Analysing the Effectiveness of Park and Ride as a Generator of Public Transport Mode Shift

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ABSTRACT

Providing accessible, cheap and plentiful car parking at commuter railway stations is often advocated as a means of encouraging car drivers to shift to public transport modes for part of their journey. Accordingly, State Governments across Australia have, in recent years, committed significant money to expanding park and ride facilities on their rail networks. While such projects are popular with commuters, questions remain over the role of park and ride in increasing public transport patronage.

Passenger interview surveys were recently carried out at selected railway stations on the Victorian metropolitan and regional rail networks to explore the extent to which park and ride facilities generate a mode shift from car-only modes to more sustainable transport modes. The results of the survey are comparable to the public transport increases recorded in similar studies undertaken in the United Kingdom and the United States. However, a significant proportion of respondents had changed their trip patterns, suggesting that the proportion of former drivers could be higher than that recorded. The study also suggested that the recorded shift resulted from a combination of changes in personal circumstances and transport related factors. These findings have implications for traditional economic models which assume that a return car trip to the city is saved for every diverted driver.

1 INTRODUCTION

Park and ride facilities are often introduced to expand the catchment area of public transport and to attract car commuters to more sustainable transport modes (Bolger 1995; Noel 1988). This is particularly important in suburban or outer-urban areas where residential densities are too small to support adequate feeder services on their own. Commuter railways in Australian cities stretch into many low-density residential neighbourhoods and the provision of cheap and plentiful car parking at railway stations may broaden local residents' mode choice from the traditional car or public transport only options. Moreover, the door-to-door travel time for a park and ride trip to the CBD is often less than an equivalent trip made by car or public transport only (Martinovich 2008). It is therefore not surprising that park and ride facilities are popular with commuters, and continue to be heavily utilised.

A number of recent studies into the UK bus-based park and ride schemes have questioned the effectiveness of park and ride as a generator of public transport mode shift amid concerns that significant numbers of users may have formerly used public transport for their entire trip (Parkhurst 1995; Simpson 2000). While the UK studies are not entirely transferable to the Australian commuter rail scenario, it raises the question whether the benefit that park and ride provides to the individual can still be justified if its effectiveness in changing travel behaviour is limited.

[1] This paper is presented with the permission of the Director of Public Transport, Victoria. Any opinions or statements made therein are solely the responsibility of the author.

This paper explores the effect of park and ride facilities in Melbourne, Australia. In particular, it looks at the overall impact of park and ride and considers whether park and ride generates a mode shift from car-only modes to more sustainable transport modes. Reasons for switching to park and ride from other transport modes are also investigated. The paper starts with a review of the research literature associated with park and ride as a generator of travel behaviour change. Section 3 describes the context in which car parking facilities were upgraded at seven railway stations on the Victorian metropolitan and regional rail networks. Section 4 describes the methodology of a survey of park and ride users at these upgraded stations, and Section 5 outlines the results of this study. These results are then analysed to test the validity of the initial hypothesis and draw conclusions on the market for park and ride. The paper concludes with a discussion on key findings and their implication for future park and ride facilities.

2 LITERATURE REVIEW

Many of the studies (see generally studies cited in Parkhurst 1996) into park and ride have focussed on the bus-based park and ride schemes in small UK cities such as Oxford and York. In an early study of the Oxford park and ride scheme (Papoulias & Heggie, cited in Parkhurst 1996), it was found that a majority of park and ride users had formerly driven to the centre, while only 8% of users had travelled to the centre by bus. A review of subsequent studies into bus-based park and ride schemes in the UK (Table 1) suggests that, on weekdays, 61% of users previously drove to the city centre, while 21% previously used other public transport options. A further 18% of users either travelled by a different mode or did not previously travel to the city centre, but the studies do not provide a further break down of these trips.

Table 1 - Summary of weekday modal split impacts in small UK cities (* cited in Parkhurst 1996; WS Atkins 1998)

			Previous Travel Mode			
Source	**City**	**Sample Size**	**Car (driver)**	**Public Transport**	**Other**	**TOTAL**
Papoulias & Heggie (1976)*	Oxford	155	57%	8%	35%	100%
Devonald (1978)*	Oxford	262	66%	24%	10%	100%
Cooper (1993)*	York	154	63%	19%	18%	100%
Parkhurst & Stokes (1994)*	York	288	66%	26%	8%	100%
Parkhurst & Stokes (1994)*	Oxford	269	55%	36%	9%	100%
WS Atkins (1998)	Brighton	220	50%	18%	32%	100%
WS Atkins (1998)	Cambridge	204	58%	10%	32%	100%
WS Atkins (1998)	Coventry	208	52%	17%	31%	100%
WS Atkins (1998)	Norwich	204	56%	24%	20%	100%
WS Atkins (1998)	Plymouth	208	70%	14%	16%	100%
WS Atkins (1998)	Reading	220	66%	28%	6%	100%
WS Atkins (1998)	Shrewsbury	205	71%	15%	14%	100%
Weighted Average			**61%**	**21%**	**18%**	**100%**

While the UK examples are important, they may not be transferable to a large metropolitan area serviced by heavy rail or rail-like express bus services, such as exists in Australian cities. Investigations undertaken in the US (Table 2) suggest that, even in large cities, park and ride facilities associated with express bus services attract a majority of their custom from former drivers. However, a small number of case studies have demonstrated that the proportion of former drivers diverted to rail-based park and ride facilities is approximately half that which is diverted to bus-based park and ride facilities. Similar results have been recorded in the few

studies undertaken outside North America. A review of park and ride use on London commuter rail lines indicated that each new parking space generates between 0.1 and 0.3 new return rail trips (Niblett & Palmer 1993). A study of the Wellington commuter rail system in New Zealand found that only 1% - 3% of motor vehicle users would switch to park and ride if additional parking spaces were available or car park improvements were made (Land Transport New Zealand 2007).

Table 2 - Summary of modal split impacts for selected US cities (Barton Aschman Inc 1981; Bowler et al. 1986; Foote 2000)

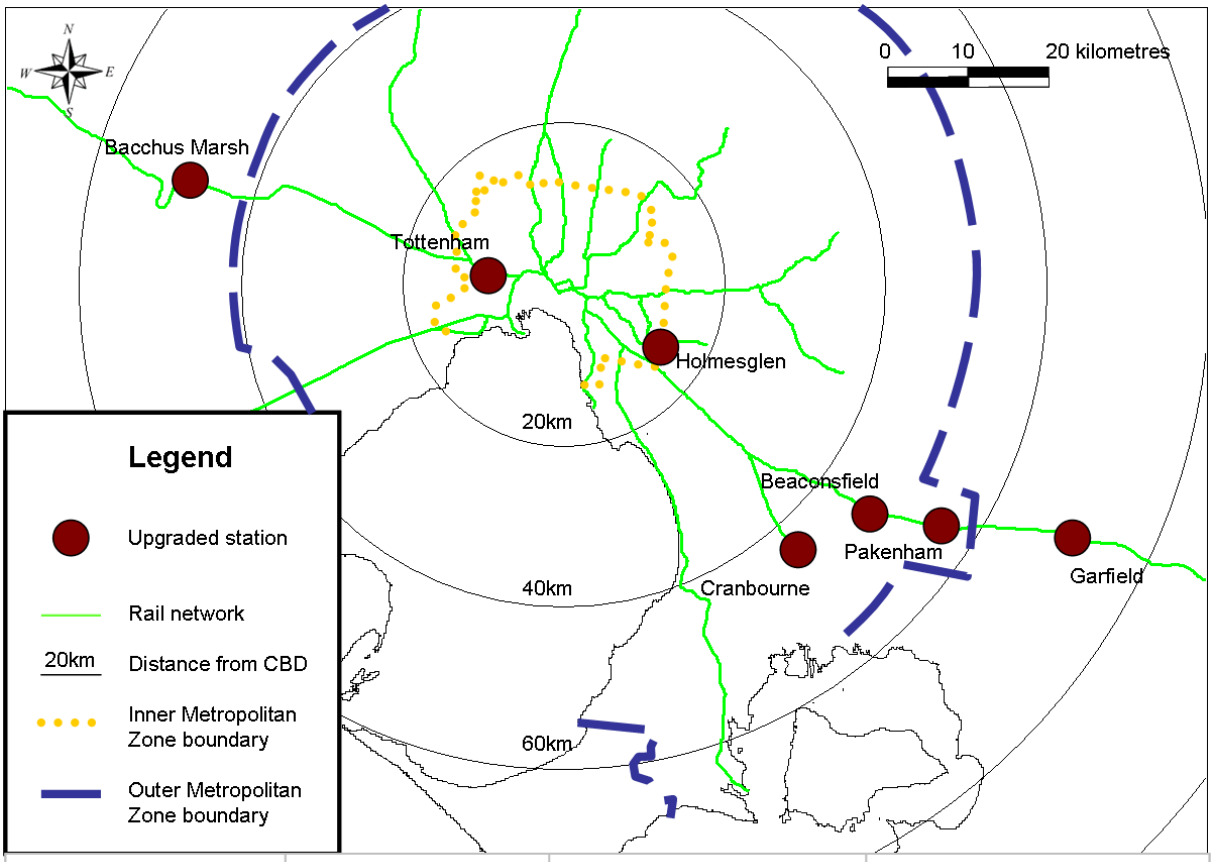
			Previous Travel Mode					
Source	**City**	**Mode**	**Drove alone**	**Carpool**	**Public Transport**	**Did not make trip**	**Other**	**TOTAL**
Barton Aschman (1981)	Hartford	Bus	57%	15%	23%	5%	0%	100%
Barton Aschman (1981)	Miami	Bus	54%	10%	22%	14%	0%	100%
Barton Aschman (1981)	Milwaukee	Bus	42%	12%	44%	2%	0%	100%
Barton Aschman (1981)	Seattle	Bus	59%	11%	29%	1%	0%	100%
Bowler et al (1986)	Dallas	Bus	50%	11%	11%	25%	3%	100%
Bowler et al (1986)	El Paso	Bus	62%	20%	7%	8%	3%	100%
Bowler et al (1986)	Fort Worth	Bus	63%	15%	8%	9%	5%	100%
Bowler et al (1986)	San Antonio	Bus	57%	10%	10%	20%	3%	100%
Bowler et al (1986)	San Francisco/LA	Bus	22%	9%	38%	29%	2%	100%
Average		**Bus**	**52%**	**13%**	**21%**	**13%**	**2%**	**100%**
Barton Aschman (1981)	Philadelphia†	Rail	44%	6%	50%	0%	0%	100%
Barton Aschman (1981)	Washington DC	Rail	25%	18%	38%	19%		100%
Bowler et al (1986)	San Francisco	Rail	37%	18%	N/A	N/A	N/A	N/A
Foote (2000)	Chicago	Rail	24%	4%	26%	18%	28%	100%
Average††		**Rail**	**29%**	**13%**	**N/A**	**N/A**	**N/A**	**N/A**

† Prior mode of travellers not making a new trip
†† Averaged results exclude Philadelphia sample as it is not comparable with the other surveys

3 CONTEXT

Park and ride plays an important role in Melbourne's public transport system. In 2008, approximately 31,500 park and ride spaces were available for use at railway stations throughout the metropolitan network (Department of Transport 2008a). While there is spare capacity at some station car parks, weekday use far exceeds supply at the majority of locations. A recent audit of parking use at metropolitan stations in Melbourne revealed that the total number of parked cars exceeded the number of parking spaces by approximately 50% (Department of Transport 2008a), with overflow parking occurring on local residential streets. Assuming a car occupancy rate of 1.12 (Transport Research Centre 1994-1999) and that every car occupant makes one return rail trip each weekday, boardings due to park and ride represent 17% of all weekday trips on the metropolitan rail network (Department of Transport 2008b). In addition to car parking on the metropolitan network, more than 4,000 car parking spaces are available at railway stations on the regional rail network.

In 2006, the Victorian State Government committed $90 million to deliver 5,000 additional car parking spaces at railway stations on the metropolitan and regional rail networks (Department of Infrastructure 2006). It was envisaged that this commitment would cover both construction and land acquisition costs. By mid-2008, the first seven car parking upgrades were opened, delivering an additional 580 car parking spaces for commuters. The location of these sites is shown in Figure 1.



	Station	Distance from CBD (km)	New spaces added 2008
Inner Metropolitan Zone	Holmesglen	14	59
	Tottenham	10	56
Outer Metropolitan Zone	Beaconsfield	45	72
	Cranbourne	42	90
	Pakenham	53	60
Regional Zone	Bacchus Marsh	47	161
	Garfield	69	82
	Total		**580**

Figure 1 - Upgraded stations on rail network (Department of Transport 2008a)

4 METHODOLOGY

This study analysed seven sites where parking has recently been upgraded, in order to understand the demand for park and ride at each of the stations. The data was grouped into three travel zones radiating from the central city (inner metropolitan, outer metropolitan and regional). The zones correspond with the fare zone boundaries for public transport travel in metropolitan and regional Victoria.

The first survey involved a count of all cars parked in and around the selected stations. Counts were undertaken at both 10am and 2pm on a single day in May 2008. The final parking demand figure was obtained by calculating the average value of these two counts. An identical survey had been undertaken at each of the selected stations in May 2007 to provide a comparative figure prior to the upgrade.

At the same time as the parking usage survey, an interview survey at each of the upgraded stations was undertaken to examine the extent to which park and ride generates a shift in travel behaviour. Due to limited resources, the survey was designed to maximise response numbers with respondents asked only four short-answer questions. Demographic data on the respondents was also collected. Surveys were conducted on a sample of inbound passengers during the weekday AM peak. For inner and outer metropolitan passengers, the weekday AM peak was assumed to be 7:00am – 9:00am. For regional passengers, the weekday AM peak was assumed to be 6:30am – 8:30am.

The questionnaire specifically targeted passengers' travel mode before and after the opening of the new car park, and (where applicable) the reasons for any change in travel behaviour. The survey aimed to interview at least 15% of all peak hour commuters. It was further hoped to capture responses from at least 15% of passengers who drove to each of the surveyed locations. The sampling frame of the survey is provided in Table 3. The sampling target was achieved at all sites except for park and ride users at Tottenham. Given the sampling methodology employed, it was assumed that the sample was non-random.

Table 3 - Park and Ride interview survey sampling frame (Department of Transport 2008b)

Station	Avg weekday AM peak boardings (7am -9am)	Sample Size	%	No. cars parked	No. car drivers in sample	%
Inner Metropolitan						
Holmesglen	778	212	27%	227	57	25%
Tottenham	470	76	16%	212	23	11%
Total	*1,248*	*288*	*23%*	*439*	*80*	*18%*
Outer Metropolitan						
Beaconsfield	166	70	42%	188	46	24%
Cranbourne	578	131	23%	372	56	15%
Pakenham	599	130	22%	386	60	16%
Total	*1,343*	*331*	*25%*	*946*	*162*	*17%*
Regional						
Bacchus Marsh	494	92	19%	374	56	15%
Garfield	49	23	47%	35	9	26%
Total	*543*	*115*	*21%*	*409*	*65*	*16%*
TOTAL	**3,134**	**734**	**23%**	**1,794**	**307**	**17%**

5 RESULTS

5.1 Park and Ride demand

Vehicle counts in both 2007 (i.e. prior to the expansion of park and ride facilities) and 2008 (i.e. following the upgrade to park and ride facilities) revealed that the demand for park and ride exceeded parking supply at all surveyed locations (Table 4). Vehicle counts in 2007 roughly matched the total number of parking spaces that were provided once the upgrades were completed. However, in the year between observations, parking demand increased further meaning that the car parks at each station were again heavily over-subscribed.

Table 4 also provides an estimate of the total weekday boardings for each station in both 2007 (metropolitan stations only) and 2008. The proportion of cars parked at each site relative to the total number of weekday boardings gives an estimate of the park and ride (driver only) mode share at each station. The data demonstrates that the park and ride mode share is smallest in inner suburban areas, and greatest in outer urban and regional areas. At four of the five metropolitan stations, park and ride mode share increased between 2007 and 2008, indicating that park and ride use grew more rapidly than public transport boardings at these locations. Across all five metropolitan stations, car parking demand increased by 21%, while public transport boardings increased by 13%. These results can be compared against the entire metropolitan rail network where, between 2006 and 2008,[2] car parking use increased by an average of 9% per annum, while boardings increased by an average of 10% per annum (Department of Transport 2008a; Department of Transport 2008b).

Table 4 - Park and Ride demand (Department of Transport 2008b); NR = Not Recorded

	2007				2008			
Station	**No. parking spaces**	**No. cars parked**	**Estimated weekday boardings**	**Mode Share**	**No. parking spaces**	**No. cars parked**	**Estimated weekday boardings**	**Mode Share**
Inner Metropolitan								
Holmesglen	136	211	2,223	9%	195	227	2,479	9%
Tottenham	72	140	1,055	13%	128	212	1,270	17%
Total	*208*	*351*	*3,278*	*11%*	*323*	*439*	*3,749*	*12%*
Outer Metropolitan								
Beaconsfield	49	138	505	27%	121	188	550	34%
Cranbourne	225	318	1,418	22%	315	372	1,635	23%
Pakenham	250	339	1,586	21%	310	386	1,733	22%
Total	*524*	*795*	*3,509*	*23%*	*746*	*946*	*3,918*	*24%*
Regional								
Bacchus Marsh	100	NR	NR	NR	261	374	771	49%
Garfield	0	NR	NR	NR	82	35	71	49%
Total	*100*				*343*	*409*	*842*	*49%*

Table 5 - Demographic profile of respondents

	Sample Profile			
Station	**Passengers from adjacent postcode(s)**	**% Male**	**<30 years of age**	**>50 years of age**
Inner Metropolitan				
Holmesglen	60.4%	67%	55%	5%
Tottenham	65.8%	58%	45%	5%
Outer Metropolitan				
Beaconsfield	82.9%	60%	34%	16%
Cranbourne	74.6%	54%	43%	14%
Pakenham	70.4%	44%	38%	23%
Regional				
Bacchus Marsh	92.4%	42%	27%	39%
Garfield	87.0%	30%	13%	43%

[2] No car parking demand figures for the metropolitan network as a whole were available for 2007.

5.2 Demographic characteristics

Demographic analysis of the interview survey respondents revealed marked differences between stations in different travel zones, but strong similarities between stations within the same zone, even where the stations are situated on opposite sides of the city (Table 5). The profile shows that users of the selected inner metropolitan stations were most likely to reside in a wider range of postcodes, and were most likely to be males under the age of 30. Users of the selected regional stations were most likely to reside in the immediate vicinity, and most likely to be females over the age of 50. Across all measures, the profile for the sample using the outer metropolitan stations fell somewhere between that of the inner metropolitan stations and that of the regional stations. Given the homogeneity of the samples within each zone, the data was aggregated to a zonal level for the remainder of the study. This aggregation aims to reduce the inconsistencies that might arise from using numerically small samples.

5.3 Travel Behaviour

5.3.1 Mode of Access

In each zone, approximately 90% of survey respondents accessed the station by either walking, driving (i.e. park and ride) or as a car passenger (Table 6). The car is the preferred mode of access for 81.7% of all users at regional stations, but only 39.9% of all users at inner metropolitan stations. As the interview survey was conducted only during the morning peak, the sample park and ride mode share was higher than the all day park and ride mode share (Table 4). Across all seven stations, a total of 307 park and ride users were recorded; this represents approximately 42% of the total surveyed sample.

Table 6 - Mode of Access by Station Location

	Inner Metropolitan		Outer Metropolitan		Regional	
Mode of Access	**N**	**%**	**N**	**%**	**N**	**%**
Walk	152	52.8%	65	19.6%	14	12.2%
Cycle	0	0.0%	2	0.6%	2	1.7%
Drive	80	27.8%	162	48.9%	65	56.5%
Passenger - driver parked	12	4.2%	4	1.2%	3	2.6%
Passenger - dropped off	23	8.0%	64	19.3%	26	22.6%
Bus	10	3.5%	26	7.9%	3	2.6%
Other	11	3.8%	8	2.4%	2	1.7%
TOTAL	**288**	**100%**	**331**	**100%**	**115**	**100%**

5.3.2 Turnover rates

Table 7 shows that of the 307 park and ride users sampled, more than one-quarter (28.0%) had been using the station for less than one year (i.e. since the opening of the new car park). The variation in new users was similar in the outer metropolitan and regional zones, with the inner metropolitan zone showing an almost even split between new users and people who had used the station for over 12 months. Given that the total number of cars parked at the inner metropolitan stations increased by only 25% over the last twelve months (refer Table 4), the turnover rates suggest that approximately one-third of all users who were driving to an inner metropolitan station in 2007 were no longer doing so in 2008.

Table 7 - Length of Tenure by Station Location (Park and Ride users only)

	Inner Metropolitan		Outer Metropolitan		Regional		Total	
Tenure	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
> 12 months	42	52.5%	130	80.2%	49	75.4%	221	72.0%
< 12months	38	47.5%	32	19.8%	16	24.6%	86	28.0%
TOTAL	**80**		**162**		**65**		**307**	

5.3.3 Prior Travel Modes

Survey results indicated that, in addition to the 86 respondents who had commenced using the park and ride facility in the preceding 12 months, a further 23 respondents were existing station users who had switched their mode of access (Table 8). In general, these 23 respondents had previously either walked or were dropped off at the station. There was very little mode change from former bus users, although three of the stations did not have a connecting bus service.

Of the total number of respondents who had started driving to the station in the preceding 12 months (N= 109), 36% stated that they had previously driven to their destination. This proportion was fairly consistent across each zone, with the higher proportion recorded in the regional zone possibly attributable to the very small sample size. A further 29% of respondents stated that they had previously not made a similar trip, with the largest number of these respondents coming from the inner metropolitan stations.

Table 8 - Prior Travel Mode by Station Location (Park and Ride users only)

	Inner Metropolitan		Outer Metropolitan		Regional		Total	
Prior Travel Mode	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Did not use same station								
Drove to destination	14	32.6%	16	33.3%	9	50.0%	39	36%
Public Transport to destination	5	11.6%	3	6.3%	3	16.7%	11	10%
Car passenger to destination	0	0.0%	1	2.1%	1	5.6%	2	2%
Other/Not Stated	1	2.3%	1	2.1%	0	0.0%	2	2%
Did not make trip	18	41.9%	11	22.9%	3	16.7%	32	29%
Total	*38*		*32*		*16*		*86*	
Same station, different access mode								
Walked	3	7.0%	8	16.7%	0	0.0%	11	10%
Car Passenger	2	4.7%	6	12.5%	1	5.6%	9	8%
Cycled	0	0.0%	1	2.1%	1	5.6%	2	2%
Public Transport, eg. Bus	0	0.0%	1	2.1%	0	0.0%	1	1%
Total	*5*		*16*		*2*		*23*	
TOTAL	**43**	**100%**	**48**	**100%**	**18**	**100%**	**109**	**100%**

5.3.4 Travel Change Reasons

Respondents who had started driving to the station in the preceding 12 months were also surveyed as to their primary reason for changing their travel behaviour (Table 9). Half of the sample indicated that their switch was due to a change in their personal circumstances – either moving house or changing job location. Analysis of this group indicates that 33% drove to

work prior to their change in circumstances. Only 16% of the people who started driving to the station in the last 12 months attributed their change to a 'transport network' issue (i.e. parking, congestion, cost of petrol, availability of public transport). Just eight respondents (7%) indicated that the availability and convenience of parking at railway stations was the primary motivation for them changing their travel behaviour. The role of park and ride in influencing respondents' primary reason for changing their travel behaviour was not investigated in the study.

Table 9 – Primary reason for changing travel behaviour by Station Location (Park and Ride users only)

	Inner Metropolitan		Outer Metropolitan		Regional		Total	
Reasons for changing	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Moved home/Changed job location	29	67%	15	31%	10	56%	54	50%
Convenience of parking	3	7%	5	10%	0	0%	8	7%
Congestion/Petrol price	2	5%	2	4%	2	11%	6	6%
Temporary change - not usual trip	3	7%	3	6%	0	0%	6	6%
No Car access	1	2%	4	8%	1	6%	6	6%
Preference for public transport	0	0%	0	0%	3	17%	3	3%
Other/Not-stated	5	12%	19	40%	2	11%	26	24%
TOTAL	**43**	**100%**	**48**	**100%**	**18**	**100%**	**109**	**100%**

6 DISCUSSION

The study showed that park and ride plays an important role at each of the stations surveyed, with greater importance on park and ride as the distance from the city increases. The delivery of an additional 580 car parking spaces did not satisfy the demand for car parking at these locations, with a remaining deficit of 382 car parking spaces. These results reflect the broader demand for park and ride facilities, where the proposed construction of an additional 5,000 parking spaces will not meet the shortfall even if all spaces were to be constructed immediately.

Previous international studies have identified that, in both small and large cities, bus-based park and ride schemes can attract approximately 60% of their users from drivers who formerly drove to their destination. Rail-based park and ride schemes are less successful, attracting only about 30% of their custom from former drivers. The reasons for the greater attractiveness of bus-based park and ride schemes compared to rail-based park and ride schemes was not explored in this study. However, it should be noted that park and ride initiatives are often introduced along with other transport and land use changes. In particular, many of the bus-based park and ride facilities have been introduced together with new services, such that the resulting mode shift is due to both improved bus service levels and the availability of park and ride facilities. This is particularly the case in the UK where many bus park and ride schemes are run as independent public transport services, competing with (and offering better service levels than) the existing bus network (WS Atkins 1998). By contrast, the rail-based park and ride schemes reviewed in this study all serviced an existing rail transport system.

On initial observation, the results of this analysis appear to confirm previous research results from North America, with 36% of the sample of park and ride users indicating that they had previously driven to their destination; a further 23% reported that they had previously used public transport in combination with other non-car modes (walking or cycling). However,

29% of respondents indicated that they had previously not made a similar trip. This proportion is higher than the corresponding proportion recorded in US rail-based studies, and at the upper end of the range of results recorded in US bus-based studies. While this study did not investigate prior travel patterns of these users, the actual proportion of former driver trips must be somewhere in the range of 36% (assuming none of these users previously drove to their destination) to 67% (assuming all of these users previously drove to their destination). If these users are removed from the analysis, 51% of the remaining users drove to their destination prior to switching to park and ride. This proportion is larger than comparable US and UK results despite the fact that, like these other systems, the stations which were surveyed in this study serviced an existing rail transport system and no substantial service upgrades had occurred on the respective lines in the 12 month period prior to the survey.

The results of the final survey question provide insights into the factors influencing the use of the park and ride facility. These insights can be used to identify appropriate locations for future park and ride upgrades, and to tailor the marketing of such improvements. For instance, of all respondents surveyed, half nominated a change in their personal circumstances as the primary motivating factor for their switch to park and ride, with transport related factors considered far less important. This suggests that many of these park and ride users would have switched to park and ride regardless of whether the car park upgrades were constructed. This hypothesis is given some support by the fact that in both 2007 and 2008, the number of cars parked in the vicinity of the station exceeded the number of car parking spaces provided. Many drivers were not troubled by the limited availability of parking at the station and simply parked their vehicle in local surrounding streets. This study did not investigate possible traveller responses if car parking were not available. However, a 2003 parking survey conducted at Surrey Hills Railway Station (which has a similar location, user demographic and modal split to Holmesglen Station) did seek such responses (Palmer & Donnison 2003). It found that, if the car park was full upon their arrival, only 4% of drivers would drive to their final destination with 48% preferring to park in a nearby street. Similar preferences were shown in the event that the parking facility was closed; 46% of drivers would either park in a nearby street or at the next station with only 5% of drivers preferring to drive to their final destination.

7 CONCLUSION

This paper has explored the hypothesis that park and ride encourages a mode shift from car-only modes to more sustainable transport modes. A review of international evidence into both bus-based and rail-based park and ride schemes revealed that approximately 30% of users of rail-based park and ride schemes previously drove to their destination, which is roughly half that transferring to use bus-based park and ride schemes. The improved bus service level that often accompanies the opening of a bus-based park and ride facility was offered as a possible explanation for the different impacts of rail-based and bus-based park and ride schemes.

Interview surveys were undertaken at selected metropolitan and regional rail stations at which parking has recently been upgraded. Survey results were broadly in line with international evidence. However, the surveys recorded a large proportion of users who previously had not made a similar trip. If these users are discounted, survey results exceeded comparable results from US rail-based park and ride schemes. Any extrapolation of these results to the metropolitan area should be undertaken with caution, as the number of car drivers in the sample represents just 0.6% of all park and ride drivers across the metropolitan area.

The analysis presented in this paper emphasises the need for governments to consider land use, transport and parking policies holistically when planning projects and initiatives that are intended to influence mode choice. The analysis of respondents' reasons for changing their travel behaviour suggests that a change in personal circumstances is a major determinant of travel behaviour change. Further, the introduction of service improvements along with the provision of park and ride facilities may result in increased mode change. Understanding these motivating factors will allow governments to target future investment in park and ride facilities more effectively.

If the findings in this paper are applied more generally across the metropolitan and regional rail networks, this may improve the estimation of economic benefits for park and ride studies. For instance, traditional models have assumed that the provision of additional park and ride capacity saves a return car trip to the city for each diverted driver. However, if a majority of diverted drivers have done so due to a change in either their origin or destination, this assumption and the resulting economic benefits that flow from this assumption may no longer hold true. A better understanding of origin–destination pairs for those who have diverted to park and ride is required to determine the true benefits of park and ride schemes.

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REFERENCES

Barton-Aschman Inc 1981, *Traveler Response to Transportation System Changes* (2nd ed), Federal Highway Administration, Washington DC.

Bolger, D 1995, 'Planning park-and-ride facilities in Canada', *Plan Canada* July 1995, 6.

Bowler, C, Noel, E, Peterson, R & Christiansen, D 1986, *Park-and-Ride Facilities Guidelines for Planning, Design and Operation*, Federal Highway Administration, Washington DC.

Department of Infrastructure 2006, *Meeting Our Transport Challenges*, Melbourne.

Department of Transport 2008a, *Audit of Railway Station Car Parks*, Melbourne.

Department of Transport 2008b, *Estimated Weekday Train Boardings 2005/06 - 2007/08*, Melbourne.

Foote, PJ 2000, 'Chicago Transit Authority Weekday Park-and-Ride Users: Choice Market with Ridership Growth Potential', *Transportation Research Record* vol. 1735, pp 158-68.

Land Transport New Zealand 2007, *Park and Ride: Characteristics and Demand Forecasting*, report prepared by Booz Allen Hamilton, Wellington.

Martinovich, P 2008, 'The Integration of Rail Transit and Land Use in Western Australia', paper presented at the Conference on Railway Engineering, Perth, 7-10 September 2008.

Niblett, R & Palmer, DJ 1993, 'Park and ride in London and the South East', *Highways and Transportation* February 1993, pp 4-10.

Noel, EC 1988, 'Park-and-Ride: Alive, Well and Expanding in the United States', *Journal of Urban Planning and Development* vol. 114, no. 1, pp 2-14.

Palmer, J & Donnison, N 2003, *Working Paper: The Influence of Parking on Public Transport Use*, Department of Infrastructure, Melbourne.

Parkhurst, G 1995, 'Park and Ride: Could it lead to an increase in traffic?' *Transport Policy* vol. 2, no. 1, pp 15-23.

Parkhurst, G 1996, *The Economic and Modal Split Impacts of Short-Range Park and Ride Schemes: Evidence from Nine UK Cities*, University of Oxford Transport Studies Unit, Oxford.

Simpson, B 2000, 'Two reasons why park and ride can backfire', *Journal of the Institution of Highways and Transportation* vol. 47, no. 6, pp 9-10.

Transport Research Centre 1994-1999, *Victorian Activity and Travel Survey (VATS)*, Melbourne.

WS Atkins 1998, *The Travel Effects of Park and Ride*, report to the Department for Communities and Local Government, Epsom.