How Urban Design Affect Personal Activity and Travel Choice - An Analysis of Travel Data from Sample Communities in Adelaide

Ali Soltani[1]
[1] PhD Candidate, University of South Australia, Adelaide, SA, Australia

1 Introduction

Recently, there has been increasing academic and governmental support for improvements to the quality of the walking and bicycling environment in Australian cities, expressed in higher attention in policy-making planning manuscripts encouraging of such travel. Several local, regional, and state authorities are starting to advise to how non-motorised transportation may help address sustainability concerns with car dependency, air quality, health, safety, and the social activity of suburban residents. Australian New Urbanism advocates have supported this idea by emphasising on 'micro-design' aspects of local communities and street design, thus providing design guidelines and encouraging urban policies that reduce the need for motor vehicle transportation (Hall and Porterfield 2001; Scheurer 2004).

Despite efforts undertaken in policy, the importance of urban design factors in determining travel behaviour is not fully understood in Australian context, thus that effective policies influencing travel patterns are difficult to formulate. An important question is that by what extent, providing bicycle/pedestrian infrastructure and programs can affect the level of walking and bicycling activities? Answering this question needs much empirical quantitative and qualitative investigation which is in general a poorly developed subject at least in Australia.

This paper first discusses theoretical frameworks that guide the travel effects of community design. Second, it reports on methods and measures used to characterise built environments with emphasis on urban design concepts. Third, employing discrete choice models explains the influences of urban factors on travel choices in four cases study suburbs in Adelaide. Discussions follow regarding the different aspects of built environment in explaining the differences of choice modes taken especially walking and bicycling. Finally, suggestions about directions for future research are made.

2 Why urban design matters

Nowadays it has been accepted in modern cities that it is impossible to design cities to cater for unrestricted car use, but urban designers can think and work towards the creation of urban spaces that are more 'human scale'. Research by Lynch (1960) first defined what it is that people use to understand, and then to enjoy, the urban scene. According to Lynch, the essential requirements for Good Urban Design include *permeability:* people can go where they want; *legibility:* people can understand their surroundings and *robustness and richness:* the space should be flexible and interesting.

Bentley et al (1985) in Responsive Environments suggest that environments offering choice have the quality they call *robustness*. This is also the quality of averting, avoiding or delaying the loss of vitality and functionality. Jane Jacobs identifies four conditions that must be present for vital cities: mixed use (to encourage different users at different times); short city blocks (for ease of access and movement); a mixture of buildings, and dense concentrations of people to support diverse activities in a compact area. With these conditions in place, greater diversity of use and increased choice of engagement with the city becomes possible.

Given the social and geographical differences, every network design can be assessed for its function to make more choices and opportunities. Barton (2000) set criteria including access (to homes and facilities); continuity (continuous and less fragmented network); safety (from vehicular traffic); directness (following the shortest path); comfort (attention to surfaces and gradients); amenity (attractiveness of streetscape); bike parks and interchange with public transport. To provide connections that simply allow through-access for pedestrians is insufficient. Evidences (Craig 2001; Giles-Corti and Donovan 2002) indicate that there must also be attention to the quality of those connections if they are to attract use. A high quality environment increases the likelihood that people will walk, to work or anywhere else. One condition is that connections "must be visible, otherwise only people who already know the area can take advantage of them" (Bentley et al. 1985).

Different urban authorities and practitioners evaluate the quality of urban design with similar standards. The Western Australian (WA) government adopted the agenda to achieving sustainability in local development through *Livable Neighbourhoods* Program. Livable Neighbourhoods are compact, well-designed, sustainable communities designed to enhance local identity, provide diverse housing options, increase land use efficiency, increase local employment and support alternative travel modes (The Western Australian Planning Commission 1997). Livable Neighbourhoods are defined by a convenient 5-minute (400 metre) walking area, totalling about 50 hectares, with a highly interconnected network of streets and compatible land use mix (such as shops within neighbourhoods). Cul-de-sacs are less frequent, with paths that provide connections for walking and cycling. Where a site is of sufficient size, neighbourhoods are clustered together around a town centre.

3 Towards New Urbanism

The land use reforms can be implemented at various geographic scales. New Urbanism reflect neighborhood and local level planning, while access, management and clustering reflect similar principles at the site and block level. New Urbanism has gained increasing attention among development professionals and the general public, particularly in regions experiencing growth-related conflicts. Many see the New Urbanism as a way to accommodate growth while enhancing community and environmental objectives.

New Urbanism does not normally exclude motorised travel, but it increases transportation options, and sometimes gives priority to walking, cycling and transit. New Urbanism supports development of a more connected street network, often using a modified grid pattern. This provides multiple routes and more direct travel between destinations compared with a disconnected street network with many dead-end roads that result in more circuitous routes, and funnel traffic onto a few roadways. Increased street connectivity has been showed to reduce per capita vehicle travel, and reduce traffic volumes on major roads (Handy et al. 2003).

Some New Urbanism designers suggest that streetscapes provide a sense of enclosure (Duany et al. 2000). As a general rule they recommend that urban street be no more than six times as wide across as the height of the buildings that line it, from the building front or row of trees on one side of the street to those on the other. Urban buildings should be designed with details and amenities that are oriented to pedestrians, not just motorists.
Good urban design makes walking and bicycling attractive as well as provides basic requirements included safety, convenience, and pleasure. Urban design issues included building orientation, street connectivity and design, and building design all contribute to the relative friendliness of the built environment to pedestrian and bicyclists. The design-related features such as safety and convenience are significant dimensions to the desirability of living and walking in an urban area. Therefore, preparing the streets to be walked through

providing sidewalks, bike lanes, cross walks, curbs, and so on are important in affecting walking and cycling modes.

Transit-oriented development (TOD) is another paradigm suggested by New Urbanism designers. A TOD is basically a mixed-use community that encourage people to live near transit services and to decrease their dependence on driving. The developments around light rail stations in the Portland areas exhibit a good TOD example. Calthorpe Associates is a leader in TOD guidelines, where "principles emphasize a pedestrian-oriented street network, street facing architecture, a mix of complimentary uses, and the use of public transportation" (Calthorpe Associates 2004).

The post-second World War new towns and suburbs in Australia had been structured around cul-de-sacs which had defensible spaces. The majority of Australian recently developed master-planned communities (MPCs) have also been based on cul-de-sac patterns with car-oriented residential development. But the community sense and focus provided by cul-de-sacs were limited to only residents and their visitors. Furthermore, cul-de-sac design has been criticised because it lacks the interconnectedness of development patterns like the gridiron. As Rudlin and Falk (1999) expressed, cul-de-sacs are just the "magic of successful streets". It can be long and boring for pedestrians because of inefficient connections to nearby destinations (Southworth 2004). Also, it may be felt by residents as confusing because they lack a coherent structure and uniqueness. The solution is not restricted freedom, but better design together with changed attitudes. Cul-de-sacs, in some cases, are safer especially for children, since keeping them far away from collector roads is a prime consideration. In some areas, alleyways connecting roads, made for permeability purposes, are being closed to prevent children hanging around after or in the evening. Jane Jacobs (1961) suggested that the streets are safer and welcoming only when there are people walking through and "eyes on the street" so that the fear of violence is reduced.

Close proximity to key amenities and activity centres such as shopping centres, schools and parklands are very crucial to reduce the need to travel for a long distance as well as make alternative modes (i.e. walking; public transport) more feasible. A self-sufficiency of the suburb can be improved not by organising job places but through closeness to key amenities. Each key amenity has own supporting area, that a residential area can be benefited in different ways. The larger the proportion of the area with proximity buffer, the suburb is more favourable for those interested in walking/cycling activities.

The lack of local facilities within easy walking distance reduces the options available to everybody, limiting choice. An important question is whether or in what situation will people use local facilities? A survey of a number of such suburbs, found that the absence of local facilities was a prime cause of dissatisfaction (Barton 2000). Another advantage of local facilities is the ability to undertake multi-purpose trips which depends on the location pattern and clustering of facilities.

4 Past empirical research

There are several empirical studies which show that higher levels of pedestrian and bicycling occur in areas with street connectivity and pedestrian amenities than in those areas lacking these features (Cervero and Kockelman 1997). In this way, a grid street form can facilitate connectivity for pedestrians. One of the urban design impacts that have been studied is that the grid street layout can reduce trip distances for both pedestrian and car users.

An Australian health study by Giles-Corti and Donovan (2002) showed that neighbourhood streets are most frequently used for physical activity. The prevalence of walking as physical activity also explains the attractiveness of streets that are natural sites for walkers. This

finding points to opportunities for increasing walking and bicycling for transport purposes. On the other hand, the study also showed that people feel the built environment is not supportive enough to induce physical activity. Long distances separating places, lack of safe places and facilities for recreation, and poor accessibility to recreational facilities are among the common barriers people perceive exist in their environment.

5 Operationalising physical form

There is a need to measure urban design attributes carefully if we wish to make robust analysis to discover their impact on travel choices. The major elements of built environment which generally make up the urban fabric of a suburb and are related to the key issues of urban design are: land use; built form; circulation and public spaces. There are objectives measures which provide ideas on how they may be addressed. This section reviews some measures taken in this study to operationalise the analysis of the built environment. A complete list of urban form measures can be found in Song and Knapp (2004).

5.1 Permeability and connectivity of street network

- *Block size:* the smaller (or shorter) blocks mean more intersections, therefore shorter travel distances and a greater number of routes between locations. This is an interesting measure for policy makers because it is easy to understand.

- *Route Directness:* route directness (RD) may be measured to compare the straight and network distance between two points. RD is the ratio of route distance to straight line distance for two selected points (Soltani and Allen 2005). This indicator shows how directly a pedestrian can reach destinations with an urban environment. This means that areas with lower RD have better opportunity to get services closer to dwellings which encourages residents to walk instead of travelling by car to reach them. On the other hand, curvilinear and limited access between neighbouring places creates circuitous routes for pedestrians unless there is a separate pedestrian network that provides more direct access.

.

5.2 Diversity of land uses

One aspect of the diversity of the neighbourhood is the balance of land uses. It is believed the greater mixing of uses facilitates walking and cycling. Similarly, in the absence of land use mixing, homes are often located at greater distances from commercial area which further discourages walking and increases dependence on the automobile. The index used here is for the diversity of land uses based on a measure of "entropy" introduced by Cervero and Kocklman (1998). The following formula has been often used for land use mix

$$\frac{-\sum_{i=1}^{s}(p_i)\ln(p_i)}{\ln(s)}$$

In this formula, p_i is the proportion of each of the *s* land use types, which *i* is the number of land uses. The higher the value of this measure the more evenly distribution of land uses is.

5.3 Closeness to activity centres

Assuming that the residents of each suburb send their children to the schools nearby, the average distance of a school to all dwellings within the suburb can be measured. Smart Growth index (Allen 2002) calculated proximity as average distance weighting the number of dwelling units in a neighbourhood. A similar method is used to measure proximity to shopping complexes and schools.

5.4 Suitability of streets for pedestrians/cyclists

The other aspect of urban design such as building orientation, set backs, building design and architecture also influence travel behaviour. The condition and cleanliness of the buildings on the local streets can be important. Also maintenance and a clean appearance are important to people who are likely to walk through them (Appleyard 1981).

Similar to the efforts taken by 1000 Friends of Oregon (1996), a Pedestrian Environment Factor (PEF) is being used in this study for characterising the local streets and measure their suitability and friendliness for pedestrians. The PEF was defined by the author who scored each residential street ranging from 0 (very poor) to 10 (very good) based on the below subheadings:

- *Safety* (ease of street crossing considering number of traffic lanes, posted vehicle speed limit, traffic calming practice, street lighting and visibility and minimal building setbacks);
- *Convenience* (presence of paved and wide sidewalk, pavement quality and level of maintenance, bike lane/path, and topography), and
- *Amenity* (building appearance and the quality of landscapes).

The PEF indicates overall pedestrian environment conditions, and then will be examined to observe its association with modal choice. A similar method applied for measuring the suitability of streets for cyclists which is called Cyclist Environment Factor (CEF). The CEF ranges between 0 (very poor) to 9 (very good).

5.5 Regional factors

There are some other urban form/design factors which might be important in influencing non-motorised choice, but as they are more related to macro-scale characteristics of urban form and less relevant to urban design issues, their description in detail are omitted here although they will be used for the follow modelling process. They include: density (residential) and the level of service for public transport.

6 Case study areas

This study was focused on differences in the travel effects of urban design between four distinct Australian suburbs: two traditional suburbs (Norwood and Unley), one early modern suburb (Para Hills), and one more recent late modern suburb (Golden Grove) that were comparable in both socio-economic respects and urban design. The two first suburbs are on the same inner ring, located approximately three kilometres from the CBD, and are about five kilometres from each other. The second two suburbs, Para Hills and Golden Grove are 18 and 23 kilometres from the CBD, both developed on hilly topography. The location and layout of these areas are depicted in Figure 1.

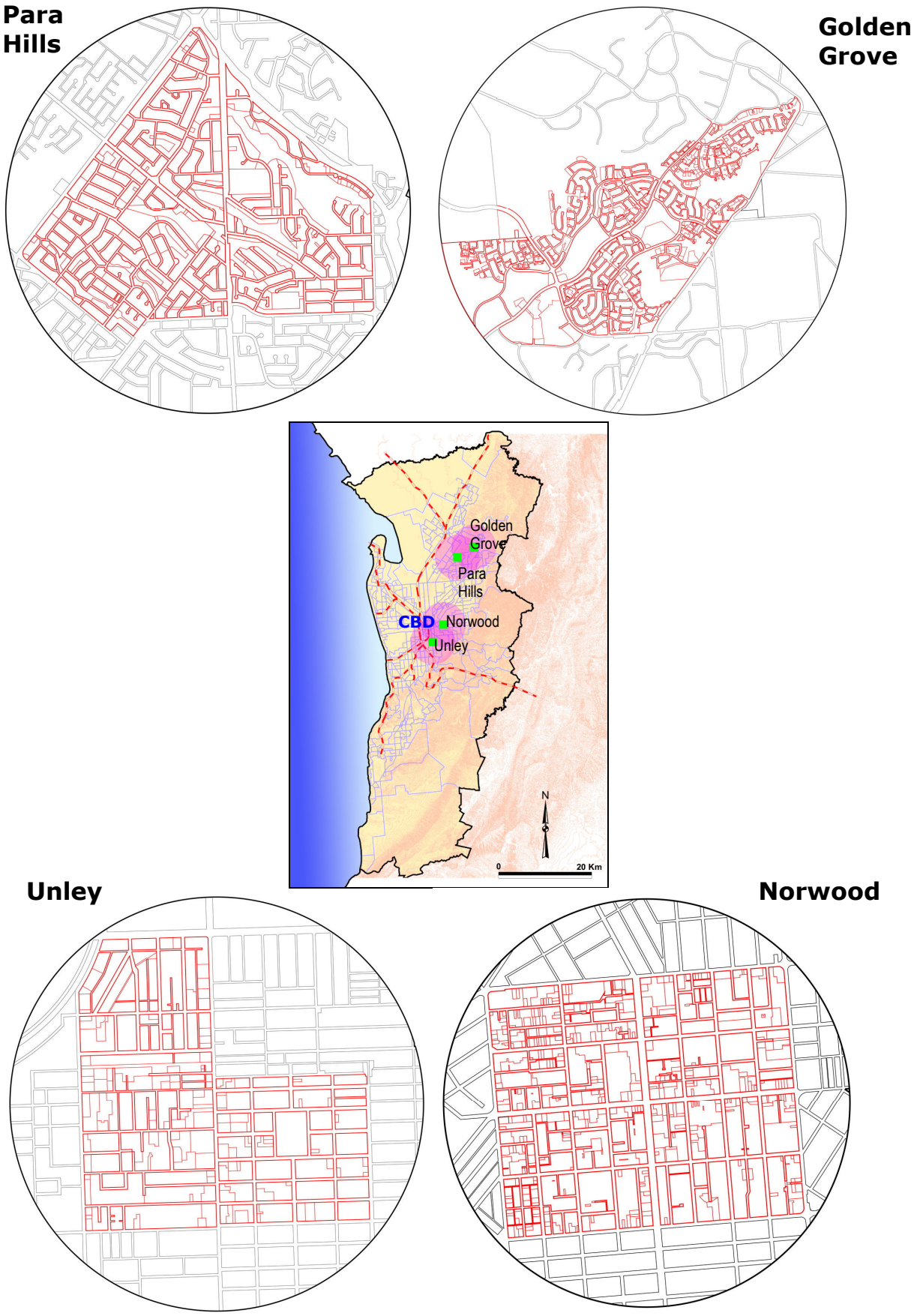

Figure 1: The location and layout of four case study areas within metropolitan Adelaide.

These two groups of suburbs have comparable median household income levels. Besides having decidedly different built environments, the only other notable difference between the two sets of suburbs is that inner suburbs accommodate a high share of administrators, and office workers, choosing the inner suburbs probably because of better accessibility to CBD. Inner suburbs have traditional neighbourhoods in many respects. Their main street, *the Parade* in Norwood, and *Unley Road* in Unley feature street walls of commercial-retail uses (Figure 2). A variety of house structures included multi-storey can be found in these inner suburbs. Also they have moderate residential densities. Outer suburbs: Para Hills and Golden Grove are opposite cases. Para Hills, located in urban fringe, is a completely different environment consisting of spread out strip development surrounded largely by parks and green spaces. The more recent (1980s — 90s) suburb Golden Grove has well established networks and landscaped recreational spaces, but it is less successful in properly addressing the creation of a pedestrian-oriented environment (Figure 3).

About 330 households living in these areas were asked to complete a travel diary. It was found about a 10 to 20 percent higher share of non-work trips by non-motorised modes among residents of inner suburbs. Probably most importantly, we found a much longer distance travelled for both work and non-work purposes by different modes, by urban fringe residents. Also, inner city residents travel more frequently than urban fringe residents (3.6 versus 3.3 per person per day). It was found that local trips, particularly to neighbouring shops, were occurring more often in inner suburbs than in the outer suburbs.

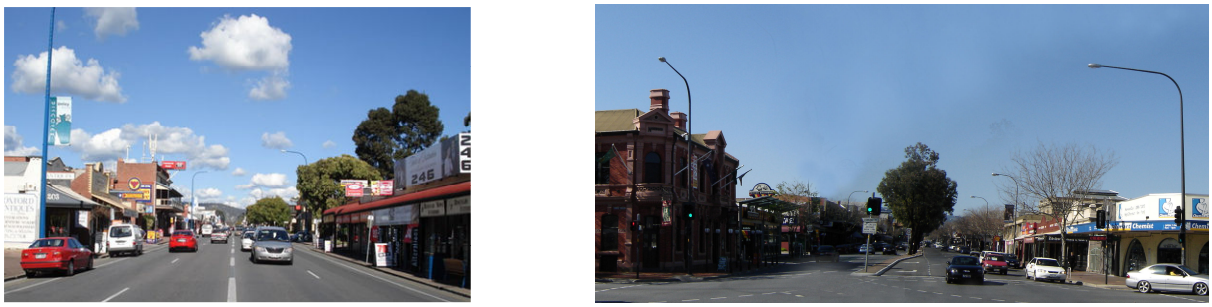

Figure 2: The older suburbs of Unley (left) and Norwood (right) promote a sense of community through their mixed-use environments and human-scale designs.

The primary findings also showed to some degree attitude effects. The household survey asked residents to record their opinion on their residential neighbourhood's suitability for different modes of travel. Residents from all communities had less sense of safety and security for walking and bicycling especially after dark.

Figure 3: The master planned development of Golden Grove is less successful in properly addressing the creation of a pedestrian-oriented environment

While residents of the recently developed master planned community Golden Grove were satisfied with surrounding landscapes and building forms, they had fewer propensities to

walking and cycling within their neighbourhood. One reason is that the layout and design of Golden Grove limits the alternative forms of travel. The average income level for the inner city households were higher, while a higher rate of car ownership can be found for urban fringe households (1.7 versus 1.5 vehicles per household), suggesting a meaningful correlation between suburbanisation and car ownership regardless of income level.

Data on these case study suburbs were collected from different sources listed below:

- Census data from (Australian Bureau of Statistics (ABS) 2001);
- Local transport data from Transport Department of South Australian Government
- Local GIS from Australian Digital cadastral Data Base (DCDB);
- Field data: the 2005 household questionnaire survey (n=328 households) and the 2004 street quality observations (n=114 streets) by the author. Figure 4 show four sample streets within the study areas: *William St* (Norwood); *Hughes St* (Unley); *Gibson St* (Golden Grove) and *Billabong St* (Para Hills);
- Composite data assembled from existing databases and field data.

Figure 4: Four sample residential streets from the case study areas.

7 Modelling travel effects of community design

To discover the impacts of urban design on travel behaviour, discrete-choice models were applied. The nested logit models (Train 2003) were employed here, consider each of the primary choices individually. The potentially restrictive assumption was made that the random components of utilities for each of the choices were independent from one another. In the models of trip modal choice, the choice set contained five alternatives: bicycling, walking, single-occupant (SOV) driving, shared riding and public transport. They could be grouped as non-motorised and motorised modes (Figure 4). Non-available choices were defined as follows: the bicycle alternative was not available when the individual was aged over 76. The Single-occupant vehicle alternative was not available for individuals with no driving license, or individuals from households with zero vehicles.

The specification of independent variables shows variables entered the models and the way they entered. The functional form of these variables mainly concerns the non-linearity of the impacts of some of these variables, as their marginal utility may vary according to their level. Basically, three types of variables were entered to a choice model: Alternative Specific Constant; Alternative Specific Attributes (ASAs) and Observation Specific Attributes (OSAs)

The ASCs measure the pure alternative effects, that is, the attributes of the alternative relative to the one without a constant term that are not measured in all other variables. ASCs represent the mean of the distribution of unobserved effects (Train 2003). The alternative specific constants (ASCs) for an alternative captures the average effect on utility of all factors that are not included in the model. On the other hand, because only differences in utility matter, so only differences in the ASCs are relevant, not their absolute amounts. Statistically significant ASCs indicate that the observed components of a model captured the major sources of variability. The same issue affects the way that observed specific attributes enter a model. Attributes of the alternatives, such as the time and cost of travel on different

modes, generally vary over alternatives. Alternative specific attributes are only collected for the alternative chosen by the survey participant. Because revealed preference (RP) surveys collect data on each observation, attributes for each observation are therefore obtainable from the respondents of the survey. But, the values for alternative specific attributes (ASAs) are unknown for the alternatives not chosen because the event of choosing these alternatives never occurred.

Following the method suggested by Primerano (2004), travel time as an alternative specific attribute (ASA) was calculated for non-chosen alternatives for modal choice models. Travel time was calculated using travel distance assuming constant average speed for different modes by dividing the distance travelled by the speed of the mode alternative for every trip (it was simply assumed that distance is multiplying speed by time).

Attributes of the decision maker included socio-economic attributes; urban form attributes and transport network characteristics did not vary over alternatives. They can only enter the model if they are specified in ways that create differences in utility over alternatives. The OSAs affect the differences in utility through their interaction with the attributes of the alternatives. The choice models of work and non-work (included shopping; social/recreational; medical/dental; education; personal business and 'other') trips were developed separately. It should be noted, that only those exogenous variables were considered which showed a significant association with dependent variables.

7.1 Modelling results

The modal choice models, including values of Alternative Specific Constants (ASCs), Alternative Specific Attributes (ASAs), values of attribute coefficients and their significance are detailed in Table 1 and table 2 for work and non-work trips respectively. The adjusted ρ^2 values were extremely good: 0.44 (work model) and 0.38 (non-work model), compared to the model with no coefficients. The t-statistics in the model were all above the threshold values of ±1.96 (95 percent confidence) showing that all ASCs and the coefficient estimates of attributes were the expected sign and were significant. Single occupant vehicle (SOV) driving mode was taken as the reference alternative.

Travel time for both two models showed a significant negative coefficient indicating the higher the values of this attribute the lower the utility. Therefore, the greater the travel times the lower the benefit to the trip-maker.

Only 5% of commuting in four sample suburbs trips were by public bus. For non-work trips (e.g. shopping; recreation/entertainment trips) public transport mode captured a higher market share, 8% of all journeys. Individuals with a driver's licence were least likely to walk to non-work destinations or a public form of transport. The only reasonably significant built environment variable was close proximity to shopping complex: the longer the distance to shopping centre within the suburb, the less likely an individual would catch public bus to non-work.

The other alternative mode for single-occupant drive was shared-ride with a share of 32% for all four suburbs. The influences of social variables included gender; number of vehicles; age and family type were significant. Females were more likely to choose 'shared ride' alternative and less likely to choose 'bicycling'; the greater the number of vehicles the less likely modes such as 'shared ride', 'walking' and 'bicycling' were used for going to work; the younger adults (16-35 years old) were less likely to choose 'walk' or 'shared-ride' to go to work, on contrast, the adults aged between 36 and 75 tended to take shred-riding for non-work travel; Individuals from families as couples living with children or adults were more likely to choose 'shared-ride' alternative to go to work compared to other types of families. It is interesting that Individuals living in single family homes were less likely to choose 'shared-

ride' to non-work or choose 'shared-ride' and 'walk' alternatives to work destinations compared to those living in other dwelling types. This was probably due to access to more parking spaces to maintaining and using fewer cars.

Table 1: Work trip choice model for the residents of four study suburbs

Variable name, Alternative	Coefficients	t-statistic
Alternative Specific Constants		
Public Transport	-5.237	-4.152
Shared Ride	.199	2.488
Walk	.232	3.171
Bicycle	-2.051	-6.622
Alternative Specific Attributes		
Travel Time (min)	-.218	-2.380
Observation Specific Attributes		
Driving license, public transport	-1.880	-1.995
Female, shared ride	.671	2.700
Female, bicycling	-.370	- 2.683
Age between16 and 35, shared ride	-1.485	-3.111
Age between16 and 35, walking	-.163	-3.010
Number of vehicles, shared ride	-.187	-3.991
Number of vehicles, walking	-.249	-4.345
Number of vehicles, bicycling	-.333	-4.919
Single family house, shared ride	-.842	-2.805
Single family house, walking	-.135	-2.279
Number of members, walking	.504E-01	2.539
Couple living with kids, shared ride	.744	2.869
Job closer than 2 km, walking	.438	3.282
Adjusted ρ^2 value (No Coefficients) = 0.44	No. of cases = 296	

Choosing to 'walk' was influenced by both urban and non-urban characteristics. Among built environment features, route directness; land-use diversity and proximity to workplace were positively associated with the decision to walk. The higher the degree of land use mixing within the neighbourhood, the more likely an individual would walk to non-work. The greater the directness of paths to non-work destinations within the neighbourhood, the more likely an individual would walk. Furthermore, if the distance to travel for job was less than two kilometres than an individual would be likely choose to walk.

Table 2: Non-work trip choice model for the residents of four study suburbs

Variable name, Alternative	Coefficients	t-statistic
Alternative Specific Constants		
Public Transport	.556	2.009
Shared Ride	.269	2.017
Walk	-4.221	-2.877
Bicycle	-2.450	-5.060
Alternative Specific Attributes		
Travel Time (min)	-1.532	-6.821
Observation Specific Attributes		
Driving license, public transport	-1.103	-2.030
Driving license, walking	-.987	-2.520
Female, shared ride	.440	2.103
Female, bicycling	-.927	-2.576
Age between36 and 55, shared ride	.420	1.986
Age between 56 and 75, shared ride	.687	2.521
Single family house, shared ride	-.549	-2.634
Distance to shopping centre (km), public transport	-1.572	-2.658
Number of members, walking	.362	2.892
Income between 500 and 1000 ($Aus), walking	.771	2.954
Route directness, walking	.730	1.967
Land use mix entropy, walking	.418E-02	2.724
Median block area (ha), bicycling	-.179	-1.985
Adjusted ρ^2 value (No Coefficients) = 0.38	No. of cases = 734	

Also, the higher the number of members within a household, the more likely an individual would walk to non-work. And individuals from households with weekly income between Aus $500 and $1000 were more likely to walk to non-work destinations compared to other income groups. The greater the number of members in a household, the more likely an individual would walk to work.

In terms of significance at the 5% probability, neighbourhood design characteristics had a far stronger influence on bicycling than walking choice. Only, block size was important to the decision to bike to walk: The bigger the size (area) of urban block within the neighbourhood, the less likely an individual would ride a bike to non-work. On the other hand, demographic characteristics such as gender and number of vehicles available in household did better explain of bicycling mode. However, there might be an indirect impact of built environment which was not proved here. For instance, females were neither to work nor to non-work purposes less likely to ride a bicycle, probably because of less confidence of riding on

shared roads or the lack of safe and secure streets which were caused by built form characteristics.

The subjective composite measures of the suitability of local streets for walking and bicycling: PEF and CEF represent the quality of the built environment were entered as exogenous variables in modelling processes, but could not play an significant role in explaining shifting in modal choices. The reason might be since these measures represent aggregated qualities of the environment together in a given neighbourhood, the modelling analysis could not find out the relative importance of the individual qualities e.g. topography or subsets of qualities. Residential density found to be correlated to some other physical form factors thus removed from the list. The level of service for public transport, calculated as the bus route's coverage was not proved to be significant in explaining modal choice.

8 Conclusion

This research can be seen as a primary but considerable experiment in the Australian context to explore the potential impacts of urban design on travel patterns. It was tried to include several possible factors which might be of importance, although factors like weather conditions or personal attitudes are absent from being controlled.

Generally, the study confirms that urban design in the four typical suburbs of metropolitan Adelaide generally have a modest but sometimes statistically significant effect on modal choices. In fact, well-connected streets, diverse land use, small urban blocks, and close distance to job were shown to induce non-motorised travel. Other exogenous urban factors, like density, street quality, regional workplace accessibility and close proximity to schools had little influences.

The fact that the residents of the older suburbs: Norwood and Unley, spend more time being actively in their neighbourhood may be a result of a strong sense of community and higher neighbourhood cohesion which are explaining by many non-physical factors and not soley urban design features. What is it about traditional neighbourhoods that are leading to the differences in travel choices that we see? Spending more time outdoors, in turn, causes an increase in social communication and social cohesion over time, and perhaps as a result reinforces increased physical activity. Comparing trip frequency per capita showed that residents of two traditional suburbs make extra trips mostly as leisure. They make some trips as they need for their daily usual requirements. However, they also make induced trips within their neighbourhood because they have that opportunity. In other words, by promoting accessibility and proving more opportunities, urban design policies may actually increase travel.

From a planning policy perspective, this suggests that greater daily activity and consequent health and environment benefits might accrue from designing human-scale, walkable communities that appeal to the preference of different social groups versus investment in master-planned communities in the hope of swaying travel behaviour. That is, pedestrian-friendly places suited to the taste preferences of socio-demographic groups might induce more physical activity over the long run through the process of residential self-selection than overt efforts to create fully planned, attractive and quality landscapes all over suburbia.

One critical question for researchers in this area has been how to measure urban form and design. Handy (2005) suggests measuring them in terms of what really matters to people. In past literature, conventional measures such as density or network layout –dummies for rectangular or curvilinear- have been used. However, this study shows that what matters for people is not sole density or network design. Greater diversity is associated with a range of activities, thus shorter distances to activities. Where distances become shorter and there are more choices of routes to get someplace, either in grid or curvilinear pattern, higher walking

activity has been experienced. Therefore, rather than relying on simple standard measures of urban form researchers must develop measures that reflect what really matters to people.

9 Future research

Through out the Adelaide metropolitan area, walking and bicycling are fringe modes and represent rare behaviours in studied areas. Even among the inner city households, and considering all utilitarian and leisure travel over a 24-hour period, only 6% bicycled and 23% walked. So discussing the potential for urban design, to induce or enable walking and bicycling should be taken with caution. Can a dramatic shift in modal choice be just expected through the modifications in spatial design alone? The theory that urban design matters remains valid and here suggests that one need to live in a quality design neighbourhood with close proximity i.e. less than 200 m to public facilities, to have a significant impact on walking and bicycling.

It would be interesting to see whether physical changes like the construction of sidewalks or improvement to bike lanes in an established suburb such as Para Hills are associated with changes in walking and bicycling after accounting for socio-economics. Are moving to environments that offer better opportunities for activity have associated increases in walking and bicycling? In this topic, recently, on going longitudinal panel studies have been started in Western Australia, which is surveying people travel behaviour prior to and after a residential moving (University of Western Australia 2004).

Regardless of the real impacts of urban design on travel, research on this relationship will help to show how design can provide choices to do something other than drive (Handy 2005). This means focusing on how design provides choices and not on how design changes behaviour and considering behaviour not as an end in itself, but as a measure of the environment quality. Further more, as people value walking as other alternatives apart from where they live, urban designers must try to maximise the opportunities for residents. “If walking is something that people value, maybe researchers should be looking at how we can provide that opportunity for people. If they take advantage of it, great, if not, at least they have the choice. Let’s not focus so much on how to change behaviour, rather let’s think about how to provide people with those opportunities” (Handy 2005).

An important question remains is whether increases in modal shift are substantial enough to justify the cost of improvements in walking and bicycling infrastructure, especially in established suburbs? In new developments zoning and subdivision rules can be modified to allow proximity to shops, parks and public services, but in established suburbs like Para Hills it is challenging. Other benefits such as overcoming health problems; air pollution and social segregation would need to be achieved.

10 References

Allen, E. (2002). Smart Growth INDEX, Criterion Planners/Engineers.

Appleyard , D. (1981). Liveable Streets. Berkeley, University of California Press.

Australian Bureau of Statistics (ABS) (2001). Census of Population and Housing: Journey to Work datasheets. Australia.

Barton, H. (2000). Sustainable Communities, the potential for eco-neighbourhoods. London.

Bentley, I., P. Murraine, et al. (1985). Responsive Environments: a manual for designers. London, Architectural Press.

Calthorpe Associates (2004) "Transit-Oriented Development." **Volume**, DOI:

Cervero , R. and K. Kockelman (1997). "Travel Demand and the 3Ds: Density, Diversity, and DesignTravel demand and 3D's: density; diversity and design." Transportation Research D **Vol. 2**(No. 3.).

Craig, D. J. (2001). Eco-villages and sustainability. Association of Pacific Rim Universities Doctoral Conference, Auckland, University of Auckland.

Duany, J., E. Plater-Zyberk, et al. (2000). Suburban Nation: The Rise of Sprawl and the Decline of the American Dream. New York, Farrar Straus & Giroux.

Giles-Corti, B. and R. J. Donovan (2002). "The relative influence of individual, social and physical environment determinants of physical activity." Social Science & Medicine **54**: 1793–1812.

Hall, K. B. and G. A. Porterfield (2001). Community by Design: New Urbanism for Suburbs and Small Communities. Sydney, McGraw-Hill.

Handy, S. (2005). Critical Assessment of the Literature on the Relationships Among Transportation, Land Use, and Physical Activity. Transportation Research Board and the Institute of Medicine Committee on Physical Activity, Health, Transportation, and Land Use.

Handy, S., R. Paterson, et al. (2003). Planning for Street Connectivity: Getting From Here to There. Planning Advisory Service Report. Chicago, American Planning Association.

Jacobs, J. (1961). The Death and Life of Great American Cities. London, Penguin.

Lynch, K. (1960). The Image of the City. Cambridge, MA, The MIT Press.

Primerano, F. (2004). Development of Accessibility Measures for Transport and Urban Planning. Transport Systems Centre. Adelaide, University of South Australia. **PhD**.

Rudlin, D. and N. Falk (1999). Building the 21st Century Home: The Sustainable Urban Neighbourhood. Oxford, Architectural Press.

Scheurer, J. (2004). New Urbanism in Australian Suburbs-A critical appraisal. AESOP 2004 Congress, Grenoble.

Soltani, A. and A. Allen (2005). A Computer Methodology for Assessment of Neighbourhoods for Walking, Cycling and Transit Use. Computers in Urban Planning and Urban Managment 2005, London, Univerity College London (UCL).

Song, Y. and G. J. Knaap (2004). "Measuring Urban Form: Is Portland Winning the War on Sprawl?" Journal of the American Planning Association (APA) **70**(2).

Southworth, J., and E. Ben-Joseph (2004). "Reconsidering the Cul-de-sac." Access(Spring 2004).

The Western Australian Planning Commission (1997). the Liveable Neighbourhoods Community Design Code. Perth, Department for Planning and Infrastructure, WA.

Train, K. (2003). Discrete Choice Methods with Simulation. Cambridge, Cambridge University Press.

University of Western Australia (2004). "The RESIDE (RESIDential Environments) Project." Retrieved Janurary 11, 2006, 2006, from http://www.publichealth.uwa.edu.au/welcom/research/hpreg/hpreg/staff/gilescorti/reside.