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Paper title: **Accessibility evaluation of the Adelaide-Crafers Highway**

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Abstract (200 words):
This paper discusses a framework used to develop measures of accessibility that take into consideration the travel behaviour of individuals in addition to other factors that are sensitive to transport and urban planning policies. The capabilities of the accessibility framework to evaluate transport policies are demonstrated to evaluate the impact of the Adelaide-Crafers Highway for road users in metropolitan Adelaide. The Adelaide-Crafers Highway was South Australia's largest road project that provides road users an alternate and more direct route between Adelaide and the suburbs of Stirling through the Mt Lofty Ranges. Road users benefit from improved travel times, reduced fuel costs, and increased safety and reduced accident costs through route length reduction, the bypassing and elimination of accident black spots, and an overall improvement of the road.

The results from the accessibility framework show how the benefits of the highway are distributed throughout metropolitan Adelaide and how the suburbs within Stirling have benefited from the highway construction based on the accessibility that individuals residing in Stirling have to their activities.

Introduction

Most measures of accessibility lack the capability to evaluate the impacts of transport policies that can directly influence travel decisions. There is a need for measures of accessibility to be more sensitive to transport policies. This paper discusses a framework used to develop measures of accessibility that take into consideration the travel behaviour of individuals in addition to other factors that are sensitive to transport and urban planning policies.

This paper commences with a discussion on accessibility and how it is defined in the context of this research. A review of accessibility measures is then undertaken to explore supply-based and supply/demand-based measures that currently exist. Following is a discussion of the accessibility framework, which was developed to combine the strengths of the measures reviewed and to measure activity from the individual-to-activity perspective rather than location-to-location perspective. The accessibility framework is first applied to metropolitan Adelaide to determine the levels of accessibility that existed in metropolitan Adelaide in 1999. The capabilities of the accessibility framework to evaluate transport policies are then demonstrated to evaluate the impact of the Adelaide-Crafers Highway for road users in metropolitan Adelaide. This paper shows how the benefits from the highway are distributed to road users throughout metropolitan Adelaide and how the accessibility of residents in the Stirling Local Government Area (LGA) to their activities is improved. The paper concludes with a discussion of the research reported in this paper and topics for further research to advance the accessibility framework developed.

Accessibility

Within transport planning, accessibility is generally defined as the ease for people to participate in activities from specific locations using a transport mode (Dalvi, 1978; Koenig, 1980; Niemeier, 1997). This definition of accessibility can be expanded to being the *ease* for *people* to participate in *activities* from specific locations to a *destination* using a *mode* of transport at a specific *time*.

The above definition of accessibility acknowledges that people vary in socio-economic and behavioural characteristics that influence the activity and travel choices they make. Accessibility varies according to the characteristics of individuals and the activity, location, mode and time choices they select.

The *ease* of participation in activities is estimated to determine accessibility and refers to any benefits or costs associated with travel. Such benefits and costs may encompass money, time, convenience and comfort to name a few. The ease of accessibility is subject to the remaining components as indicated in italics, namely people, activities, destinations, modes and time.

Accessibility is different for all activity types because of their location, availability, and their importance to individuals. Properties of destinations vary by the spatial separation of their location with respect to the location of individuals and by the characteristics of the destination itself. Each transport mode varies in relation to costs, benefits and perceptions. Obvious differences among modes are travel speeds and waiting times associated with each mode. Motorised forms of transport exhibit different properties such as operating to fixed timetables and/or locations or being flexible to allow travel to occur between any two locations at any time. The availability of activities, the attractiveness of areas and the state of the transport system vary throughout different times of the day and between different days of the week.

In summary, accessibility is more than just overcoming spatial separation between locations, it also acknowledges the differences between the people for whom the measure is calculated, the activities to which people need access, the properties of the locations of activities, the modes of transport that overcome the spatial separation between people and activities and the effects of available time on accessibility.

Accessibility measures

A significant amount of research focuses on advancing the methods used for calculating accessibility and how to identify and encourage its use in transport and urban planning. There are two possible directions with respect to calculating accessibility measures (Morris, Dumble and Wigan, 1979): one where the measure is *supply* based; and the other where the measure also contains a contextual component representing *demand*.

Supply-based measures of accessibility measure the accessibility to opportunities based solely on the properties of the physical transport and traffic system and the arrangement of land-uses. A combined measure that incorporates a contextual component representing demand however includes non-physical characteristics of the urban system such as the population's characteristics and their travel behaviour.

Topological

Topological accessibility is defined as the *nearness* or *propinquity* between geographic locations (Jiang, Claramunt and Batty, 1999). Topological accessibility is traditionally the number of links connecting one vertex to another in a connected graph (Pirie, 1979). The fewer links required, the more accessible the vertex is within the network. A number of topological measures exist based on deriving shortest path matrices that indicate the least number of links required to be passed to reach another vertex (Briggs, 1972).

Space-time framework

The space-time framework is a concept first developed by Hagerstrand (1970) that introduces the constraints of time with space to determine the behavioural possibilities of an individual (Miller, 1991). Space-time prisms are three-dimensional objects with an x-y plane representing space and a z-coordinate representing time. The space-time framework assumes that events undertaken by an individual have a spatial and temporal component and individuals can only participate in activities at a single location and point in time (Miller, 1991). The basic data requirements for the space-time framework are: the time available for activities; the distance between relevant locations; and velocities of travel between locations (Miller, 1991). Beyond this, data representing the constraints of space and time on people can also be used to determine what activities are available to a person (Jones, 1981).

Opportunity/impedance based

The *impedance-based* method is the most commonly used method for measuring accessibility and is one of the most researched and developed methods to date. In its most basic form (commonly called *relative accessibility*), it is calculated using the formula

$$A_{ij} = O_j f(C_{ij}) \qquad \textbf{Equation 1}$$

where A_{ij} is the accessibility from zone i to zone j, O_j represents the opportunities present in j and $f(C_{ij})$ is the impedance function of generalised cost for travel from i to j.

The *integral* form of this measure is summed over all j destinations and is referred to as *cumulative opportunity weighted by impedance* or more commonly known as the *gravity-based model*. There are three branches of the gravity-based measure: *potential accessibility*; *behavioural utility*; and *consumer surplus*.

Potential accessibility: The potential accessibility measure is derived from the singly-constrained gravity model used in travel demand models. The gravity model has analogy with Newton's law on gravity where in terms of transport, the number of trips made between two locations is proportional to their sizes and inversely proportional to their distance apart. This analogy was originally derived by Hansen (1959) where he discussed a simple land-use model based on accessibility to determine development and population growth in a region.

Behavioural utility: Behavioural utility is based on the assumption that individuals are rational entities and will make choices to maximise their own satisfaction or in the case of choice modelling, maximise utility. The utility of an alternative is derived from the observable attributes (weighted by their contribution to influence a decision) and unobserved attributes (random variables estimated from a distribution representing the sampled population).

A measure of accessibility can be derived from the derivation of marginal choice probabilities in logit models of multidimensional choice (see Ben-Akiva and Lerman, 1985). This measure of accessibility, which is also called the *inclusive value* or *logsum*, has the form

$$V_n' = \ln \sum_{i \in C_n} e^{V_{in}} \qquad \textbf{Equation 2}$$

where V' is the deterministic component (observable attributes) of the maximum utility for an individual n and V_{in} is the deterministic component of each secondary choice i in the set of choices C_n. This measure represents in a single value the benefit an individual obtains from a set of alternatives.

Economic based: An economic based measure, called *consumer surplus* uses economic theory to determine accessibility. Consumer surplus is the benefit, in monetary terms, that an individual receives from a consumption choice situation (Train, 2002). It can also be referred to as a measure of the willingness-to-pay for a commodity as it is the difference between what a person is willing to pay for a commodity and what they actually pay. The extra (or less) value an individual receives above (or below) what they paid is consumer surplus. When a change occurs (ie. a price movement) the margin between what the person is willing to pay and what they actually pay changes. The difference between what they were willing to pay and actual payment under the two scenarios represents the change in consumer surplus.

When using the multinomial logit model, it is possible to use the inclusive value and a coefficient representing cost to estimate consumer surplus as follows

$$E(CS) = \frac{1}{\alpha} \ln\left(\sum_{j=1}^{J} e^{V_j} \right) + C \qquad \textbf{Equation 3}$$

where the logsum part is equivalent to Equation 2, *α* represents the negative of the coefficient of time or cost from the deterministic component of the utility function and *C* is an unknown constant term that represents the difference between the actual value of consumer surplus and the estimated value (Train, 2002).

The estimated change in consumer surplus is then formulated as

$$\Delta E(CS) = \frac{1}{\alpha}\left[\ln\left(\sum_{j=1}^{J^1} e^{V_j^1} \right) - \ln\left(\sum_{j=1}^{J^0} e^{V_j^0} \right) \right] \qquad \textbf{Equation 4}$$

where the superscripts 0 and 1 represent before and after scenarios, the two logsums represent the inclusive values derived from the behavioural models under the two scenarios, and *α* represents the negative of the coefficient of time or cost within the behavioural model to give the estimated change in consumer surplus a unit of measure (Train, 2002).

Accessibility framework

An accessibility framework was developed to combine the strengths of existing accessibility measures for use in transport and urban planning. The aim was to have a framework where policies related to transport and urban form could be tested and implemented to improve accessibility for all socio-economic groups.

The method used to develop the accessibility framework was activity-based rather than just location-based. This means that the accessibility framework determines the accessibility of an individual to an activity rather than the accessibility between locations. Considering accessibility in this way implies that accessibility is dependent on three components, namely the:

- Traveller (individual or group);
- Transport system (mode, roads and traffic characteristics); and
- Land-use (characteristics of land-uses at origins and destinations).

Policies aimed at improving accessibility for people by targeting issues of social welfare and social exclusion need to consider the characteristics of the people for which the policies are targeted towards. Without considering the travel patterns of people, there is no indication of the extent that policies will be received or target the people for whom they were intended.

Data

Data related to metropolitan Adelaide used to develop the accessibility framework and to model the Adelaide-Crafers Highway included:

- information on the metropolitan Adelaide transport system that includes the road network, the public transport system (particularly the level of service), and provisions available for private motor vehicles (such as parking);
- land-use datasets depicting population, employment, education enrolment places, retail facilities and social and recreational facilities in Adelaide to provide an indication of what and how much is offered for activities at various locations; and
- revealed preference data on the socio-economic and behavioural characteristics of the population in various areas of the urban space.

The revealed preference data used were collected from the 1999 metropolitan Adelaide Household Travel Survey (MAHTS99). MAHTS99 was conducted by Transport SA to gather information on the population's travel behaviour for the purpose of planning Adelaide's transport needs (Transport SA, 1999). The survey gathered information based around people's day-to-day activities over two consecutive days within the Adelaide Statistical Division. A sample of approximately 9,000 homes, representing 2% of all private dwellings, was randomly selected. The final information gathered also included household and personal characteristics of participants.

Behavioural Models

The behavioural models incorporate into the accessibility framework the preferences and needs of individuals travelling and participating in activities within an urban space. Analysis of the MAHTS99 data revealed the travel behaviour characteristics of the population in metropolitan Adelaide and provided insight into:

- the relationships between decisions made by individuals;
- data preparation for development of the behavioural models; and
- the influence of variables on the decision making process to aid development of behavioural models.

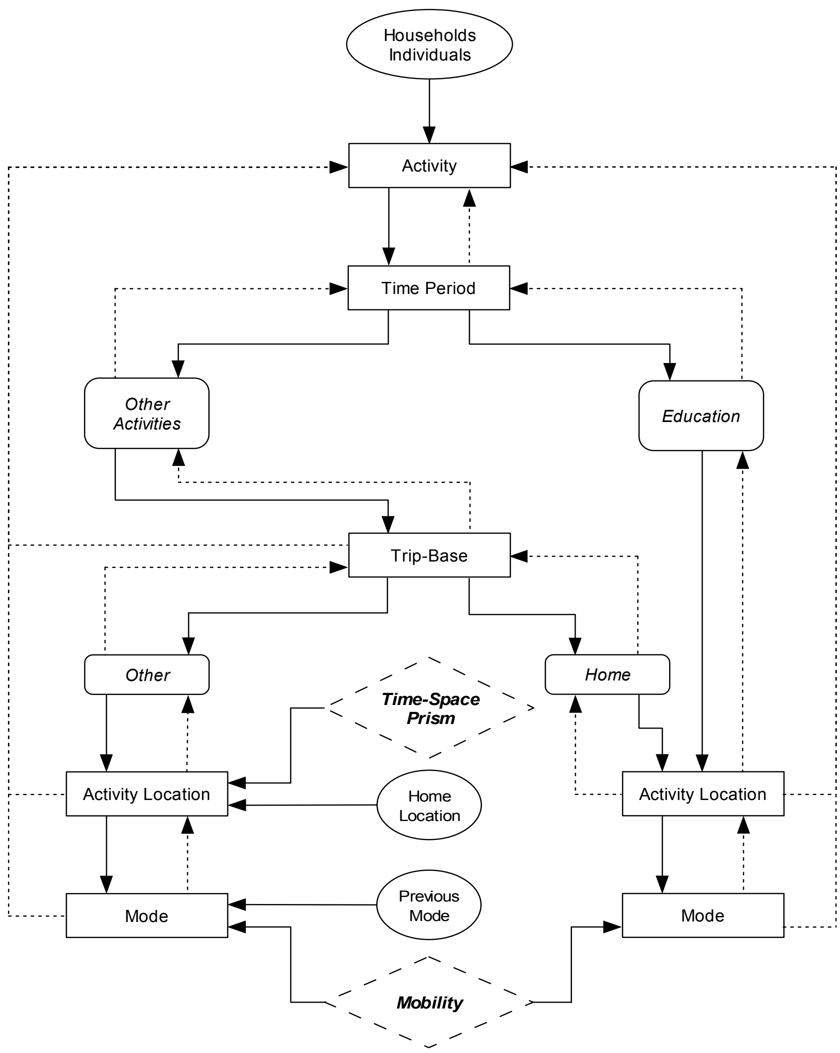

Figure 1 Behavioural model choice framework

The flow chart presented in Figure 1 shows the framework used to capture the choices individuals make that influence their accessibility to activities. The choices are represented in the rectangular boxes, the properties of the traveller are represented by the oval shapes, the alternatives of a choice set are represented by the rounded edge rectangular boxes, and the procedures used to restrict the choice sets of individuals based on their characteristics or their situations anytime during the survey period are represented by the diamond-shaped boxes. Five types of travel choices were modelled, these were: activity choice; time period choice; trip-base choice; location choice and mode choice. All models are multinomial logit with exception of the mode choice models, which are nested logit.

The choice models in Figure 1 are represented in a hierarchical structure where the activity is the first choice made by the decision unit. The arrows indicate the flow of information between modelled choices and attributes. From the lowest to the highest in the hierarchy of models, the upward flow of information (represented by dotted-lined arrows) is undertaken via the inclusive value (represented by Equation 2) determined for lower layers. The inclusive value represents in a single value the total user benefit to an individual given the alternatives available and the properties of factors that influence the choice of alternatives. Ultimately, this accessibility measure provides the benefit associated with participating in an activity. The more disaggregate models also provide the benefit of participating in an activity but at a finer detail. The downward arrows represent the trip choices made or attribute information, which transcend to the next model.

The framework includes the characteristics of the individual and their household to take into consideration the differences in travel choices made by individuals and the influence of other household members and the resources available to the household. In addition, the choice of activity is also influenced by time of day, the possible trip-base from where travel to the activity can originate from, the possible location of such activities and the modal choice options available to the individual. To put it simply, the choice of activity is influenced by the benefits derived from all the options available to an individual to participate in an activity.

The time period choice model estimates the periods of departure time choice to an activity. This choice is influenced by the net benefit of the possible locations from which an individual can commence travel to the activity.

Trip chaining is considered by modelling the trip-base of trips. The choice is whether to participate in an activity directly from home or from another location. Modelling the trip-base considers the benefit of the location of the home to activities and the benefit derived from linking trips to pursue activities from other locations. The choice of trip-base is dependent upon the opportunities at locations surrounding the location of the trip-base, hence the inclusive value from the location choice model feeds back into the trip-base choice model.

The choice of location is highly influenced by the individual's ability to overcome the spatial separation between where they are currently and where they want to be. Hence, the decision of location choice for an activity is influenced by the mode choice alternatives available to the individual to overcome this separation.

The final decision is the choice of mode to travel to the location of the activity. The mode choice is also influenced by the mobility options available. Essentially, this procedure determines what mode alternatives are actually available to the individual using the MAHTS99 data (Primerano, 2003).

The main flow of the decision process is described above, however there are variations to this depending on some of the decisions made along the way. The first of these variations is when the activity ‘education’ is chosen. The trip-base option was not modelled since the sample number of non home-based education trips was small (six per cent of education trips and 0.4 per cent of total trips were non home-based education trips). Hence, if education is the chosen alternative then the next decision is the choice of location for the activity. This leads to the time period choice model being influenced by the benefit of the possible opportunities or in this case, the number of enrolment places to education institutions available to an individual. From this point, the framework follows the home-based path as for all other activities.

The other variation occurs when the trip-base choice is made. There are two alternatives: either the trip originates from the home or from another location. If the trip originates from a location other than the home then the location choice and mode choice models slightly differ to their counterparts of home-based travel. The activity location choice for trips originating away from the home is influenced by the location of the home to consider that individuals away from their home will choose locations that will get them closer to home. The other variation is the restriction of the location choice set based on the space-time prism concept. It is considered that if an individual is away from their home, then they are limited in time and space by their current and next activity. The space-time prism concept was not used for home-based trips because it was assumed that a person could shorten their stay at home to spend extra time travelling.

The variation to the modal choice models of trips originating away from the home is the inclusion of the influence of mode chosen for the previous trip. It was assumed that if a person leaves the home using a particular mode of transport then that person would most likely use that mode of transport for most of their other travels until that person returns home (Bowman and Ben-Akiva, 2001).

Accessibility in metropolitan Adelaide

Before investigating the impact of the Adelaide-Crafers Highway on the population of Adelaide, it is worth examining the accessibility of metropolitan Adelaide before the highway was constructed. The first step to examine the accessibility of individuals within an urban area is to analyse a measure that provides an indication of the overall levels of accessibility. The inclusive values (using Equation 2) from the activity choice model were aggregated from the individual disaggregate level to the Local Government Area (LGA) and to a level indicating accessibility for the entire metropolitan area of Adelaide. Each inclusive value is divided by the inclusive value for metropolitan Adelaide (with an inclusive value of 5.266) as a means of gauging the level of accessibility of each LGA in comparison with the rest of the LGAs.

The map in Figure 2 shows the levels of accessibility for each area as compared to the entire metropolitan area. The areas close to and including the Adelaide Central Business District (CBD) and Glenelg have the highest levels of accessibility. The Adelaide CBD has the highest accessibility level of all areas, which is to be expected as many activities are available within the Adelaide CBD and the population living in the Adelaide CBD are generally of a high socio-economic status. Areas found to have lower levels of accessibility are areas furthest away from the Adelaide CBD that includes Gawler, Willunga, and Noarlunga.

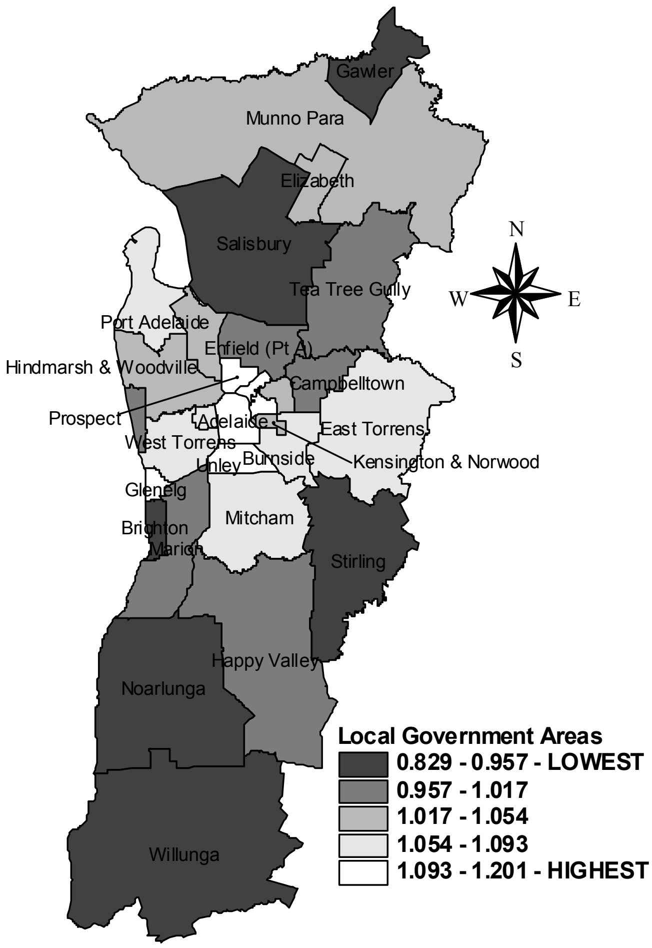

Figure 2 Levels of accessibility by LGA for individuals in 1999

Evaluation of the Adelaide-Crafers Highway

The Adelaide-Crafers Highway was South Australia's largest road project funded by the Federal Government under the National Highways program. The new route shown in Figure 3 was opened on the 5 March 2000 (well after MAHTS99) providing road users an alternate and more direct route between Adelaide and the hills towns such as Stirling and Mt Barker in the Mt Lofty Ranges. The Princes Highway is the major national road that connects Adelaide with Melbourne, Victoria. The new route, which also includes a tunnel through the hills provides a more gradual incline, is more direct and is shorter in distance.

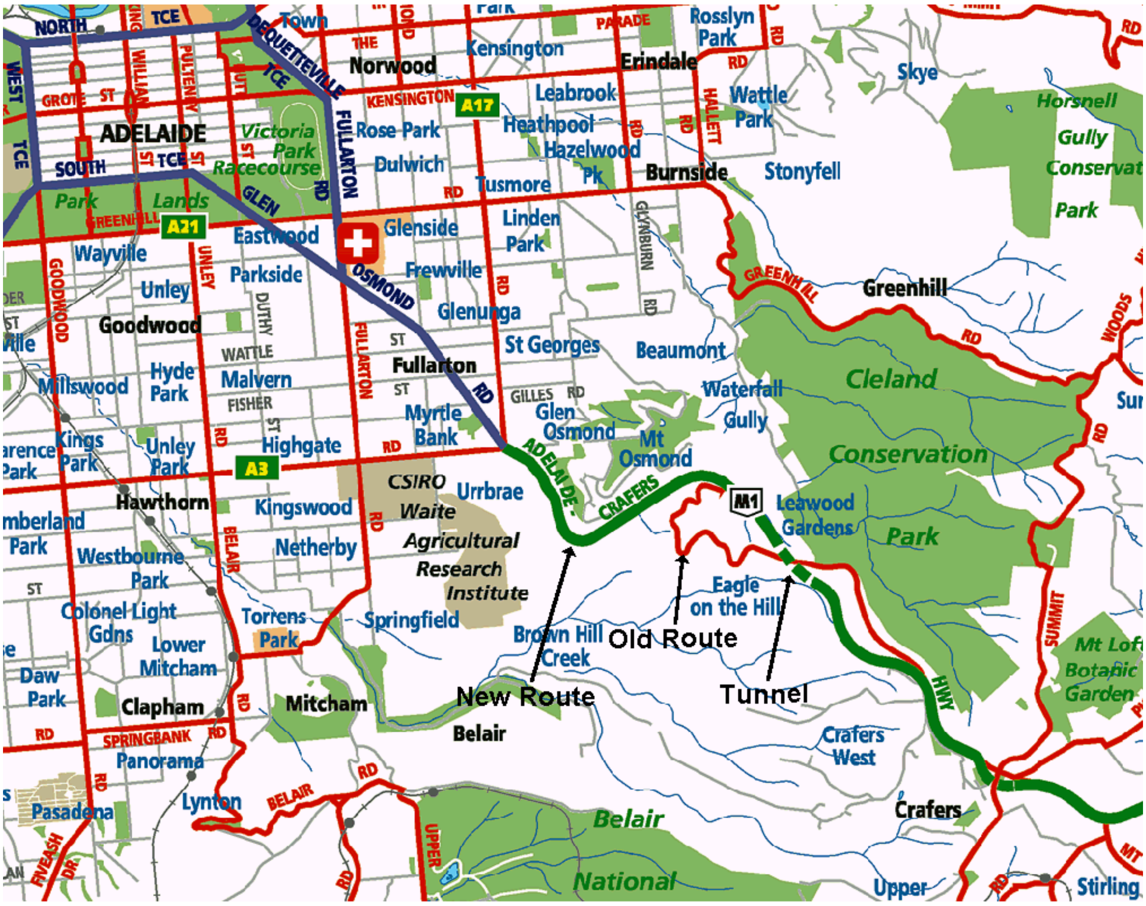

Figure 3 The Adelaide-Crafers highway including the old route

The benefits to road users include improved travel times, reduced fuel costs, and increased safety and reduced accident costs (in particular through the bypass of Devil's Elbow, a major accident black spot). The total length of the route improvement under the Adelaide-Crafers project was 8.3 km, a little over two kilometres shorter than the old route with estimated travel time reductions of five to ten minutes for the residents of the Adelaide Hills (approximately 10,000) and residents of more distant areas. Along with the improved road for motor vehicles, a bicycle path was also constructed for part of the new route. It is estimated that by 2006 the annual road user benefits will total $36 million with local businesses and residents accruing approximately $11 million of benefits each year. In addition, benefits were also expected for freight and commercial vehicle operators (Transport SA, 2003).

Implementation

Travel distances were updated for travel between Transport Area Zones (TAZ) in Stirling and all other TAZs in metropolitan Adelaide to reflect the distance reduction caused by the new highway. All travel distances to and from TAZs within Stirling were reduced by two kilometres except between TAZs within the Stirling LGA, which were left unchanged since although there would have been a reduction, it is uncertain how much that reduction would have been for travel within the Stirling LGA. Using the new travel distances, travel times and the fuel and taxi fare components of the travel costs were re-estimated. In cases where travel times were based on the start and end times of trips as given in MAHTS99, all such relevant travel times that were ten minutes or over were reduced by 7.5 minutes.

Results

The impact of the Adelaide-Crafers Highway on metropolitan Adelaide is demonstrated in Table 1. The figures in Table 1 include inclusive values (IV) (as formulated in Equation 2) and estimate of the change in consumer surplus (CS) (as formulated in Equation 4). The new inclusive value, new rank and rank change represents the improvement in accessibility for that area with respect to metropolitan Adelaide due to the construction of the highway. The change in the inclusive value represents how much the inclusive value has changed for each area due to the highway. The change in consumer surplus, represented for both time and money shows the time and money saved for each trip made by each resident with the introduction of the highway as compared to the scenario without the highway. The figures include an estimate of the change in consumer surplus per year, which represents the distribution of cost savings from the highway over metropolitan Adelaide for all trips made by all residents per year.

Table 1 is sorted by the change in consumer surplus per person per trip values to show the residents of which area benefit from the highway the most per capita. The reason for this is that it shows the true benefit derived from the policy on a per capita basis without the influence of other factors such as population size or other accessibility issues not addressed by the policy.

For metropolitan Adelaide as a whole, it is estimated that road users would have received cost savings of over $17 million dollars per year if the highway was opened in 1999. Compared to the estimate of $36 million per year by 2006 stated in Transport SA (2003), the estimate from the accessibility framework is reasonable considering the assumptions made to produce the behavioural model estimates during implementation, that trips that did not start or terminate within metropolitan Adelaide were not considered, and inflation from 1999 to 2006.

Stirling benefits the most from the highway construction where each resident has on average a surplus benefit of over two minutes for every trip they undertake. This equates to an average surplus of just over 30 cents saved per trip per resident in Stirling. From the highway development it is estimated that residents of Stirling will accumulate a cost benefit of over $8 million per year. This estimate is comparable to the estimated $11 million benefits to residents and local businesses quoted in Transport SA (2003) given the estimates from the behavioural models assumes that:

- the accessibility framework excludes trucks as a mode of transport;
- there is no benefit for intrazonal travel; and
- no cost benefits are derived from the additional safety and comfort the highway provides road users.

Table 1 Benefits derived by road users from the development of the Adelaide-Crafers Highway if it were available in 1999

Local Government Area	New IV	New rank	Rank change	IV change	CS (min)	CS ($)	CS per year
Stirling	5.252	22	3↑	0.215	2.149	$0.315	$8,028,956.58
East Torrens	5.618	10	2↑	0.053	0.465	$0.056	$1,098,446.17
Adelaide	6.335	1	0	0.009	0.090	$0.012	$514,820.31
Unley	6.139	4	0	0.009	0.106	$0.016	$1,398,971.70
Burnside	5.765	7	0	0.007	0.073	$0.011	$1,151,928.74
St Peters	5.978	5	0	0.007	0.065	$0.010	$175,008.13
Mitcham	5.625	9	0	0.006	0.057	$0.009	$980,180.46
Walkerville	5.778	6	0	0.005	0.071	$0.010	$219,122.44
Glenelg	6.261	2	0	0.005	0.042	$0.005	$57,867.77
Payneham	5.554	13	0	0.003	0.039	$0.006	$104,735.10
Happy Valley	5.148	24	1↓	0.003	0.038	$0.005	$566,246.55
Enfield (Part A)	5.263	21	0	0.003	0.032	$0.005	$649,827.53
Munno Para	5.522	14	0	0.002	0.023	$0.004	$513,005.90
Enfield (Part B)	5.451	17	0	0.002	0.018	$0.002	$41,891.83
Kensington & Norwood	5.466	16	0	0.001	0.014	$0.002	$19,104.64
Noarlunga	4.821	28	0	0.001	0.010	$0.002	$240,436.34
Campbelltown	5.232	23	1↓	0.001	0.009	$0.002	$199,028.28
Marion	5.139	25	1↓	0.001	0.009	$0.002	$317,900.23
Tea Tree Gully	5.324	20	0	0.001	0.007	$0.001	$432,057.73
Willunga	4.572	29	0	0.001	0.006	$0.001	$36,610.27
Salisbury	4.944	27	0	0.000	0.005	$0.001	$307,995.25
Brighton	4.986	26	0	0.000	0.004	$0.001	$9,495.95
Hindmarsh & Woodville	5.469	15	0	0.000	0.004	$0.000	$49,209.41
West Torrens	5.635	8	0	0.000	0.003	$0.000	$31,551.14
Thebarton	5.600	11	1↓	0.000	0.003	$0.000	$4,156.09
Henley & Grange	5.355	19	0	0.000	0.003	$0.000	$11,848.78
Prospect	6.143	3	0	0.000	0.001	$0.000	$4,957.46
Port Adelaide	5.591	12	1↓	0.000	0.000	$0.000	$4,565.21
Elizabeth	5.411	18	0	0.000	0.000	$0.000	$892.97
Gawler	4.365	30	0	0.000	0.000	$0.000	$91.47
metropolitan Adelaide	5.272			0.005	0.054	$0.008	$17,170,910.43

From the map in Figure 4, other areas that benefit greatly from the Adelaide-Crafers Highway are East Torrens, Burnside, Unley and Mitcham, which are close to where the highway commences. The majority of areas to benefit the least from the highway development are those areas from the southwest along the coast to the northwest of metropolitan Adelaide.

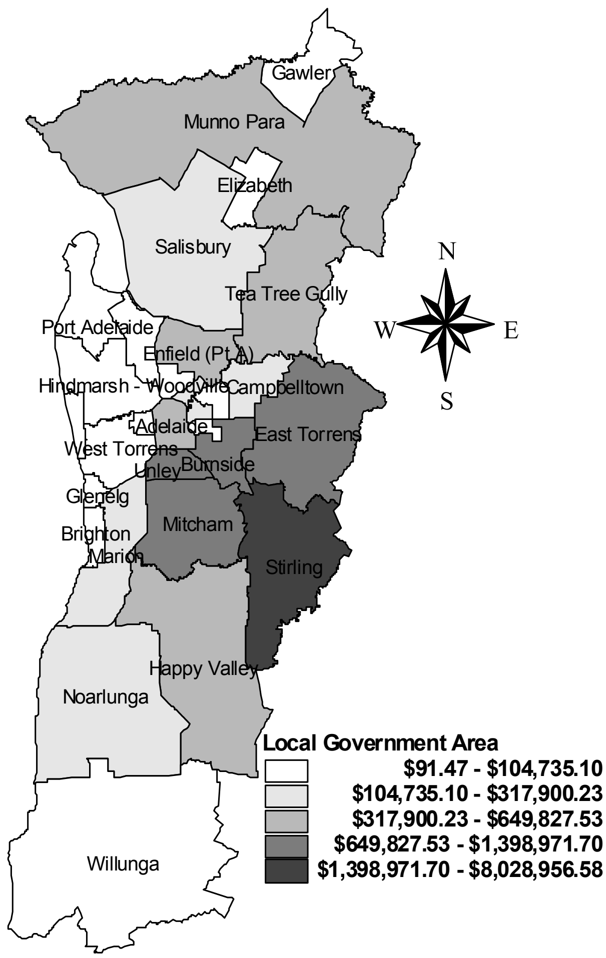

Figure 4 The distribution of benefit per year from the Adelaide-Crafers Highway to road users throughout metropolitan Adelaide

Accessibility webs were used to compare accessibility of individuals residing in Stirling to activities relative to the entire population of the metropolitan area. Since the inclusive values between activity types are unrelated (they are derived from different models), all values are normalised with the inclusive values of each activity derived for metropolitan Adelaide. Accessibility webs are derived from the use of similar graphs for fundamental analysis of public listed companies on financial stock markets by investors to compare a company with companies of a similar type to determine how a company rates as an investment among its peer companies. Similarly, the accessibility web shows how the accessibility of individuals to an activity in one area compares with all other areas. The accessibility web identifies the strengths and weaknesses of an area in terms of accessibility of residents in these areas to activities as compared to the metropolitan average.

Comparing the accessibility webs of Stirling in Figure 5 under the scenarios of before and after the highway shows the impact of the highway on accessibility of the residents of Stirling to activities. Accessibility to every activity type modelled increases with education, personal business and shopping activities increasing just beyond the level for metropolitan Adelaide. In addition, Table 1 shows that the overall accessibility level of Stirling (with a new inclusive value of 5.252) as compared to the other LGAs in metropolitan Adelaide increases three places to be just under the accessibility level for metropolitan Adelaide (with a new inclusive value of 5.272).

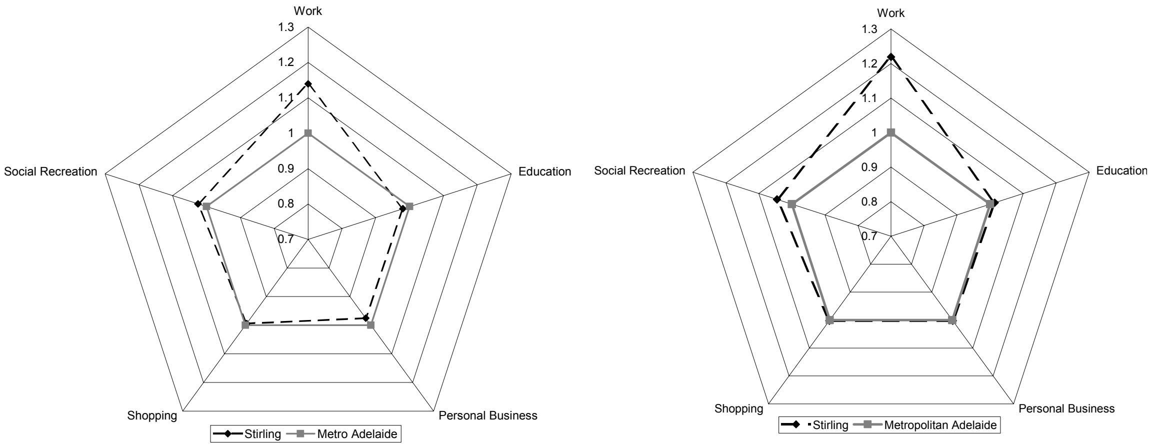

Figure 5 The accessibility webs for residents in Stirling without the highway (left) and with the highway (right) in 1999

Conclusions

Accessibility was defined as the ease for individuals to participate in activities. The ease is influenced by five factors, namely: the individual; activities; destinations; transport modes; and time. A number of methods used to calculate measures of accessibility that were supply-based and those that included demand were identified and discussed. It was found that no single measure could cater for all the issues associated with transport and urban planning. This is where a framework using a hierarchical structure of discrete choice models could bring together all kinds of measures to address specific issues in planning. The accessibility framework combines the strengths of some of the existing methods of calculating accessibility measures to develop a powerful and sophisticated accessibility framework for policy analysis and evaluation.

The accessibility framework determines the benefit or need for an individual or group of people to travel to an activity. The framework revolves around a hierarchy of decisions individuals make when deciding to participate in an activity. The benefits of binding the framework around behavioural models include:

- incorporating the influence of the individual's behavioural characteristics by considering their socio-economic characteristics and the influence of time and space constraints on their travel behaviour;
- user benefit estimates obtained from available choice alternatives of individuals; and
- allowing for the various components of accessibility to be dissected.

The accessibility framework was applied to metropolitan Adelaide to describe the levels of accessibility as they were in 1999. The framework was then used to evaluate the impact of the Adelaide-Crafers Highway in terms of the distribution of benefit to road users in metropolitan Adelaide and to further investigate benefits to the residents of the Stirling LGA.

The accessibility framework has proved to be powerful to assess the effectiveness of policies to change levels of accessibility in a manner intended by the policy maker. Although the framework has been shown to evaluate policies based on modifying the characteristics of the transport system, the framework can also evaluate policies based on the adjustment of the characteristics and spatial arrangement of land-uses.

Further research

The additional benefit derived from the increase in safety and comfort provided by the Adelaide-Crafers Highway was not included as part of the overall benefit gained by road users from the construction. Since MAHTS99 was a revealed preference survey, the data collected from MAHTS99 do not contain any information in regards to how individuals value safety and comfort of a journey. An additional stated preference survey is required where specific questions regarding issues of driver safety and comfort can be asked with results incorporated within the existing revealed preference survey.

During the development of the behavioural models, the travel times used were crude estimates because the travel times given in MAHTS99 were unreliable, little intrazonal information was available and there was a lack of route choice information. Ideally, a sophisticated system for calculating travel times needs to be developed for metropolitan Adelaide where travel times at different times of the day, along various routes and among different types of modes can be calculated accurately. More route choice information would also enable route choice behavioural models to be developed to add another decision choice dimension to the accessibility framework.

Evaluating a transport network upgrade such as the Adelaide-Crafers Highway using the accessibility framework would be ideally undertaken within a Geographical Information System (GIS) where travel times and distances could be automatically updated along affected routes. In the case of the Adelaide-Crafers Highway, rather than the planner having to recalculate all of the travel times between all zones and incorporate the changes manually within the accessibility framework, all they should do is incorporate the highway within GIS and allow the appropriate calculations to take place. This will improve the usefulness of the accessibility for transport planners to assess the effectiveness of transport network upgrades and also benefit urban planners in a similar way where the arrangement of land-uses can be implemented.

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