these investments, Perth has much ground to cover if it is to offer a genuine alternative to the car as a transport mode. Public transport network plans have offered some respite, not enough to offer accessibility for all, but the major hurdle now is public investment in future network plans. This raises two questions – first, why have governments not prioritised investment in public transport in Perth’s boom periods, especially given the significant costs of congestion to the economy and society? Second, who should pay for future investment and how can contributions be more fairly distributed? The past accessibility gains have been achieved through state government investment and public asset sales, not by either federal government or the private sector. What should be the role of the latter two in future investment given the impacts on the economy, society and environment of car-based congestion?

Improvements to accessibility can be achieved by adopting a focussed public transport service, infrastructure and land-use strategy consisting of several elements. Increases to service frequency have good accessibility outcomes in the short run and they are easy to implement (but operationally resource intensive). They meet an effectiveness ceiling, however, where bus congestion mounts (or rail lines reach their capacity limits).

Urban intensification of the inner/middle suburban area, coupled with insertion of new heavy or light rail infrastructure, is far more complex, but if done well it has great long-term accessibility effects (including good resilience). Rail extensions to the urban fringe do not deliver as impressive an accessibility advantage as the above two actions, partly due to the peripheral nature of the settlement structure and its impact of centrality and partly due to the low-intensity development which delivers small activity catchments. Importantly, we need to consider this urban development approach in the context of path dependency – extending the urban fringe through greenfield development has been the *modus operandi* for decades and little attention has been given to serving its accessibility needs by anything but private car. But ultimately, who pays for the impact of this on inaccessibility while others profit from the easier development gains? Where fringe development is permitted, it must be linked to public transport and attention given to increasing the intensity and diversity of land-uses. Overall though, urban fringe development should slow significantly in favour of intensification in inner- and middle-ring suburbs at locations around public transport stops/stations.

While scenarios like these can paint a picture of what sort of land-use change and public transport investment is required, sound and strong planning is required in a way rarely seen today (compared to the early years of the first boom period) in state or federal government in order to develop effective long-term plans. All tiers of government and the private sector need to focus their energy in this arena and move beyond the ‘road-versus-public transport’ debate towards a future that offers genuine integrated solutions for development and accessibility. Planning must provide for effective integration between land-use development and transport investment. Financing these projects must sit outside of the four-year political cycle, and form part of a long-term investment plan where transport projects are considered in one place, rather than as separate road and public transport silos. Given the extent

to which land-use change can deliver public transport accessibility, new forms of finance must be investigated and developer gains channelled to public good (as discussed in chapter 28). The community has voiced its expectation that public transport be valued over private transport; this must be acted on. Clearly, delivering public transport accessibility depends upon addressing these institutional matters. Urban accessibility is too important for the future wellbeing of our cities to be left to political game playing.

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