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The spatial distribution of the travel to work by sustainable transport modes in Australian cities from 2001 to 2011

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Abstract

The transport network plays a significant role in the development of sustainable, resilient and liveable cities. To understand the impacts of current policies and to guide the future planning of liveable settlements, it is important to monitor and analyse trends in transport behaviour. The aim of this research is to investigate changes over time in the spatial distribution of the principal sustainable modes of transport in Australia's capital cities.

The analysis reported in this paper uses the 2011 Census to update and extend this earlier analysis of 2001 and 2006 Census JTW data by Stone and Mees (2011). TableBuilder Pro was used to analyse ABS Census data from 2001, 2006 and 2011 to explore trends in mode share for the journey to work by public, private and active forms of transport. The spatial distribution of these trips is analysed through Destination-Zone data including the Central Business District (CBD), adjacent inner-city locations (the CBD 'frame') and dispersed suburban locations across the wider Statistical Division. We analyse the spatial distribution of recent growth in urban public transport patronage, as well as walking and cycling, to determine the extent to which inner-city workers are contributing to recent increases in travel by sustainable modes.

The main findings were that the share of employed persons work trips to the CBD and CBD 'Frame' had increased for each of the capital cities analysed between 2006 and 2011, excluding the CBD 'frames' of Brisbane and Perth. It was also found that the majority of this growth was attributed to public transport, with private car trips to the inner city areas decreasing and passenger car trips significantly decreasing. As a result, the majority of JTW trips beyond the inner city areas was still undertaken by private transport, with minor increases and major declines in cycling and walking rates respectively, particularly for Adelaide and Hobart.

These main findings demonstrate that inner city locations have been able to attract a greater share of work trips through the use of sustainable transport usage. It has also demonstrated that travel to work within suburbia is still dominated by private transport. To tackle these unsustainable patterns, the paper concludes with recommendations for a suite of policies to improve the efficiency and effectiveness of public transport operations through application of network planning principles and concurrent policies to reduce the incentives to private car use in Australian suburbs.

Key words: transport sustainability, journey to work, mode share

1. Introduction

The transport network plays a significant role in the maintenance and development of healthy, sustainable, resilient and liveable cities. Transport network improvements are necessary to ensure Australian cities are globally competitive, productive, sustainable, liveable and socially inclusive (Commonwealth of Australia, 2011). We face many environmental, economic and political challenges in creating sustainable transport networks in Australia's dispersed cities. These include:

- Growing traffic volumes and inefficient public and active transport networks that contribute to congestion on the road network of Australia's cities and to the performance of the Australian economy, with the cost of road delays expected to increase by 290% to $53.3 billion by 2031 (Commonwealth of Australia, 2010; Commonwealth of Australia, 2015);
- Population growth, employment growth and an ageing population, along with an increase in local air pollution and greenhouse gas emissions, while increasing the dependence on insecure oil supplies and natural resources (Commonwealth of Australia, 2011; Stone & Mees, 2010; Mees & Groenhart, 2014); and
- The continuation of and expensive infrastructure-first approach to address these above issues, despite mounting evidence that such approaches are not working (Mees and Groenhart 2014).

To understand the impacts of current policies that guide the planning of our cities, it is important to analyse the latest trends in transport behaviour. The aim of this research is to investigate changes over time on the performance and spatial distribution of the principal sustainable modes of transport in Australia's capital cities. We are testing the assumption that the growth in the use of sustainable transport modes that have been observed in the past decade or more has been driven by a disproportionate concentration of new employment opportunities in the inner suburbs of Australia's capital cities, where sustainable transport modes offer more attractive travel alternatives to private transport modes.

Whilst private vehicular transport remains the dominant mode of transport, the thrust of future urban policy research should move towards the increased modal share and uptake of sustainable transport modes. Therefore we are exploring the trends in the use of sustainable transport modes that require fewer resources in energy and space, as well as an ability to foster greater economic and social resilience for urban and regional settlements in the 21st century.

This research extends an earlier analysis of 2001 and 2006 Census Journey to Work (JTW) data by Stone and Mees, presented at the ATRF in 2011, and should be read in conjunction with that earlier paper. The design and scope of this research was influenced by Thomson's 1977 argument that the strength of a city's centre is the primary determinant of transport outcomes. Recent research by Ewing and Cervero (2010) builds on Thompson's argument, finding that almost any development in a central location is likely to generate less automobile travel than the best-designed, compact, mixed-use development in a remote location. They note that destination accessibility is by far the most important land use factor in determining a household or person's amount of driving. These authors also found that concentration of destinations is significant in reducing driving rates.

Seen in this light, the 2011 analysis of changes in the spatial distribution of the JTW by sustainable modes by Stone and Mees produced some surprising results. The concentration of new employment in inner-city locations during the 2001 to 2006 period was less intense than expected. Their analysis also found that the proportion of work trips by public transport to destinations in the inner zones fell slightly between 2001 and 2006 in all cities except Sydney and Canberra. This was considered surprising given that public transport infrastructure and service patterns are principally designed for this market. Furthermore, it was also expected

that work travel to the inner zones of Australian cities would account for most of the growth in the use of sustainable modes of transport. This new analysis will investigate whether or not these trends have continued to persist.

The analysis uses JTW data from the 2011 Census. TableBuilder Pro was used to analyse ABS Census data from 2001, 2006 and 2011 to explore trends in mode share for the journey to work by public, private and active forms of transport in Australia's capital cities (excluding Darwin), as shown in tables and figures 1 to 7. The spatial distribution of these trips is analysed through Destination-Zone data including the Central Business District (CBD), adjacent inner-city locations of Sydney, Melbourne, Brisbane and Perth (the CBD 'frame': the locations of which are described in the Appendix) and dispersed suburban locations within the capital city Statistical Division (SD) as defined in 2001. We analyse the spatial distribution of recent growth in urban public transport patronage, as well as active transport usage (i.e. walking and cycling), to determine the extent to which inner-city workers are contributing to recent increases in travel by sustainable modes. This paper complements the research undertaken by Mees and Groenhart (2014) of the JTW in Australian capital cities between 1976 and 2011.

2. Analysis

2.1 Sydney

2.1.1 Distribution of employment

In Sydney, the share of employed persons in the CBD increased from 13.4 per cent in 2006 to 14 per cent by 2011; the share of employed persons in the Sydney CBD 'frame' increased from 7.3 per cent in 2006 to 7.9 per cent by 2011; while the share of employed persons for the remainder of the Sydney SD decreased from 79.3 per cent in 2006 to 78.1 per cent by 2011. The increase of employed persons in the Sydney CBD 'frame' represents a reversal of the trend seen in the 2001-2006 period, where the share of employed persons decreased from 8.6 per cent in 2001 to 7.3 per cent by 2006. Together with continued growth of job numbers in the CBD, this represents a continuing trend to concentration of employment in the inner areas of Sydney since 2001.

2.1.2 Distribution of public transport work trips

There were considerable gains for the share of public transport work trips across the Sydney SD between 2006 and 2011, with the share of train trips to the Sydney CBD 'frame' increasing from 24 per cent in 2006 to 27.1 per cent by 2011, while the share of train trips to the remainder of the Sydney SD increased from 8.1 per cent in 2006 to 9.6 per cent by 2011. Overall, 74.3 per cent of work trips to the Sydney CBD were undertaken by public transport in 2011, while only 15.8 per cent of work trips were undertaken by car. The share of bus trips across the Sydney SD increased from 6.5 per cent in 2006 to 7.1 per cent by 2011. Compared to the 2001 data, this shows an overall positive trend in public transport work trips across the Sydney SD, with train being the main driver behind this, particularly for destinations in the CBD 'frame'.

2.1.3 Distribution of active transport work trips

Cycling trips to work increased across all the destination zones, with the mode share of cycling trips to the Sydney CBD increasing from 0.8 per cent in 2006 to 1.5 per cent by 2011, while the share of cycling trips to the Sydney CBD 'frame' increased from 1.5 per cent to 2.6 per cent by 2011. This continued the positive trend from 2001-2006, with the greatest increase being observed in the inner areas. There was also a continuation of growth in people walking to work in the inner areas, though the share of walking trips to the remainder of the Sydney SD decreased from 4.6 per cent in 2006 to a share of 4.2 per cent by 2011. This reverses the positive growth in walking during the 2001-2006 period.

Table 1: Share of work trips and modes used by destination zones for the Sydney SD

	Sydney SD			Sydney CBD			Sydney CBD Frame			Remainder Sydney SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**10.3**	**13.4**	**14.0**	**8.6**	**7.3**	**7.9**	**81.1**	**79.3**	**78.1**
MODES:												
Public Transport	**22.4**	**22.0**	**24.4**	**74.6**	**73.0**	**74.3**	**43.3**	**33.9**	**38.0**	**12.8**	**11.5**	**13.3**
Train	15.8	15.0	16.7	50.5	47.8	48.1	32.2	24.0	27.1	9.1	8.1	9.6
Tram/Ferry	0.4	0.5	0.6	2.8	2.9	2.9	0.4	0.5	0.7	0.1	0.1	0.1
Bus	6.2	6.5	7.1	21.3	22.2	23.3	10.7	9.4	10.1	3.7	3.4	3.7
Car Total	**68.3**	**70.0**	**67.6**	**18.4**	**18.8**	**15.8**	**46.4**	**53.7**	**47.4**	**77.7**	**80.9**	**79.8**
Driver	61.7	63.9	62.6	14.9	15.3	13.2	41.5	49.0	43.6	70.4	74.2	74.2
Passenger	6.6	6.1	5.0	3.5	3.5	2.6	4.9	4.7	3.8	7.3	6.7	5.6
Bicycle	**0.6**	**0.7**	**0.9**	**0.5**	**0.8**	**1.5**	**0.9**	**1.5**	**2.6**	**0.6**	**0.6**	**0.7**
Walked Only	**4.5**	**5.1**	**5.0**	**4.0**	**5.8**	**6.6**	**6.8**	**8.8**	**9.6**	**4.3**	**4.6**	**4.2**
Other Modes	**4.2**	**2.2**	**2.0**	**2.5**	**1.6**	**1.8**	**2.7**	**2.1**	**2.4**	**4.6**	**2.3**	**2.0**

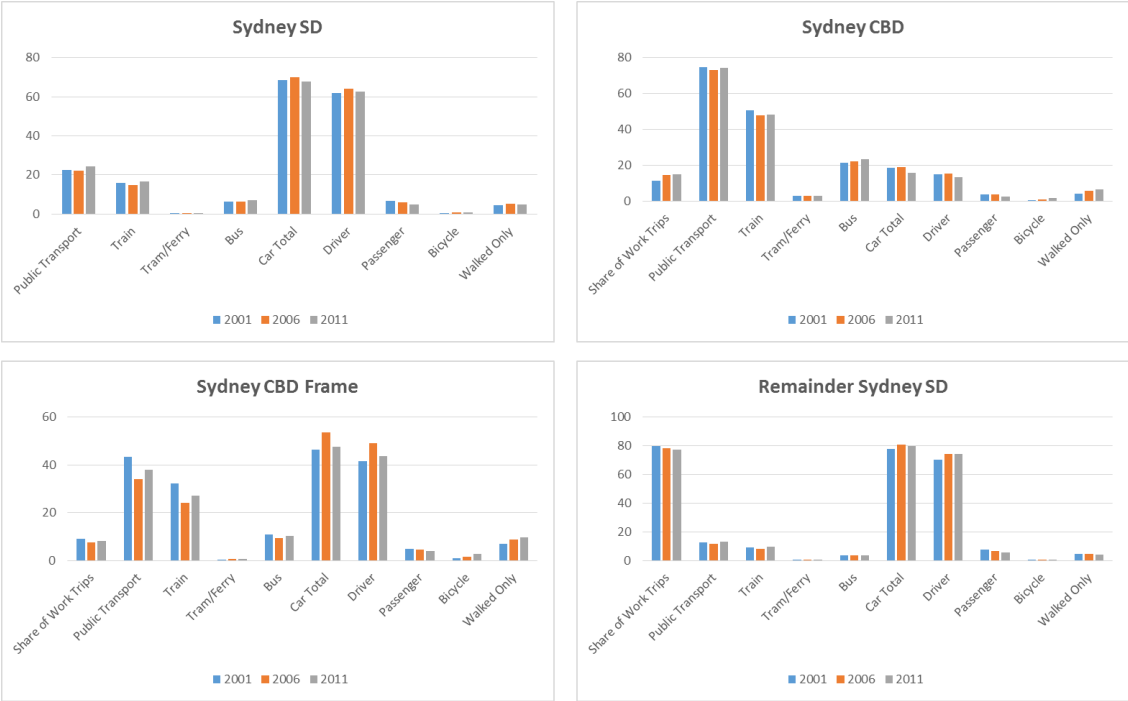


Figure 1: Share of work trips and modes used by destination zones for the Sydney SD

2.2 Melbourne

2.2.1 Distribution of employment

In Melbourne, the share of employed persons in the Melbourne CBD increased from 9.9 per cent in 2006 to 10.6 per cent by 2011; the share of employed persons in the Melbourne CBD 'frame' increased from 9.3 per cent in 2006 to 11.3 per cent by 2011; while the share of employed persons for the remainder of the Melbourne SD decreased from 80.8 per cent in 2006 to 78.1 per cent by 2011. This has continued the trend of concentration of employment within the inner area of Melbourne since 2001, with the 'frame' taking the greater share of this growth at the expense of the remainder of the Melbourne SD.

2.2.2 Distribution of public transport work trips

There were considerable gains for the share of public transport work trips across the Melbourne SD between 2006 and 2011. The share of train trips to the Melbourne CBD increased from 48.6 per cent in 2006 to 51 per cent by 2011, while the share of train trips to the Melbourne CBD 'frame' increased from 23.7 per cent in 2006 to 29 per cent by 2011. The share of train trips to the remainder of the Melbourne SD increased from 4 per cent in 2006 to 4.7 per cent by 2011. Overall, 65.6 per cent of work trips to the Melbourne CBD were

undertaken by public transport by 2011, while only 24.1 per cent of work trips were undertaken by car. The share of tram trips across the Melbourne SD increased from 2.7 per cent in 2006 to 3.1 per cent by 2011. Despite the decrease in employed persons for the remainder of the Melbourne SD, public transport has continued to increase its share of trips to work, up from 5.7 per cent in 2001 to 7.5 per cent by 2011.

2.2.3 Distribution of active transport work trips

Cycling trips to work increased across all the destination zones across the Melbourne SD, where the mode share of cycling trips to the Melbourne CBD increased from 2.3 per cent in 2006 to 3.3 per cent by 2011, while the share of cycling trips to the Melbourne CBD 'frame' increased from 3.3 per cent to 4 per cent by 2011. This continued the trend from 2001 of cycling trips increasing across all the destination zones, with the greatest increase being observed in the inner areas. There was relatively little change with walking in the inner areas, though the share of walking trips to the remainder of the Melbourne SD decreased from 3.2 per cent in 2006 to 3 per cent by 2011. This trend was a reversal from the 2001-2006 period, where walking to work increased from 2.9 per cent in 2001 to 3.2 per cent by 2006.

Table 2: Share of work trips and modes used by destination zones for the Melbourne SD

	Melbourne SD			Melbourne CBD			Melbourne CBD Frame			Remainder Melbourne SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**9.5**	**9.9**	**10.6**	**8.5**	**9.3**	**11.3**	**82**	**80.8**	**78.1**
MODES:												
Public Transport	**13.1**	**14.7**	**17.6**	**60.5**	**62.7**	**65.6**	**28.2**	**31.8**	**38.1**	**5.7**	**6.3**	**7.5**
Train	9.2	10.6	12.7	46.8	48.6	51.0	20.7	23.7	29.0	3.4	4.0	4.7
Tram/Ferry	2.4	2.7	3.1	11.1	11.5	11.9	5.7	6.5	7.4	1	1.0	1.1
Bus	1.5	1.5	1.7	2.7	2.6	2.7	1.7	1.6	1.7	1.4	1.3	1.6
Car Total	**80**	**78.6**	**75.8**	**33.4**	**28.2**	**24.1**	**64.1**	**58.1**	**51.2**	**87.4**	**87.7**	**87.0**
Driver	73.8	73.1	71.0	27.9	23.6	20.5	58.9	53.6	47.4	81.1	82.1	81.9
Passenger	6.1	5.4	4.8	5.5	4.6	3.5	5.2	4.6	3.8	6.3	5.7	5.1
Bicycle	**1**	**1.4**	**1.7**	**1.4**	**2.3**	**3.3**	**2.1**	**3.3**	**4.0**	**0.8**	**1.0**	**1.1**
Walked Only	**2.9**	**3.7**	**3.6**	**2.9**	**5.6**	**5.7**	**3.4**	**5.3**	**5.2**	**2.9**	**3.2**	**3.0**
Other Modes	**3**	**1.6**	**1.4**	**1.8**	**1.3**	**1.3**	**2.2**	**1.5**	**1.4**	**3.3**	**1.7**	**1.4**

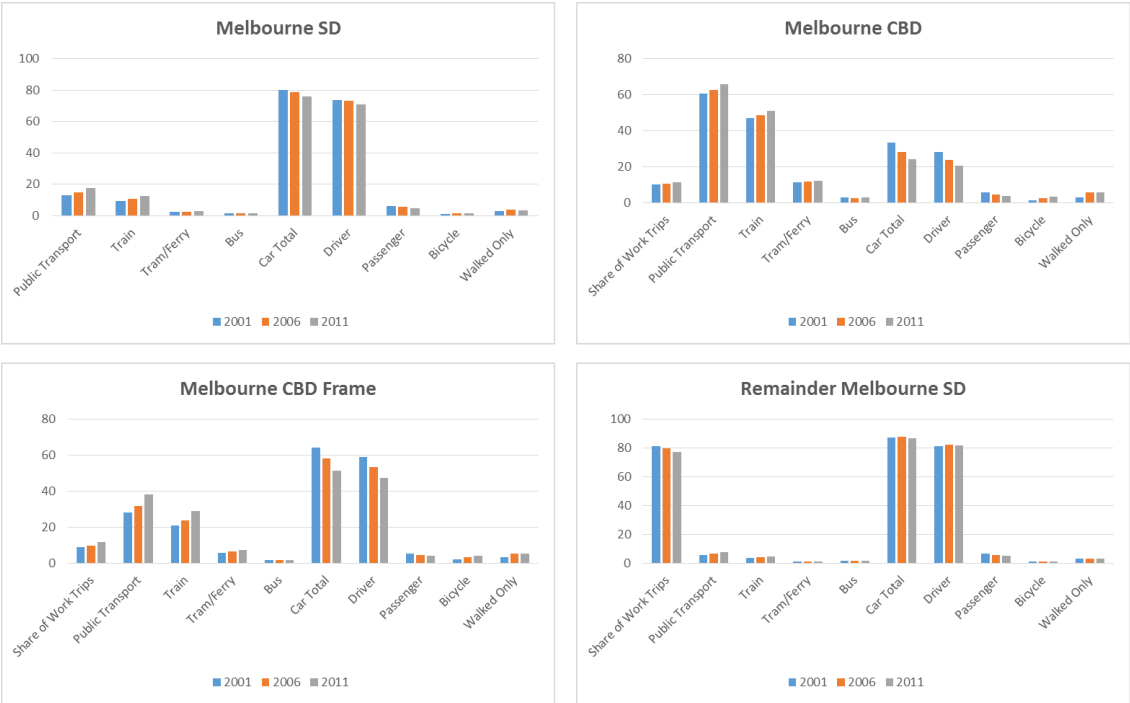


Figure 2: Share of work trips and modes used by destination zones for the Melbourne SD

2.3 Brisbane

2.3.1 Distribution of employment

Distribution of employment in Brisbane has remained almost constant over the period from 2006 to 2011. The share of employed persons in the Brisbane CBD increased from 8.3 per cent in 2006 to only 8.4 per cent by 2011. In the Brisbane CBD 'frame', the share of jobs decreased from 5 per cent in 2006 to 4.7 per cent by 2011, while the share of employed persons for the remainder of the Brisbane SD increased from 86.7 per cent in 2006 to only 86.8 per cent by 2011. The increase of employed persons in the Brisbane CBD represents a minor reversal of the trend seen in the 2001-2006 period, where the share of jobs decreased from 8.7 per cent in 2001 to 8.3 per cent by 2006. These fluctuations are reversed in the CBD 'frame', where the share of employed persons increased from 4.5 per cent in 2001 to 5 percent by 2006. For the remainder of the Brisbane CBD, the distribution of employment remained virtually constant from 2001 to 2011.

2.3.2 Distribution of public transport work trips

There were considerable gains for the share of public transport work trips across the Brisbane SD between 2006 and 2011. The share of train trips to the Brisbane CBD increased from 32.8 per cent in 2006 to 34.1 per cent by 2011, while the share of bus trips to the Brisbane CBD 'frame' increased from 24.9 per cent in 2006 to 28.1 per cent by 2011. Overall, 64.8 per cent of work trips to the Brisbane CBD were undertaken by public transport in 2011, while only 25.4 per cent of work trips were undertaken by car. The share of bus trips across the Brisbane SD increased from 6.3 per cent in 2006 to 7.3 per cent in 2011. In the CBD 'frame', public transport has continued to increase its share of trips to work, up from 51.3 per cent in 2001 to 61 per cent by 2011. Likewise, the remainder of the Brisbane SD has also increased its share of public transport trips to work, up from 6 per cent in 2001 to 8.6 per cent by 2011.

2.3.3 Distribution of active transport work trips

Cycling trips to work increased across all the destination zones, where the mode share of cycling trips to the Brisbane CBD increased from 1.5 per cent in 2006 to 2.3 per cent by 2011, while the share of cycling trips to the Brisbane CBD 'frame' increased from 2.2 per cent in 2006 to 2.9 per cent by 2011. This continued the trend from 2001 of cycling trips increasing across all the destination zones, with the greatest increased being observed in the inner areas. Excluding the Brisbane CBD, which saw a minor increase in the share of work trips by walking, there was little change in walking to work across the Brisbane SD, with the share of walking trips across the remainder of the Brisbane SD remaining static at 3.5 per cent. This is in contrast to the 2001-2006 period, where walking increased across the Brisbane SD.

Table 3: Share of work trips and modes used by destination zones for the Brisbane SD

	Brisbane SD			Brisbane CBD			Brisbane CBD Frame			Remainder Brisbane SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**8.7**	**8.3**	**8.4**	**4.5**	**5.0**	**4.7**	**86.8**	**86.7**	**86.8**
MODES:												
Public Transport	**12.8**	**14.7**	**16.3**	**56.2**	**61.5**	**64.8**	**51.3**	**56.2**	**61.0**	**6.0**	**7.3**	**8.6**
Train	7.1	7.8	8.5	32.0	32.8	34.1	28.3	29.2	31.0	3.3	3.9	4.5
Tram/Ferry	0.3	0.5	0.5	1.3	2.1	2.2	1.2	2.0	1.9	0.1	0.3	0.2
Bus	5.4	6.3	7.3	22.8	26.5	28.5	21.8	24.9	28.1	2.6	3.1	3.9
Car Total	**78.2**	**77.5**	**76.3**	**36.8**	**29.8**	**25.4**	**41.0**	**34.3**	**29.0**	**84.7**	**85.1**	**84.3**
Driver	70.2	70.3	69.8	28.2	23.0	19.8	32.0	26.6	22.8	76.8	77.8	77.7
Passenger	8.0	7.3	6.4	8.7	6.8	5.6	9.0	7.7	6.2	7.9	7.3	6.5
Bicycle	**1.1**	**1.1**	**1.3**	**1.1**	**1.5**	**2.3**	**1.9**	**2.2**	**2.9**	**1.1**	**1.0**	**1.1**
Walked Only	**3.0**	**3.7**	**3.7**	**2.9**	**5.3**	**5.6**	**2.6**	**5.0**	**5.0**	**3.0**	**3.5**	**3.5**
Other Modes	**4.8**	**3.0**	**2.4**	**3.0**	**2.0**	**1.9**	**3.3**	**2.4**	**2.1**	**5.1**	**3.1**	**2.5**

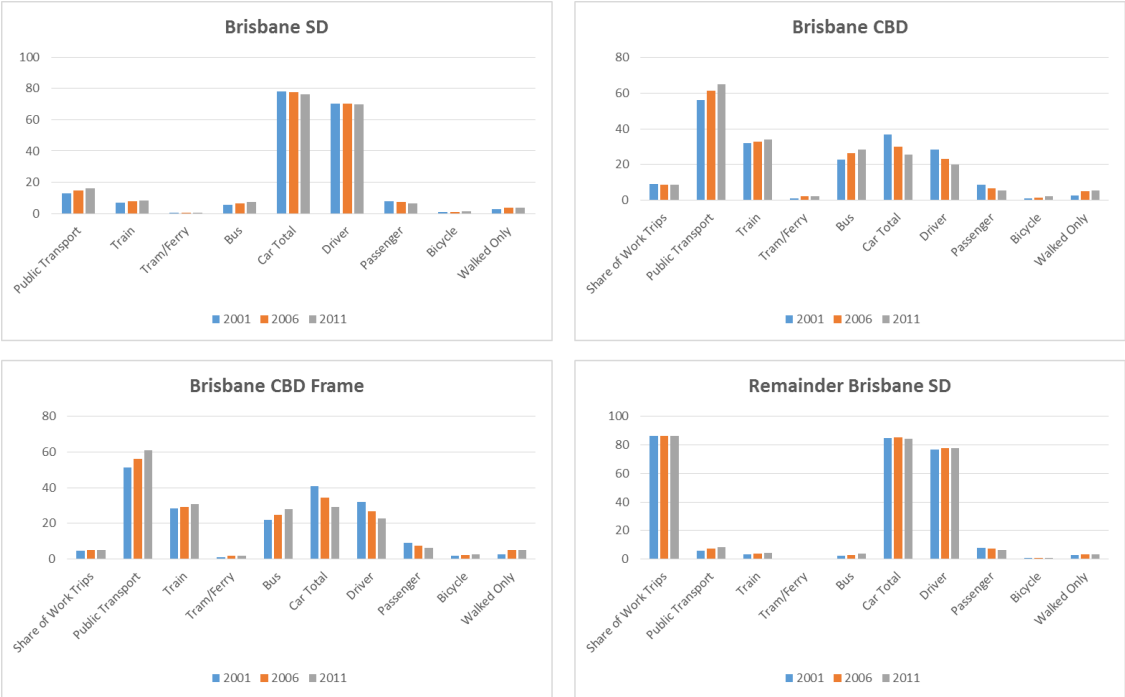


Figure 3: Share of work trips and modes used by destination zones for the Brisbane SD

2.4 Perth

2.4.1 Distribution of employment

Distribution of employment across Perth remained relatively constant in the period from 2006 to 2011, after some concentration in the inner zones between 2001 and 2006. The share of employed persons in the Perth CBD increased marginally from 10 per cent in 2006 to 10.1 per cent by 2011, while the share of employed persons in the Perth CBD 'frame' decreased from 7.7 per cent in 2006 to 7.6 per cent by 2011.

2.4.2 Distribution of public transport work trips

There were considerable gains for public transport for work trips across the Perth SD between 2006 and 2011. The share of train trips to the Perth CBD increased from 24.9 per cent in 2006 to 39.1 per cent by 2011, while the share of train trips to the Perth CBD 'frame' increased from 13.5 per cent in 2006 to 21.7 per cent by 2011. Overall, 57.8 per cent of work trips to the Perth CBD were undertaken by public transport in 2011. Perhaps as a result of the substantial increase in taking the train to work, the mode share for bus across the Perth SD decreased from 5.2 per cent in 2006 to 4.5 per cent by 2011. The growth figures in the share of public transport trips are very encouraging given that relatively little changed with regards to distribution of employed persons across the SD between 2006 and 2011.

2.4.3 Distribution of active transport work trips

Cycling trips to work increased across all the destination zones, where the mode share of cycling trips to the Perth CBD increased from 2 per cent in 2006 to 2.9 per cent by 2011, while the share of cycling trips to work to the Perth CBD 'frame' increased from 1.9 per cent to 2.6 per cent by 2011. This continued the trend from 2001 of cycling trips increasing across all the destination zones, with the greatest increased being observed in the inner areas. There was also modest growth for walking in the inner areas, though the share of walking trips to the remainder of the Perth SD fell slightly from 2.5 per cent in 2006 to a share of 2.4 per cent by 2011. This reversed a modest positive trend in the 2001-2006 period, where walking to work throughout the remainder of the Perth SD had increased from 2.2 per cent in 2001 to 2.5 per cent by 2006.

Table 4: Share of work trips and modes used by destination zones for the Perth SD

	Perth SD			Perth CBD			Perth CBD Frame			Remainder Perth SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**7.7**	**10.0**	**10.1**	**8.6**	**7.7**	**7.6**	**83.8**	**82.3**	**82.3**
MODES:												
Public Transport	**9.2**	**10.7**	**13.0**	**47.6**	**50.5**	**57.9**	**21.4**	**23.8**	**30.5**	**4.0**	**4.2**	**5.5**
Train	4.6	5.4	8.5	23.3	24.9	39.2	11.3	13.5	21.7	2.0	2.0	3.2
Tram/Ferry	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0
Bus	4.6	5.2	4.5	24.2	25.4	18.6	10.0	10.2	8.8	2.0	2.1	2.2
Car Total	**83.6**	**83.6**	**81.2**	**47.2**	**43.1**	**34.3**	**72.2**	**70.1**	**61.6**	**88.5**	**90.3**	**89.2**
Driver	76.7	76.9	75.1	38.6	35.5	28.5	65.4	63.7	55.8	81.8	83.6	83.1
Passenger	6.9	6.8	6.1	8.6	7.7	5.8	6.9	6.3	5.8	6.7	6.7	6.1
Bicycle	**1.1**	**1.2**	**1.4**	**1.3**	**2.0**	**2.9**	**1.7**	**1.9**	**2.6**	**1.0**	**1.0**	**1.1**
Walked Only	**2.2**	**2.6**	**2.7**	**1.8**	**3.0**	**3.7**	**2.1**	**2.7**	**3.6**	**2.2**	**2.5**	**2.4**
Other Modes	**3.9**	**1.9**	**1.7**	**2.1**	**1.3**	**1.2**	**2.6**	**1.5**	**1.7**	**4.2**	**2.0**	**1.8**

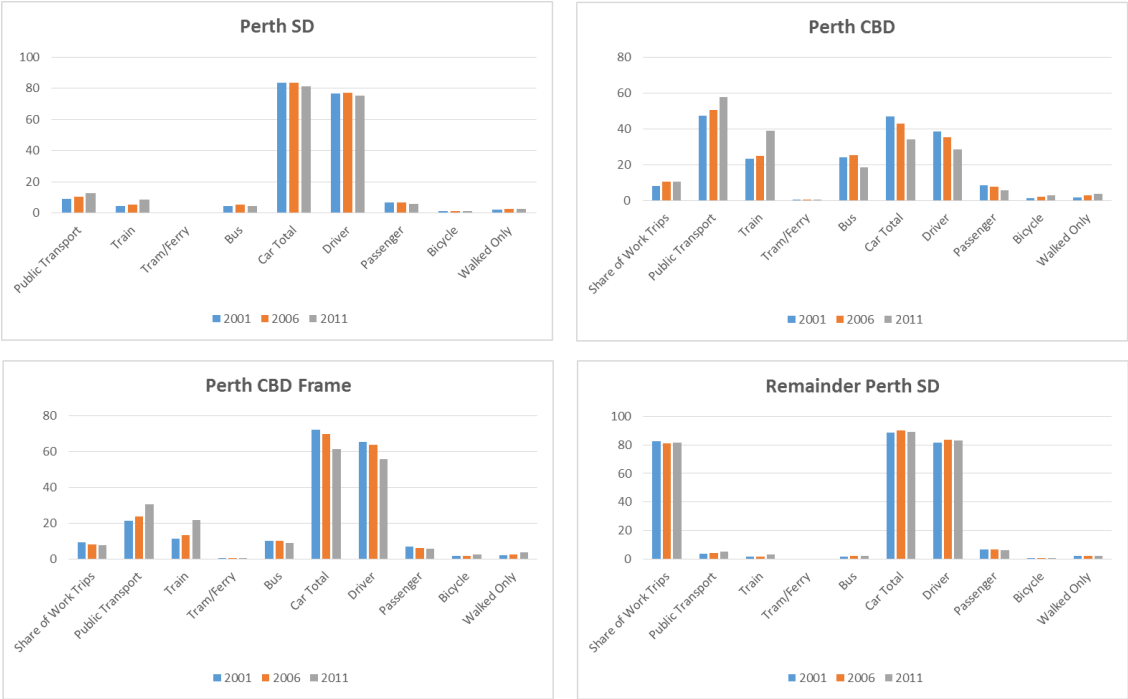


Figure 4: Share of work trips and modes used by destination zones for the Perth SD

2.5 Adelaide

2.5.1 Distribution of employment

The share of employed persons in the Adelaide CBD increased from 20.9 per cent in 2006 to 22.2 per cent by 2011, while the share of employed persons for the remainder of the Adelaide SD decreased from 79.1 per cent in 2006 to 77.8 per cent by 2011. This has continued the trend of concentration of employed persons in the Adelaide CBD since 2001.

2.5.2 Distribution of public transport work trips

There were mixed results for public transport work trips across the Adelaide SD between 2006 and 2011. While the share of train trips to the Adelaide CBD increased from 8.9 per cent in 2006 to 9.2 per cent by 2011, the share of train trips for the remainder of the Adelaide SD decreased from 1.0 per cent in 2006 to 0.8 per cent by 2011. Furthermore, only 36 per cent of work trips to the Adelaide CBD were undertaken by public transport in 2011, with 55.3 per cent of work trips were undertaken by car. The number of people who took the tram to work increased from 1.4 per cent in 2006 to 2.8 per cent by 2011. These trends are a reversal of what occurred in the 2001-2006 period, with an example being an increase in the number of employed persons within the remainder of the Adelaide SD catching public transport to work.

2.5.3 Distribution of active transport work trips

The mode share of cycling to the Adelaide CBD increased from 2.2 per cent in 2006 to 3 per cent by 2011, while the remainder of the Adelaide saw the share of cycling trips to work decrease from 1.3 per cent in 2006 to 1 per cent by 2011. This continued the trend from 2001 of cycling to work trips to the Adelaide CBD, though across the Adelaide SD, there was a slight decrease in the number of people cycling to work between 2006-2011, going against the observed increase of cycling trips to work from 2001-2006. There was minor growth for walking trips in the Adelaide CBD, though the share of walking trips for the remainder of the Adelaide SD decreased from 2.9 per cent in 2006 to a share of 2.5 per cent by 2011. This goes against the 2001-2006 trend where walking trips to work for the remainder of the Adelaide SD increased from 2.6 per cent in 2001 to 2.9 per cent by 2006. As a result, walking trips across the Adelaide SD decreased between 2006-2011, after growth was observed in 2001-2006.

Table 5: Share of work trips and modes used by destination zones in 2011 for the Adelaide SD

	Adelaide SD			Adelaide CBD			Remainder Adelaide SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**19.8**	**20.9**	**22.2**	**80.2**	**79.1**	**77.8**
MODES:									
Public Transport	**8.9**	**10.4**	**10.9**	**30.0**	**34.4**	**36.0**	**3.4**	**3.8**	**3.5**
Train	2.1	2.7	2.7	7.1	8.9	9.2	0.8	1.0	0.8
Tram/Ferry	0.3	0.4	0.7	1.0	1.4	2.8	0.1	0.1	0.1
Bus	6.6	7.4	7.5	22.0	24.2	24.0	2.6	2.8	2.6
Car Total	**83.7**	**83.1**	**83.1**	**63.2**	**57.4**	**55.3**	**89.0**	**90.1**	**91.3**
Driver	76.6	76.5	77.0	53.9	49.1	47.4	82.5	84.0	85.8
Passenger	7.1	6.6	6.1	9.3	8.3	7.8	6.5	6.1	5.6
Bicycle	**1.2**	**1.5**	**1.4**	**1.7**	**2.6**	**3.0**	**1.0**	**1.3**	**1.0**
Walked Only	**2.6**	**3.2**	**2.9**	**2.8**	**4.2**	**4.3**	**2.6**	**2.9**	**2.5**
Other Modes	**3.6**	**1.8**	**1.6**	**2.3**	**1.4**	**1.5**	**3.9**	**1.9**	**1.6**

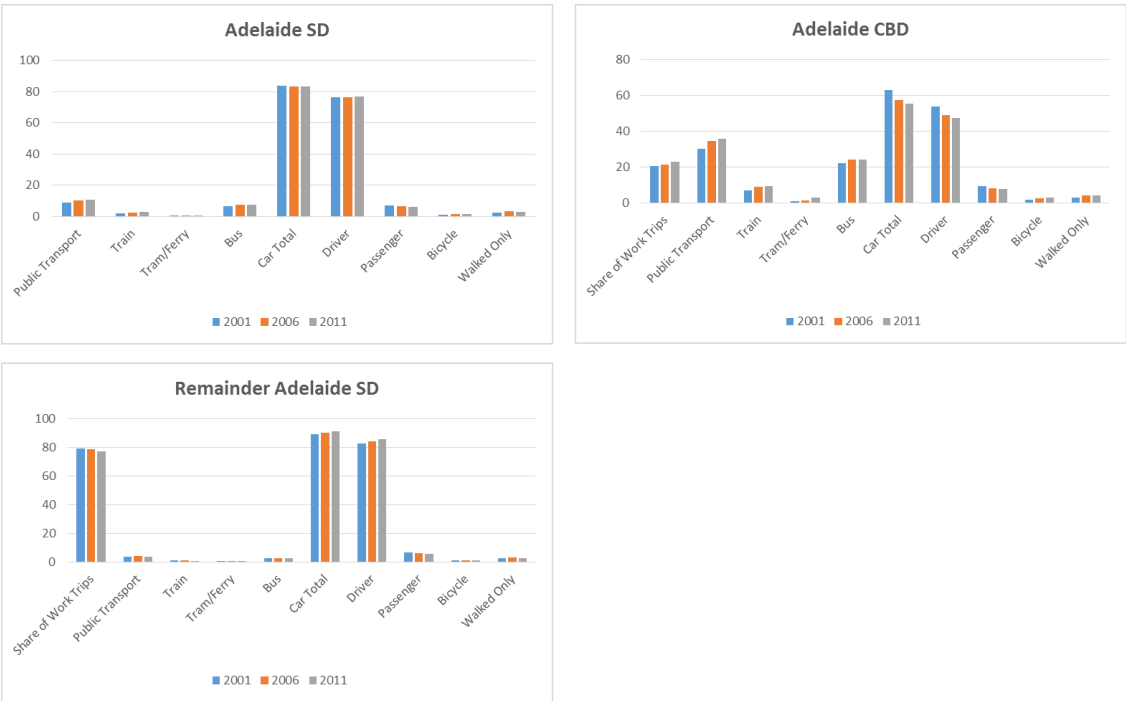


Figure 5: Share of work trips and modes used by destination zones for the Adelaide SD

2.6 Canberra

2.6.1 Distribution of employment

The share of employed persons in the Canberra CBD increased from 14.6 per cent in 2006 to 16.1 per cent by 2011, while the share of employed persons for the remainder of the Canberra SD decreased from 85.4 per cent in 2006 to 83.9 per cent by 2011. This has continued the trend of concentration of employed persons in the Canberra CBD since 2001.

2.6.2 Distribution of public transport work trips

There were mixed results for public transport work trips across the Canberra SD between 2006 and 2011. While the share of bus trips to the Canberra CBD increased from 18.1 per cent in 2006 to 18.3 per cent by 2011, the share of bus trips for the remainder of the Canberra SD decreased from 5.7 per cent in 2006 to 5.2 per cent by 2011. Furthermore, only 18.4 per cent of work trips to the Canberra CBD were undertaken by public transport in 2011, while 68 per cent of work trips were undertaken by car. These trends continued those seen since 2001, though there was a slower uptake of employed persons taking public transport to work in the CBD during the 2006-2011 period, compared to the 2001-2006 period.

2.6.3 Distribution of active transport work trips

The mode share of cycling trips to the Canberra CBD increased from 3 percent in 2006 to 4.4 per cent by 2011, while the remainder of the Canberra SD saw the share of cycling trips remain static at 2.4 per cent. This continued the overall trend from 2001 of cycling work trips to the Canberra CBD, with the uptake of employed persons cycling to work to the CBD much greater in the 2006-2011 period as opposed to the slower uptake in the 2001-2006 period. There was also modest growth for walking in the Canberra CBD from 6.4 per cent in 2006 to 7.1 per cent by 2011, though the share of walking trips to the remainder of the Canberra SD decreased from 4.5 per cent in 2006 to a share of 4.4 per cent by 2011.This differs from the 2001-2006 period where the number of employed persons walking to work in the remainder of the Canberra SD increased. Furthermore, the uptake of employed persons walking to work across the Canberra SD in the 2001-2006 period was much faster than observed in the 2006-2011 period.

Table 6: Share of work trips and modes used by destination zones for the Canberra SD

	Canberra SD			Canberra CBD			Remainder Canberra SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**11.1**	**14.6**	**16.1**	**88.9**	**85.4**	**83.9**
MODES:									
Public Transport	**6.7**	**7.6**	**7.5**	**12.5**	**18.2**	**18.4**	**5.9**	**5.7**	**5.3**
Train	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
Tram/Ferry	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Bus	6.6	7.5	7.4	12.3	18.1	18.3	5.8	5.7	5.2
Car Total	**82.6**	**82.8**	**83.1**	**77.3**	**70.2**	**68.0**	**83.3**	**85.0**	**86.0**
Driver	73.1	73.8	74.7	62.8	56.8	55.7	74.5	76.8	78.5
Passenger	9.4	9.0	8.3	14.5	13.4	12.3	8.8	8.2	7.5
Bicycle	**2.3**	**2.5**	**2.7**	**2.7**	**3.0**	**4.4**	**2.2**	**2.4**	**2.4**
Walked Only	**4.2**	**4.8**	**4.8**	**3.9**	**6.4**	**7.1**	**4.2**	**4.5**	**4.4**
Other Modes	**4.3**	**2.2**	**2.0**	**3.5**	**2.2**	**2.1**	**4.4**	**2.3**	**1.9**

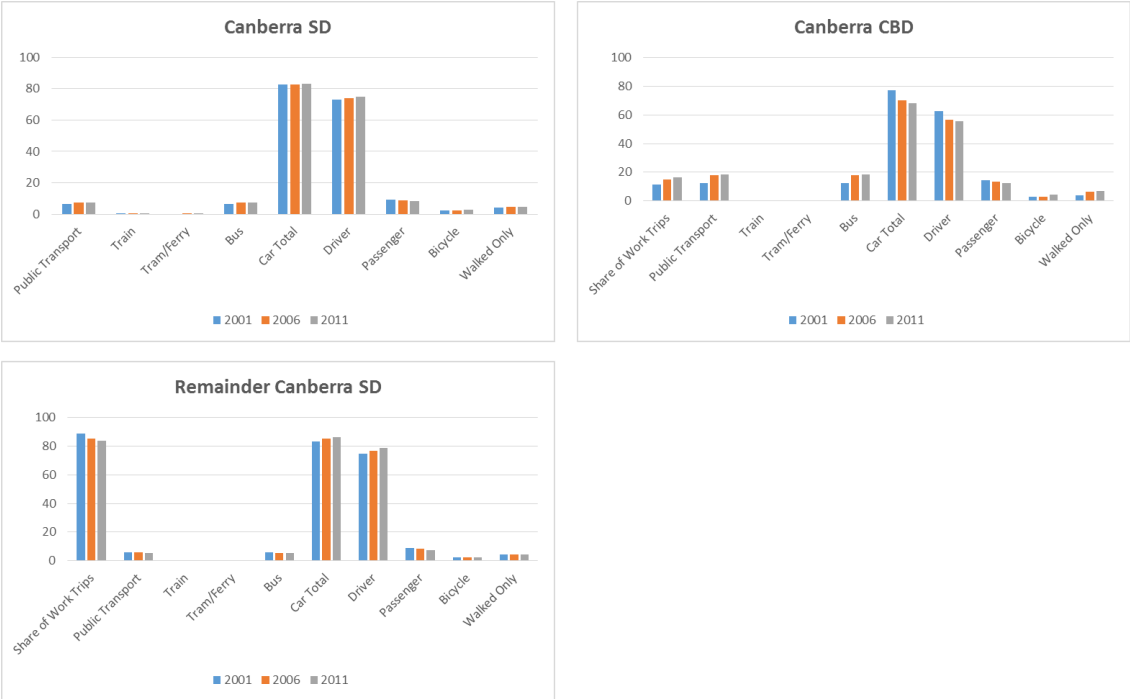


Figure 6: Share of work trips and modes used by destination zones for the Canberra SD

2.7 Hobart

2.7.1 Distribution of employment

Employment in Hobart became more concentrated in the CBD: the share of employed persons in the Hobart CBD increased from 19.8 per cent in 2006 to 23.2 per cent by 2011. This has continued the trend seen since 2001.

2.7.2 Distribution of public transport work trips

The share of bus trips to the Hobart CBD increased from 14.5 per cent in 2006 to 15.5 per cent by 2011, while the share of bus trips for the remainder of the Hobart SD decreased from 4.2 per cent in 2006 to 3.6 per cent by 2011. Furthermore, only 15.6 per cent of work trips to the Hobart CBD were undertaken by public transport in 2011, with 69.5 per cent of work trips were undertaken by car. These trends have continued since 2001, though there was a slower uptake of employed persons taking public transport to work in the Hobart CBD in the 2006-2011 period, compared to the 2001-2006 period.

2.7.3 Distribution of active transport work trips

The mode share for cycling trips to the Hobart CBD increased from 1.4 per cent in 2006 to 1.8 per cent by 2011, while the remainder of the Hobart SD saw the share of cycling trips decreased from 1.1 per cent in 2006 to 0.9 per cent by 2011. This continues the overall trend from 2001 of cycling work trips to the Hobart CBD, with the uptake of employed persons cycling to work to the CBD much greater in the 2006-2011 period as opposed to the slower uptake in the 2001-2006 period. Furthermore the positive growth that was observed in the 2001-2006 period of employed persons cycling to work within the remainder of the Hobart had decreased during the 2006-2011 period. There was also a decline for walking trips to work across the Hobart SD, with walking in the Hobart CBD decreasing from 11.9 per cent in 2006 to 11.6 per cent by 2011, with the remainder of the Hobart SD decreasing from 6.5 per cent in 2006 to a share of 5 per cent by 2011. This is in contrast to the 2001-2006 period, where there was growth in employed persons walking to work across the Hobart SD.

Table 7: Share of work trips and modes used by destination zones for the Hobart SD

	Hobart SD			Hobart CBD			Remainder Hobart SD		
	2001	2006	2011	2001	2006	2011	2001	2006	2011
Employed Persons				**19.4**	**19.8**	**23.2**	**80.6**	**80.2**	**76.8**
MODES:									
Public Transport	**6.1**	**6.4**	**6.6**	**14.1**	**14.6**	**15.6**	**4.1**	**4.3**	**3.7**
Train	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Tram/Ferry	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
Bus	6.0	6.3	6.4	13.9	14.5	15.5	4.0	4.2	3.6
Car Total	**81.8**	**83.0**	**84.1**	**71.0**	**70.7**	**69.5**	**84.5**	**86.1**	**88.7**
Driver	72.5	73.6	75.0	56.9	56.2	55.1	76.4	78.0	81.2
Passenger	9.3	9.4	9.1	14.1	14.5	14.4	8.1	8.1	7.5
Bicycle	**1.0**	**1.2**	**1.1**	**1.2**	**1.4**	**1.8**	**0.9**	**1.1**	**0.9**
Walked Only	**7.1**	**7.6**	**6.5**	**10.7**	**11.9**	**11.6**	**6.1**	**6.5**	**5.0**
Other Modes	**4.1**	**1.9**	**1.7**	**3.1**	**1.3**	**1.5**	**4.3**	**2.1**	**1.7**

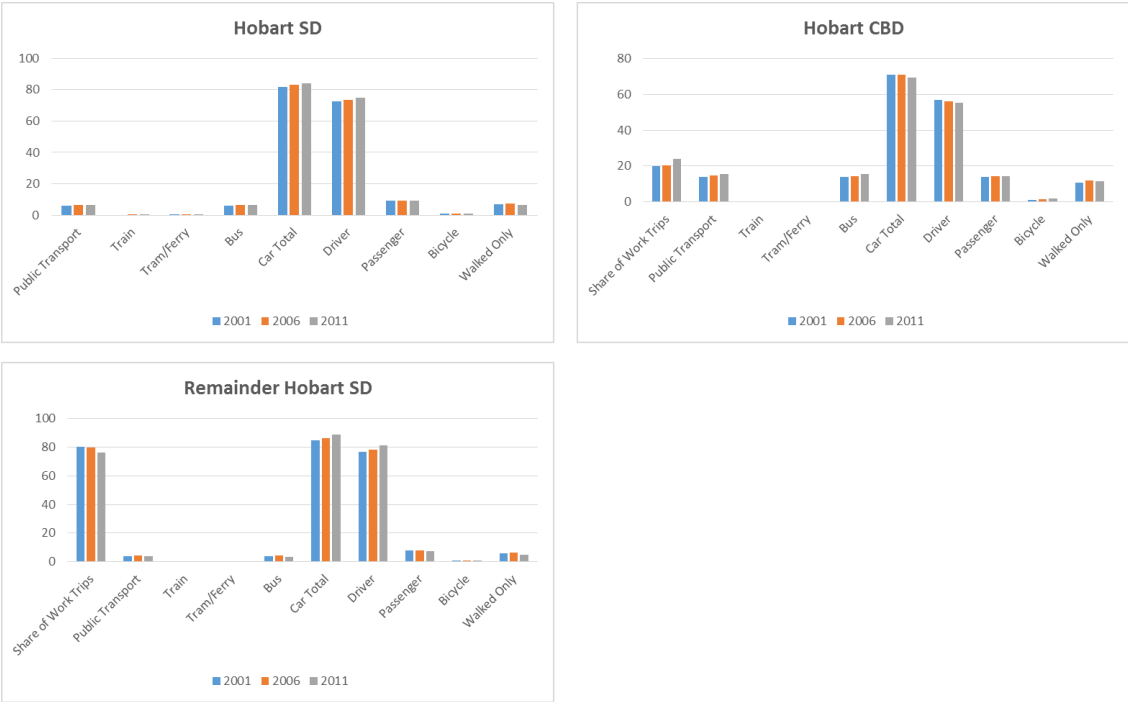


Figure 7: Share of work trips and modes used by destination zones for the Hobart SD

3. Conclusion

A key purpose of this research has been to test the assertion that the growth in the use of sustainable transport modes that has been observed in the past decade or more has been driven by a disproportionate concentration of new employment opportunities in the inner suburbs of Australia's capital cities, where sustainable transport modes offer more attractive travel alternatives to private transport modes. Besides the CBD 'frames' of Brisbane and Perth, where a slight increase in the dispersal of jobs had occurred, all the capital cities analysed throughout this research have attracted a greater concentrated share of employed persons to the CBD and CBD 'frames'.

Overall, as was the case for the Mees and Stone (2011) research, it was found that during the 2006-2011 period, this assumption does not hold true for the larger cities analysed for this research. While the growth in public transport occurred across all the CBD and CBD 'frames', the remainder of the Sydney, Melbourne, Brisbane and Perth SDs still experienced the greatest share growth of public transport uptake. This was complemented by their respective

CBD 'frames' also achieving a greater growth in the share of public transport trips in the 2006-2011 period than the CBDs. This was considered surprising given that the CBD has fixed radial rail and bus network that services these CBDs, along with achieving a greater concentration of the share of employed persons in the 2006-2011 period (excluding Melbourne). This could suggest a saturation of these assets in the CBD given the current availability of parking and level of service for public transport, cycling and walking. For all the cities analysed in this research, the greatest share of travel to work is undertaken with private transport, with walking trips across the remainder of the SDs decreasing between 2006 and 2011.

Despite these trends, it was also observed that, in most cities, mode share for public transport dropped significantly from the CBD to the CBD 'frame', where the majority of car trips are still undertaken by the car. Travel to the Brisbane 'frame' is an exception. Here, public transport has a greater mode share than the car. Furthermore, the mode shares for active travel were similar in the CBD and CBD 'frames', excluding the Sydney CBD 'frame', where the share of walking and cycling to work was greater than for its CBD counterpart. More can be done to improve public transport mode share for the 'frames' through better networks for distribution of workers arriving to the CBD on heavy rail and to prioritise more car disincentive measures such as more parking restrictions in the CBD.

For the smaller cities of Adelaide, Canberra and Hobart, the assumption holds true, with their CBDs increasing their share of employed persons and subsequently increasing their share of public transport trips at the expense of the remainder of their SDs. Despite this, the majority of employed person travelling to their CBDs used private transport to travel to work, with the share of car use increasing for the remainder of their SDs, a trend that was not observed for the larger cities in this analysis. Furthermore, these areas have seen a decrease in the number of employed persons taking the active forms of travel to work in the remainder of their SDs, with the exception of Hobart, which saw a decrease a share in its active transport use across its entire SD.

There are a range of implications for policy and decision makers to consider in relation to the JTW trends as described above. There is a greater need to look at these trends and to reassess the current and future land use and transport policy plans that have been or will be developed for Australia's capital cities and regions. There is also a need to push for an integrated land use and transport plans that encourages the development of employment and mixed-use clusters that are complimented by a sustainable transport system. The Institute for Transportation and Development Policy's (ITDP) eight *Principles for Transport in Urban Life* and Gustav Nielsen's Public Transport Network Principles are some notable examples that can be adopted (ITDP, 2012; Nielsen, 2005). This will ensure a user-hierarchy system that puts people first will lead to more productive, sustainable and liveable human settlements.

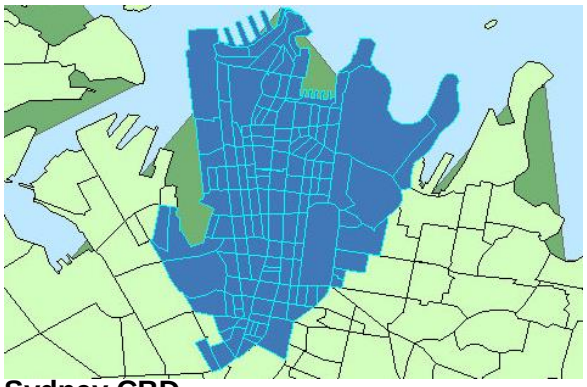
There should also be a greater consideration of the impacts that current strategic policies, initiatives and infrastructure projects will have on the current JTW commute patterns for the SDs of Australian cities. The current proposals across Australian cities to construct city-shaping infrastructure within the CBDs will continue to attract the current modal share of JTW trips to the inner areas, especially in absence of any similar policies and series for the remainder of the SD for these cities. The fact that there is still a reliance of mega-road projects also suggests that the current mode share dominance of private transport across the SD of Australian cities will continue into the foreseeable future. Therefore, car-disincentive policies such as reduced speed zones, reduced parking subsidies, reduced parking supply and congestion charging, along with the reallocation of financing towards multi-million dollar road systems are some further ideas that should also be considered by policy and decision makers.

This research has also demonstrated the need to undertake further research to understand the different JTW trends that are occurring between each of Australia's capital cities. The flexibility of TableBuilder Pro as a tool to create custom Destination Zones for this analysis suggests that this can be a useful tool to hypothesis and question a range of different phenomena at a range of different geographic scales.

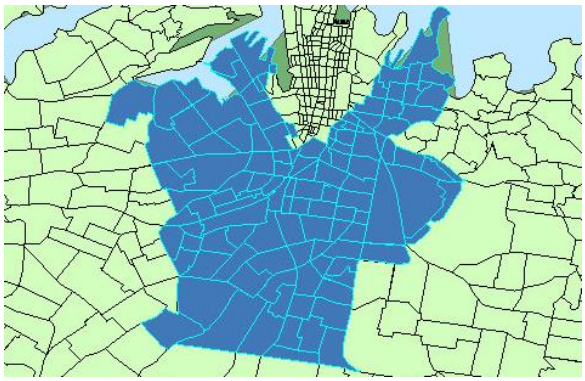
Appendix

For this research, it is important to note the different geographical scales being used. For the 2001 and 2006 Census databases that Stone and Mees (2011) utilised, the smallest geographical scale that could be used for that analysis were based at the Statistical Local Area (SLA) level for place of work, while for this analysis, a combination of SLA for Usual Place of Residence (origin zones) and Usual Place of Work (destination zones) were utilised. These differences in the different statistical boundaries can be attributed to the addition of geographical scales to the 2011 edition of TableBuilder Pro.

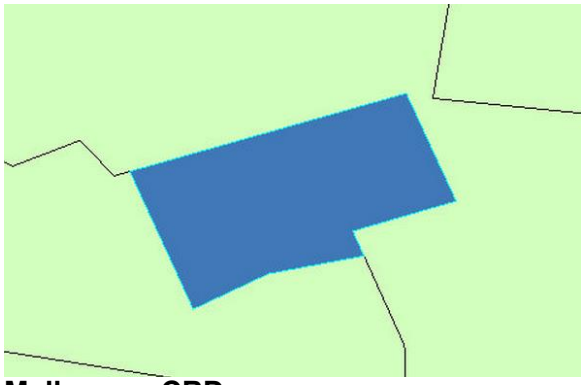
The destination zones were selected as the geographical scale of choice for place of work as the smaller zones could be amalgamated to the customised regions developed for this analysis. Furthermore, the other geographical scales provided for the place of work category in TableBuilder Pro did not correlate with the amalgamated SLAs utilised for the Stone and Mees (2011) analysis. Since destination zones are not part of the Australian Statistical Geography Structure, the custom destination zones that were created through the amalgamation of the destination zones did not always correlate with these of the corresponding amalgamated SLAs.



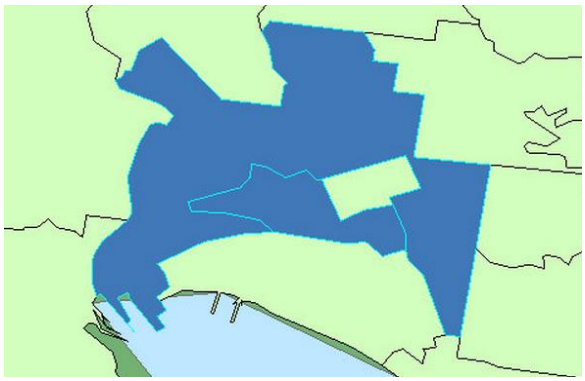
Sydney CBD



Sydney CBD 'frame'



Melbourne CBD



Melbourne CBD 'frame'

In **Brisbane**, the CBD destination zone lies between Ann and Charlotte Streets and the 'Remainder Brisbane Inner' zone extends north and west from the CBD to Hale St, College Rd and Wickham Terrace and south to the river at Gardens Point.

In **Perth**, the CBD is bounded by the river, the Mitchell Freeway, the railway and Victoria Ave. The inner remainder zone includes Kings Park and the suburbs of East and West Perth.

In **Adelaide**, the inner zone covers the CBD grid, its surrounding parks and the North Adelaide precinct.

In **Canberra**, the inner zone is the CBD (or Civic).

In **Hobart**, the inner zone is a constrained area of the CBD bounded by Macquarie, Barrack, Brisbane and Campbell Streets.

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Disclaimer

The research and output produced in this paper are not representative of the views of the ACT Government, where George is currently employed, and the University of Canberra, where George currently studies.