GIS-BASED PROGRAM FOR ACCESSIBILITY MODELLING

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Abstract: This paper details the development of an interactive GIS-based accessibility modelling system. The system integrates data on the spatial, demographic, socio-economic, land use, and transport elements for accessibility analysis. It is menu-driven via an easy to use graphical user interface. It contains separate modules for determining the accessibility levels to education, health, employment and shopping facilities in an area by a particular mode of travel. It can therefore be used to compare the performance of the various transportation network systems such as public transport. Two types of accessibility measures are available: relative accessibility and the Hansen integral accessibility measures. The travel cost function used is user-defined providing another flexibility for users keen on using a particular type of travel cost function to do so. The output is a thematic display of the area colour-shaded according to the computed accessibility index. The utility of the system is tested and evaluated by investigating accessibility levels to heath facilities by both private and public transportation modes in metropolitan Adelaide.

Key Words: Accessibility, transportation planning, GIS, user-interface, land use.

1. INTRODUCTION

Transportation systems exist to improve individual accessibility by increasing the ability of people to overcome spatial separation in order to participate in various activities. In particular, the availability of specific transportation services in time and space dictate the extent and quality of participation of the individual in various services and activities. This is of particular importance to people with no access to private transport (e.g. the car) and so has to rely on public transport or walking. Since many services are often located outside the range that people are willing to walk in order to partake in those activities, the ease of movement in a region as provided by the available transportation system has a direct influence on the behaviour of the population. For much of the last century, planning for efficient movement by private automobile has been the dominant transport planning paradigm. The effects of this enhanced motorised-mobility have become well known, namely, urban sprawl, energy depletion, air and noise pollution, climate change, and road safety concerns. Improved access to services can lead to a reduction in the demand for vehicular travel and hence a reduction in the adverse environmental impacts of traffic. Therefore the current thinking in planning circles is the new urbanism and a call for a shift in the focus of transport planning in favour of enhanced accessibility provision from vehicular mobility (Cervero, 1996; Dalvi, 1978) and emphasis on integrated transport/land use planning. With accessibility planning, the focus is on people and places and the ease of reaching activity centres in contrast to the supply-side focus in motorised transport planning. A better integration of spatial and transport planning is therefore a key to achieving better accessibility and to manage the need for travel. This can be achieved by, for instance, a better spatial mix of economic activities involving land use changes that lead to more compact community designs, and the effective use of community-based public and non-motorized transport (including trams, para-transit, walking, and cycling). In this way improved accessibility can be achieved while reducing the demand for energy-consuming mobility. Accessibility can thus be use as an important measure of urban spatial structure (Suryanarayana *et al.*, 1986). But to fulfill this calls for operationisation of accessibility planning measures through the development and ease of applying better measures of evaluating performance such public transport service coverage.

The application GIS in transport planning has grown rapidly in recent years. With availability of quality spatial information, some parametric measures of accessibility levels, categorised by spatial co-variables such as zone of residence, can be obtained and displayed in an interactive GIS graphic environment. This can provide better appreciation of regional characteristics and variations between different regions in the study area, which can be made available to a wide range of interested people. In addition, GIS enables analysis to be conducted at any scale level, thereby overcoming the difficulties in applying accessibility measures to large scale areas such as a metropolitan region. These capabilities have resulted in the development of some GIS based accessibility studies and a re-visit of the use of accessibility measures in service and transport/land use planning (Hansen, 1993; Villamore, 1994; MacKay and Poralin, 1994; Geertman and Van Eck, 1995; Gutierrez *et al.*, 1993; Miller, 2000). Most of these studies are however site specific and had involved using the GIS mainly for output display.

The paper details the development of an interactive GIS based system for accessibility planning purposes in a metropolitan region. The system termed "GISAM" contains options for the investigation and analysis of accessibility levels for the following types of facilities: education, health, shopping and employment. It is designed in such a way that accessibility levels can be computed at various disaggregate zonal levels (such as local government area (LGA), census districts (CCD), traffic analysis zones (TAZ)) for any mode of travel. It is therefore possible to evaluate the impact of a particular transport mode on accessibility to opportunities. The utility of the system is tested and evaluated by investigating accessibility levels to heath facilities by both private and public transportation modes in metropolitan Adelaide.

2. DEVELOPMENTAL PROCESS

2.1 Formulation of accessibility measures

No single exact definition of the term accessibility exists, but generally, it is defined as some measure of spatial distribution of activities about a point adjusted for the ability and the desire of people and firms to overcome separation. The many definitions used to describe the term include the following:

- Observed or expected travel cost between two points (Jones, 1981);
- Opportunity an individual at a given location has to take part in a particular activity or a set of activities (Hensher, 1979);

- The number of opportunities reached within a given travel time or distance (Wachs and Kumagi, 1973; Black and Conroy, 1977);
- The ease by which activities can be reached from a given location using a particular transport system (Dalvi and Martin, 1976; Hansen, 1959; Ingram, 1971);
- The possibility to reach a location within an acceptable amount of time, money and effort with respect to a specific policy (Hilbers and Verroen, 1993).

As with its definition, several meaningful accessibility measures (or indicators) have been proposed (Koenig, 1978; Black and Conroy, 1977; Hansen, 1959, Dalvi and Martin, 1976; Morris *et al.*, 1979; Suryanarayana *et al.*, 1986; Ingram, 1971). The choice of which type of measure to use depends to a great extent on the type of problems to be addressed. Here two accessibility measures are available for use namely, the relative accessibility and the Hansen type integral accessibility measures. The relative accessibility describes the degree of connection between two points (such as a given location and a specific activity) on the same surface (Dalvi and Martin, 1976). It is computed as the distance or time to travel from a specific location to the nearest activity (e.g. hospital or post office). It is employed here to determine the degree of connection in terms of travel cost between each analysis unit (such as TAZ) and a specific facility. It is simple and easy to comprehend, and provides a useful measure for the location of facilities. Consider, for example, the location of emergency services such as fire service or ambulance station. The problem is one of determining a point such that the travel time (taken as the imperative for emergency services) to reach its area of influence is within a pre-defined threshold value. The relative accessibility measure as defined in equation 1 below in such cases can used to determine the relative area of influence of each facility.

$$AR_{ik}^{m} = \min f(c_{ij}) \tag{1}$$

where $f(c_{ij})$ = a function representing the deterrent effect or cost of travel;
c_{ij} = the cost of travel from i to j; and
AR_{ik}^{m} = relative accessibility for zone *i* for mode *m* for a facility type *k*.

The integral accessibility describes the inter-connection between a given point and all others points (or activities) in the area (Ingram, 1971). Here the integral accessibility measure is used to compute, for each analysis zone, the overall accessibility to all facilities of a particular type via a specific mode of travel. The Hansen-type distributional functional form of accessibility measure as defined by equation 2 is used (Davidson, 1977)

$$A_i^m = \sum_{j}^{n} \frac{B_j}{c_{ij}^{\alpha}} \tag{2}$$

where A_i^m = accessibility of zone i using mode M to a particular type of facility;
B_j = attractiveness measure of facility j;
α = a constant parameter based on perceived travel behaviour or system performance indicator;
c_{ij} = the cost of travel as defined above; and
n= the total number of individual facilities available.

This measure is simple to implement and generates a single measure of accessibility for each analysis zone. The computed values can be used to colour code each zone or generate contour plots for the area. The output from the various transport modes can be used to explain and compare any differences in travel patterns using these modes. Though this measure may be difficult to explain, when the parameter α is set to unity, it gives an easy and simple measure, expressed as the number of opportunities that can be accessed per unit cost. As accessibility measure depends on the distribution of both the transportation network and facilities, it could be used to study the effect of changes in the transportation network and/or in the distribution of various facilities and services. When assessed over different time periods, these measures can also be used to determine changes in accessibility levels over time.

The deterrent (or travel cost) function is required for computing the optimum paths between the zone centroids and the locations of facilities. This impedance can be define in several ways: simple distance, travel time or general cost, which can be taken to include distance, speed and in recent years incorporation of some environmental factors (e.g. Taylor, 1996). In this study, the travel costs between analysis zone and facility locations are estimated as the total travel times as computed via the shortest path algorithm. This way travel times could be computed which reflected the actual time of travel (ie off-peak, peak periods, etc.) and by the mode of travel. The definition of the travel times along the link on both directions are user specified, enabling the user to select functions relevant to the type of analysis and problem on hand. If travel along a particular direction is prohibited in the case of one way streets the appropriate directional cost is made negative

From equation 2 another term of consideration is the attractiveness variable B_j used to represent the number of opportunities available at a facility. The definition of this variable depends on the activity under study (Morris *et al.*, 1979). Again this is user defined, thus allowing for the use of the appropriate measure suitable for the type of problem on hand. Typical definitions of the attractiveness of some facilities used in this study are shown in Table 1

Table 1: Typical definitions of attractiveness of facilities

Type of facility	Attractiveness
Employment	Number of jobs
Education	School enrolment (full time equivalent)
Health	Number of hospital beds
Shopping	Floor space

2.2 Accessibility model development

The development of the system proceeded along the following lines:

1. Data collection and creation of ARC/INFO map layers for the road network system, public transport network, health facilities, educational institutions, employment avenues and shopping centres.

2. Capture the nearest node on the transport network to each zonal centriod and draw a

dummy link to connect this node and the zone centriod, and then generate a new and an updated network topology.

3. Compute the optimal shortest-path tree between each zone centriod and facility location for the each transport system.
4. Combine the matrix of optimum-cost path of each facility type obtained above with the attribute data from both facility and traffic analysis zone to generate a file containing all details required in the computation of the accessibility measures.
5. Compute the accessibility index required using information from above step.
6. Display the computed accessibility index.

In determining of the optimum paths between the zones and facility locations, an externally developed routine called "MINIMUM-PATH" was used. The ARC/INFO resident shortest path routine could be used to perform this process, but was not used because it was found to be very slow and uneconomical for large networks. This "MINIMUM-PATH" routine was developed in Pascal based on Dijkstra's algorithm (Dijkstra, 1959) for determining the optimum paths between points. This routine is executed from within the GIS through a macro, which also supplies it with the underlying network and land use spatial data required for computing the optimum path between each zone and the location of the facilities. A second external routine is then used to compute the various accessibility measures. The computed measures are then used to generate a thematic map of the area with each zone shaded according to its accessibility level. In practice, the number of opportunities that can be accessed at any facility is its maximum capacity. Hence during the computation of integral accessibility as given by equation 2, a minimum value of one cost unit is assumed. This ensures that the contribution by any particular facility to the overall accessibility does not exceed it maximum capacity.

3. USER-INTERFACE AND STRUCTURE THE PROGRAM

To streamline the analysis and computation of the various measures of accessibility under different conditions and circumstances a GIS-based Accessibility Model termed "GISAM" was developed to perform the above steps. It is operated via a well-structured menu driven user interface in the form of pull-down menus, designed using the PC ARC/INFO simple macro language (SML). The external developed routines are incorporated into the system using the interface method of integrating models and routines into a GIS. The other methods available for integrating GIS and models are the model dominant approach (embedding GIS functionalities entirely within the model) and the GIS dominant approach (implementing the models within and as part of the GIS (Trinidad and Marquez, 1994; Fedra, 1994). The interface approach provides the least interference between GIS and models/routines. Here the developed routines behave like modules resident within the GIS and operate via a user interface. The structure and main components of this program are shown in Figure 3. It has six main options: specific activity, nearest, education, health, shopping and employment. Below each of these are the various submenus, each of which is used to compute specific accessibility measure based on their application and functionality. The output from each option is a map display of the area with each zone shaded according to the magnitude of its computed accessibility. A brief description of each of the main options is presented below.

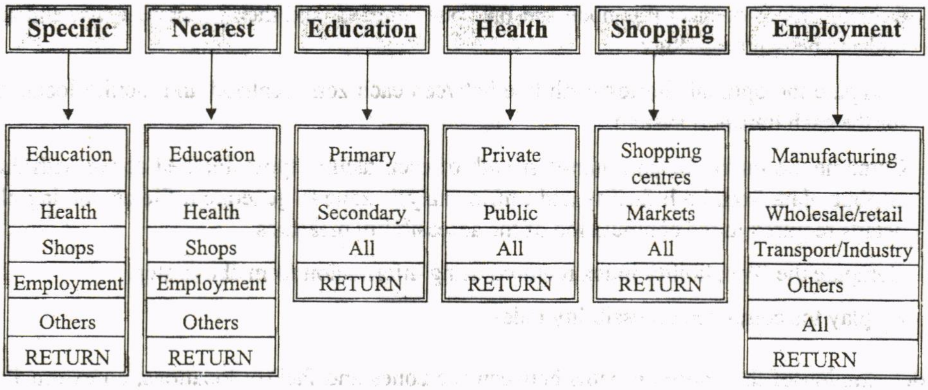

Figure 1: Structure of GISAM- a GIS-based accessibility model

3.1 Specific option

This option is used to determine the accessibility to a particular type of facility. For example, it may be used to compute accessibility levels to employment opportunities in a particular employment centre (such as the city centre) or a particular hospital (e.g. Children's Hospital) to all areas. The computed accessibility measure is used to automatically generate a colour coded thematic map of the area. The computed accessibility measure reflects the ease of movement between each zone and the facility in question. It can be used to compare the performance of two facilities of the same type by evaluating the proportion of the population that can access each facility within a specified travel cost. A practical use of such information is the location and citing of a new facility. This can be done interactively. The facility can be located at different points in the area and the accessibility of each point computed. By comparing the computed accessibility for each location the most convenient place to locate the facility can be determined by selecting the point which gives the best accessibility.

3.2 Nearest option

This option is used to determine the relative accessibility (using equation 1) to the nearest facility of a specific type from each zone. For example, the education sub-option is used to compute the relative accessibility (say the travel cost) from each zone to the nearest school. In like manner, health, shops and employment options when selected are used to determine the accessibility to the nearest health, shopping and employment facility respectively. The "others" selection choice is used to compute the accessibility to any other facility (e.g. fire service station or recreational park) from each zone. The accessibility measure obtained is in terms of the minimum travel cost to reach the nearest facility from each zone. This option is of particular importance in determining the location of emergency services such as fire services, ambulance services or a health centre in the event of an emergency where the location of the nearest one is of prime importance. From the output areas, which are deficient in the provision of certain facilities or lying outside the maximum time limit of the influence of the emergency services can be pin-pointed easily.

3.3 Education option

The education option is used to determine the integral accessibility to education facilities as given by equation 2. The accessibility index can be computed for primary schools only, secondary school only or all schools by selecting the appropriate submenu.

3.4 Health option

This option is used to compute the integral accessibility from each zone to health facilities (hospital and health centres) in the area. The "private" option is used to compute the accessibility to private health facilities while the "public" option is used when accessibility to public health facilities is required. For accessibility to all facilities the "ALL" option is used.

3.5 Shopping option

The shopping option is used to determine the integral accessibility to shopping facilities. The "shopping centres" option is used to compute the integral accessibility for shopping centres in the area, while the "market" option is used when accessibility to market places is required. If accessibility to all types of shopping facilities is required the "ALL" option is used.

3.6 Employment option

This option is used to compute the integral accessibility to all employment opportunities. Selection of any of the choices will result in the calculation of accessibility index to those types of employment opportunities. The "Manufacturing" option is used to compute accessibility to manufacturing employment opportunities. Likewise "wholesale/retail" option is used to determine the accessibility to retail jobs, etc. The "others" option is used for the other types of employment including recreation and personal services, finance, public administration and community services. If accessibility to all employment opportunities in a region is required the "ALL" option is used. By being able to compute accessibility to different job opportunities one could match the location of employment opportunities with socio-economic and demographic groupings.

4. CASE STUDY

4.1 Data collection and accessibility measurement

This section presents the results of the application of the "GISAM" system to evaluate accessibility to health facilities in Adelaide City, Australia. It investigates the accessibility to health facilities by both public and private transport systems. The results from both transport systems are compared and discussed to determine the level of influence of public transport on accessibility to these facilities in Adelaide. The accessibility is computed for private hospital, public hospitals, private and both types combined. In all, there are 47 main hospitals and health centres, of which 14 are publicly owned and 33 privately owned.

The unit of analysis in this case study is the Adelaide travel analysis zones (TAZ) used for the 1996 household survey (CCD or LGA could have been used as alternatives). The attraction variable used is the number of hospital beds available at the hospital or health facilities. The impedance function (travel cost) used was the travel time between the centroid of each TAZ and the facility by the mode of travel. It is computed as the shortest distance in minutes from each TAZ to the health facility. The travel times for trips between TAZ and each health facility were thus taken as surrogates for travel cost (Briggs and Jones, 1973; Dalvi and Martin, 1976).

The Adelaide bus network system and entire road network are used in the examination of accessibility by public transport and by private car respectively. The comparison of the accessibility indices obtained from the two networks is used to evaluate the performance of the public transport system.

The integral accessibility measure as given by equation 2 was computed as the total number of hospital beds in each facility divided by the travel time to that facility. The constant parameter (α) was set to unity. This gives the unit of accessibility as the number of hospital beds that can be accessed per minute of travel (BPM). The relative accessibility measure is given simply by the travel time from each TAZ to the facility. Any differences in accessibility levels between the two transportation systems (private versus public transport by bus) thus result from the difference in travel time between the TAZ and facility locations using each mode of travel. For the private transport it is assumed that the car is available for use any time. The travel time is therefore computed from the length of link and the speed of travel (assumed to be allowable speed limit). The accessibility values obtained using these speeds may thus be taken to represent the maximum accessibility levels that can be attained using the current transportation system by car.

For bus travel this depends on the speed of travel along the particular transportation system and the frequency of service. The frequency of service and speed of travel were obtained from the 1995 TransAdelaide bus time table. The speed obtained from this time table is the bus journey speed which include any delays at the bus stops. The journey speed of travel on each link was computed from the length divided by the time spent on the link. This time was determined from the approximate arrival times as indicated on the bus time table. For each link this speed is taken as that of a typical bus using that link. It should be noted that a link may serve several bus routes each of which may use different times to traverse that link. The journey time used in this analysis is therefore approximate and may be different for some buses using the link. For consistency the assumed speed of travel was based on road class and the location and its location. The values used are shown in Table 2 below. Higher journey speeds were obtained on the O-Bahn busway (72 km/hr), high speed arterial roads in the outer suburbs (65 km/hr).

Table 2: Bus frequency of service and journey speeds

Location	Bus frequency (mins)	Journey speeds (km/hr)
CBD	5	18
Inner suburbs	10 and 15	20
Inner-outer suburbs	20	30 and 35
Outer suburbs	25 and 30	35 and 38

The determined speeds for both private and public transportation systems were added as link attribute to the respective private and public Adelaide transport network system. The speeds on the dummy links connecting the TAZ centroid and its nearest node are assumed to be 60 km/hr for private cars, and an average walking speed of 4 km/h for the public transportation system. The total time to travel along the dummy link is assumed to be given by the actual travel time (obtained from the length of link divided by the speed of travel) and any terminal (waiting) times involved. For the private car the terminal time is assumed to be zero, while for the public transport this is assumed to be equal to half the frequency of service.

4.2 Analysis and discussion of results

The results of the accessibility levels to health analysis are presented below. For ease of comparison the outputs using both private and public transportation systems are shown in the same figure. To compare the performance of the bus transportation system based on the integral accessibility to health facilities, a ratio of integral accessibility by bus to that of the private car is computed. This performance indicator is computed from equation 3 as:

$$R_i = \left[\sum_j^n \frac{B_j}{c_{ij}^{\alpha}(1)}\right] \Big/ \left[\sum_j^n \frac{B_j}{c_{ij}^{\alpha}(2)}\right] \qquad (3)$$

where R_i is defined as the effectiveness ratio for zone i;

$c_{ij}^{\alpha}(1)$ = travel cost from zone i to facility j for mode of travel by bus;

$c_{ij}^{\alpha}(2)$ = travel cost from zone i to facility j for mode of travel by car; and

B_j and n are as defined previously.

The magnitude of this ratio gives an indication of the effectiveness of the bus services to that of the car for each zone (Shindler and Ferrari, 1967). In the case of the relative accessibility (expressed in terms of travel time), the efficiency of the bus system is assessed as the difference between the computed relative accessibility by bus and the private car. This measure gives and an idea about the average time lost in travel to a facility by bus compared to the private car. It is given as:

$$c_{ij}(1) - c_{ij}(2) \qquad (4)$$

where $c_{ij}(1)$ and $c_{ij}(2)$ are the travel times between zone *i* and facility *j* by bus and car respectively.

The overall integral accessibility levels to health facilities in the region are depicted in Figure 2. The results show identical patterns of accessibility distribution for both bus and private transportation systems. Due to the concentration of the health facilities within the central part of the metropolitan area the accessibility is found to peak in the city centre reducing with increasing distance from the city centre. From the figure it is found that the outer suburbs seem under-provided with access to health facilities, due to the observed lack of health facilities situated in these areas. The minimum accessibility level obtained was 116 BPM for car travels and 60 BPM by bus. The maximum values obtained were 1979 BPM and 664 BPM

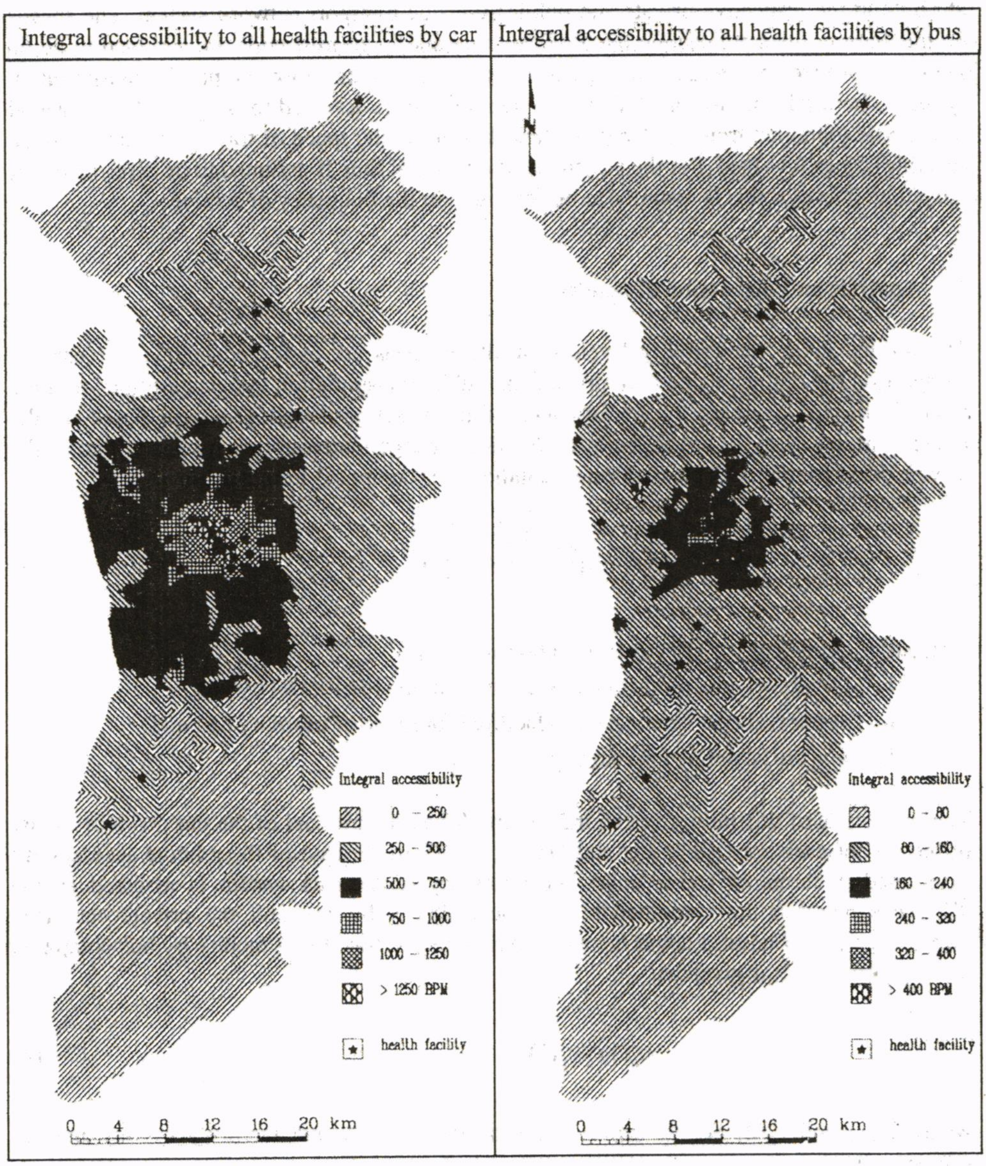

Figure 2: Integral accessibility to health facilities in Adelaide by bus and car

for car and bus travel respectively. The mean accessibility was 673 for car travel with a standard deviation of 372. By bus, the mean accessibility level was 147 with a standard deviation of 78.

The result of the comparative analysis of accessibility to all health facilities for both modes is displayed in figure 3. The efficiency of the bus service was found to range from 11.3 percent to 64 percent compared to that of the car. The mean value was about 23.5 percent with a standard deviation 6.6 percent. This value indicates that on the average for accessibility to health services the current bus transportation system operates at about a quarter of that of an efficient private transportation system operating at the maximum allowable speed.

Figure 4 shows a plot of relative accessibility to the nearest health facility. The figure depicts the location of all health facilities with each TAZ shaded according to its relative accessibility measure given by the time taken to reach the nearest health facility. This accessibility map shows that the distributional pattern is identical for both public and private transportation systems. However, as expected, it is observed that the times taken by bus are higher than those of the private transport. On average, most areas in metropolitan Adelaide (except two zone located at the southern end) were found to be within 15 minutes drive from the nearest health centre by car. By bus, it is observed that about half of the metropolitan region can access the nearest health facility within 30 minutes. The maximum times taken to reach the nearest health facility were 26 minutes and 50 minutes by private car and bus respectively. The mean travel time by car was found to be 3.2 minutes with a standard deviation of 2.98. The mean by bus was 19.9 minutes with a standard deviation of 8.77. The areas of high accessibilities were found to be in the CBD and inner suburbs. The southern-most part of Adelaide metropolitan area was found to exhibit the lowest level of accessibility to the nearest health centre. These results indicate that as future development takes place in the southern sector, there may be the need to locate new health facilities nearby. Table 3 below shows the summarised accessibility levels obtained by both modes of travel to the facilities studied.

Table 3: Summary of accessibility levels

Transport Mode	Car				Bus			
Type of Facility/Statictic	max	min	mean	std	max	min	mean	std
Health - All (BPM)	1979	117	674	372	664	60	147	78
Health - Public (BPM)	1198	62	362	214	533	33	79	47
Health - Private (BPM)	901	54	312	181	574	27	67	44
Nearest health centre (min)	26	2.7	4.2	2.98	50	8.3	19.9	8.77

5. CONCLUSIONS AND SUMMARY OF FINDINGS

An interactive GIS based system for use in determining accessibility levels to various opportunities have been developed and tested. It is menu driven, user friendly and requires no knowledge of the GIS. The system computes accessibility values at various disaggregate levels of the facility using simple and easy to understand measures of accessibility. The fact that the facilities are not aggregated at the zonal level guarantees credibility of the analysis results and so adds more meaning to the use of accessibility as a planning tool. Accessibility

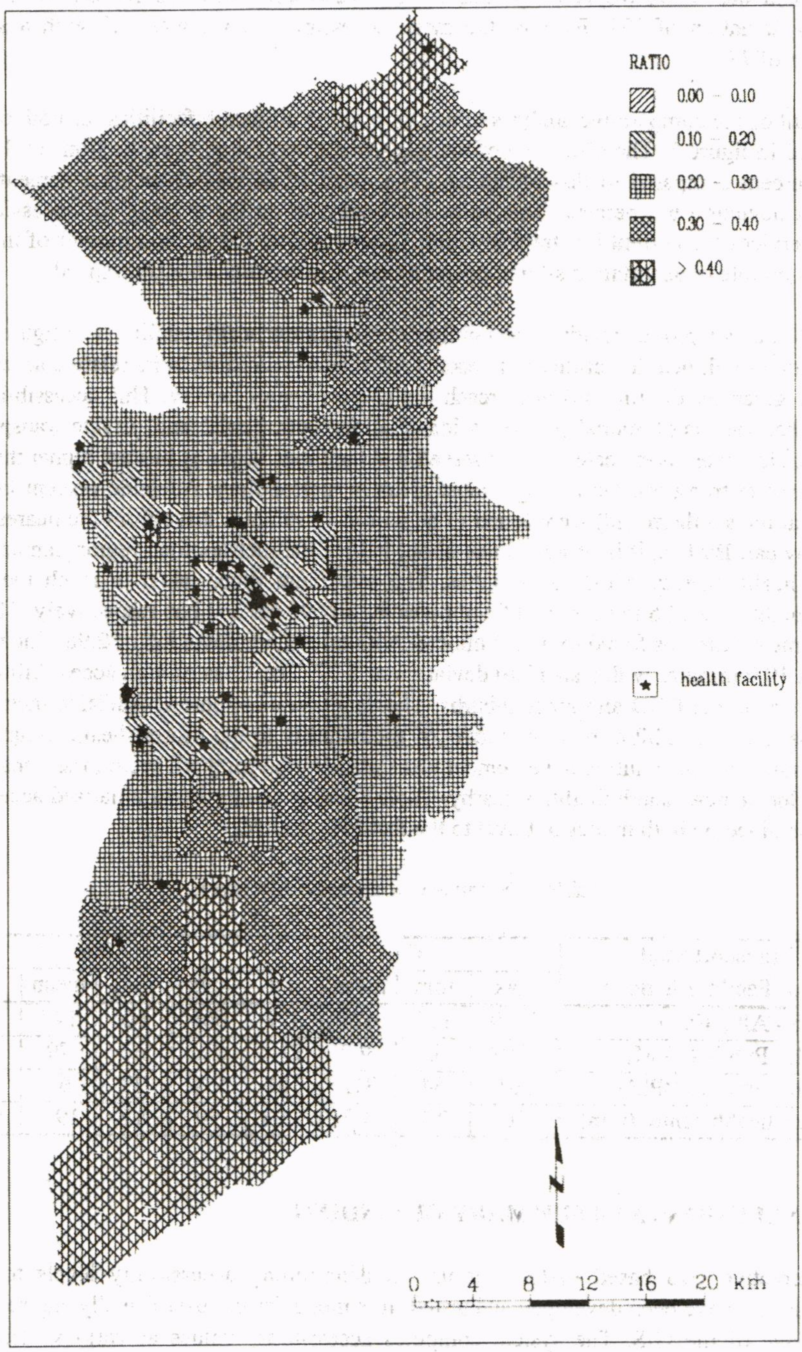

Figure 3: Ratio of accessibility to health facilities in Adelaide by bus to that of car

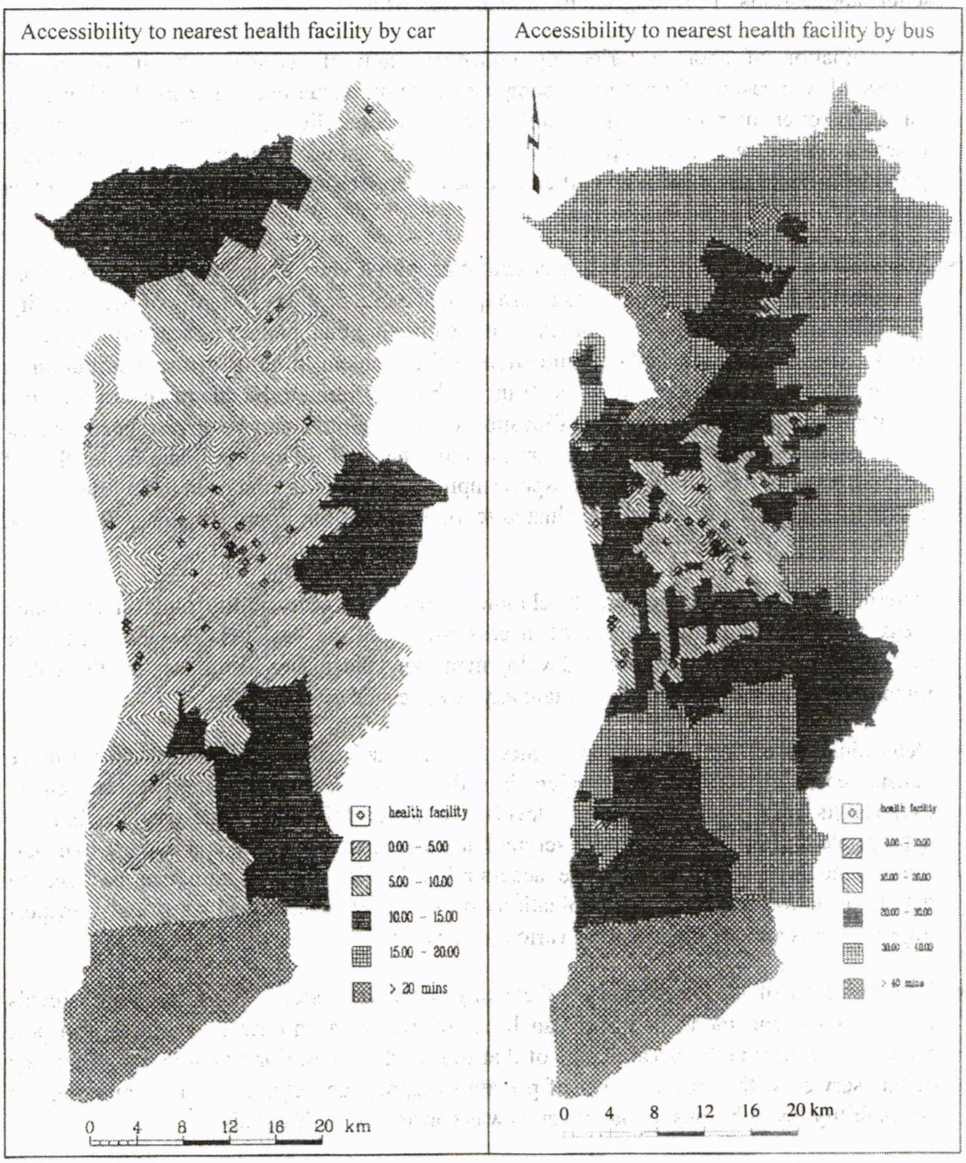

Figure 4: Relative accessibility to nearest health facility in Adelaide

has been used in several important situations in planning with several potential benefits. Practical applications of the program include the following:

- Determination of areas experiencing under-provision of services. The importance of accessibility measures lie not in its computed absolute value but rather its distribution or variations over the region. It is the difference in accessibility level from zone to zone or between modes, which is important in planning. It shows areas that are either under-provided or over-provided with particular type of services and activities compared to other areas.

- Studying the accessibility of particular activities with a view to optimising their locations in order to serve certain disadvantage groups of people or areas in terms of accessibility. The study may involve the determination of the distributional pattern of accessibility levels to this type of activities, and determination of the problem in terms of the distribution of the facility and the transport network. If the problem is found to be due to lack of facilities or inappropriate locations then re-allocation of the facilities can be investigated or new ones installed at appropriate places. On the other hand, if the real problem is not that of land use pattern, then alternative transport improvements in the area need to be tested. Any alternative proposed need to be evaluated to verified that the improvements will have the desire beneficial effect in the area.

- Determination of areas for new development. From the accessibility plots undeveloped areas with existing high levels of accessibility can be isolated as target area for development. However, before a development can take place, its impact on the entire region needs to be evaluated to ascertain any adverse side effects.

- Determination of land use/transport mix for new isolated developments. This can be considered as an accessibility problem in order not to develop a system whose density exceeds its maximum accessibility levels. To avoid this it is necessary to find the appropriate locations of all types of services and activities in the area and making transport improvements in order to increase accessibility levels. The program can be used to determine beforehand likely combinations of locations of the land uses and transport improvements and for investigating various alternatives.

- Determination of the performance of existing transport system. The accessibility levels computed for one mode of travel can be compared with another or an ideal transport system to determine the performance of that transport system. For example, the efficiency of bus service with respect to that of private transport can determined by comparing the accessibility levels by bus to that of car as was considered in this study.

- Estimation of the likely effects of changes in transportation network or the distribution of land use activities. The accessibility levels before and after the improvements can be used to evaluate the effect of any improvement in transport infrastructure or the distribution of land uses. Similarly, the approach can be used to compare changes in accessibility levels over two time periods.

- Location of additional emergency facilities like health centres, fire stations and post offices). The "Specific" main option of the program can be used to determine the optimum areas that can be served by the existing facilities. From these analyses areas not served can be isolated as likely locations of additional facilities.

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