Measuring Pedestrian Accessibility

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1. Introduction

Accessibility analysis has an increasing role in policy making and evaluation, particularly for policies targeted towards social exclusion. In the UK, local transport authorities are required to undertake accessibility planning and to develop accessibility strategies as part of the Local Transport Plan (LTP) process. Accessibility measures are useful in helping to identify groups of people and locations with poor levels of access to services and facilities, for policy formulation and for monitoring progress.

This paper describes work, currently being undertaken as part of a programme of research looking at Accessibility and User Needs in Sustainable Urban Environments (AUNT-SUE), to develop a GIS-based tool (AMELIA) for assessing the extent to which transport policies address the needs of the socially-excluded. AMELIA includes the availability of the mode of travel, trip purpose, socio economic differentiation, travel time and travel cost. As part of the design process for AMELIA, methods of accessibility measures are being explored and this paper discusses pedestrian accessibility measures along with their data requirements.

2. Accessibility measures

There are many different measures of accessibility that vary in terms of detail, parameters and perspectives. These measures have been reviewed elsewhere (Geurs and Eck, 2001; Geurs and Wee, 2004; Halden et al, 2005). Opportunity measures describing the level of accessibility to spatially distributed activities, such as the number of people within 30 minutes travel time of a destination or the number of jobs within 30 minutes travel time from an origin, are widely used in practice in the UK (Department for Transport, 2004). There are several reasons for this: the measures rely on available data or data that could be easily collected; they can be easily implemented in a GIS, and hence the measures and results can be better visualized and hence easily understood and interpreted by planners and policy makers. Such tools are available (Mackett and Titheridge, 2004), many based on GIS, in particular Accession (2006), which is the software commissioned by UK's Department for Transport to help planners carry out such measures.

However, the tools and methods have been applied at a macro-level and tend to be focused on motorized transport modes such as cars and public transport from transport access points rather than the complete journey. Where attempts have been made to include the whole journey, pedestrian access and egress tends to be dealt with rather crudely, using either a crow-fly buffer around the transport access point, or by representing the pedestrian network using road centre line data. Road centreline data are currently available from Ordinance Survey probably the most common being the Landline plus data and the new Mastermap product – ITN (Integrated Transport Network). The ITN road centreline data includes pedestrian only tracks and paths, but does not differentiate footways on each side of the carriageway. Hence pedestrian accessibility measurements to transport access points and destinations are simplified and may not be suitable when measuring for certain groups of people such as the elderly and wheel-chair dependent. The main reason for this is the lack of availability of pedestrian network data of footways and crossings. A database has been set up for the city of St Albans in the UK, as part of AMELIA work, as explained in Section 3 with methods for measuring pedestrian accessibility discussed in Section 4.

3. Data

Detailed micro-level data that influence pedestrian accessibility has been collected on the street. Data were collected on the following: buildings, characteristics of the footway, road crossings, bus stops and car parks. The aim is to collect data on all the physical barriers to walking for reaching a destination. Data collected on footways include obstacles to movement, width, the material, and its condition, and the gradient where it was steep enough to pose a possible problem. Data collected on road crossings include the location, the width of crossing, the width of the island, if there is one, the type of crossing, and dropped kerb gradients. Such micro-level data were also collected for transport access points such as bus stops and car parks and for destinations.

Based on the above data a GIS database was compiled for St Albans using the digital data from the Ordnance Survey Land-Line Plus data as the base. Using the footways and crossing data collected, a detailed pedestrian network layer of link-node structure was created by manually digitizing the pavements and crossings using the Land-line data as a backdrop. The links representing footways and crossings were used to store the respective attribute information collected, which could be modelled for network analysis purposes such as the cost of traversing a particular link or as a barrier.

4. Methods

The simplest way of performing a location based or opportunity measure in GIS would be to generate a buffer based on crow-fly distance and find the number of either people or destinations contained within it. This has been used as an approximate measure mainly for walking when pedestrian network data are not available. With the setting up of the St Albans database consisting of a detailed pedestrian network, more accurate network based measures that reflect the actual distance and factors representing travel impedances or barriers could be analysed. Three different methods to measure opportunities based on network distance have been considered:

a) Service area method

b) Network buffer method

c) Network method

Method (a) typically generates a polygon indicating bands of travel time or distances. (Figure 1). These bands are generated using the pedestrian network distance, with the edges of band representing lower and upper limits of distance specified by user. The procedures and options for constructing such areas varies between GIS software packages, and may or may not allow zone construction procedures to be defined (Smith et al.,2006). Similar polygon bands representing travel time contours called as 'isochrones' are used in many accessibility planning tools (London Transport, 1999; Robins 1999; Accession, 2006). This type of polygon generation are more suitable for macro accessibility analysis such as by car, wherein assumption of walking distance off-road or minor roads have been made. However, for measuring pedestrian accessibility particularly along networks of footways and crossing with attributes to consider physical barriers, this method may not be suitable. Note that Figure 1 includes destinations along footways that are not accessible. Since all the pedestrian walkways are included in the data, there is no other way those building could be accessed. Hence this method may result in over-estimating the destinations accessible by pedestrians.

Figure 1. Service area method

Method (b), instead of generating polygons, just uses the network that could be accessed and buffers them to measure the destinations that are accessible (Figure 2). While this method is better in terms of not including areas or destinations where there are no accessible footways, the width to be buffered proved sensitive. The reason being that the widths of footways and streets vary and hence the buffer could not be applied uniformly. If the width of buffer is chosen very small say 5m, destinations with bigger offsets from the footways are not measured. Also, in some wide pedestrian-only streets, modelled as a single footway, the destinations, though accessible, may not be included in the buffer. If it is increased to compensate, say to 7 or 8 m, destinations on the opposite side of the footway may be included in the buffer for narrower streets. This factor becomes critical when measuring for users who use wheel chairs or elderly. Hence this method may result in over or under-estimates of the number of destinations which are accessible depending on the street characteristics of the area such as layout, width.

Figure 2. Network buffer method

Method (c) does not rely on overlaying techniques to measure the destinations accessible. Instead of generating service area polygons or buffer, it just uses the network directly. This is achieved by generating dummy links from each destination to the pedestrian network modeled (Figure 3). The centroid of each building is connected to the nearest footway. This eliminates the issue of under or over estimating the number of destinations accessible as each individual destination can be reached through the network. Hence this methods measures the exact number of destinations along footways that are accessible by pedestrians, when compared with the above two methods. However, this method would require programming to automate the generation of dummy links as it may be time consuming to do it manually. Still, the links could only connect the centroid of the building to the nearest footway spatially. Hence manual editing of some links may be required considering the building entry point.

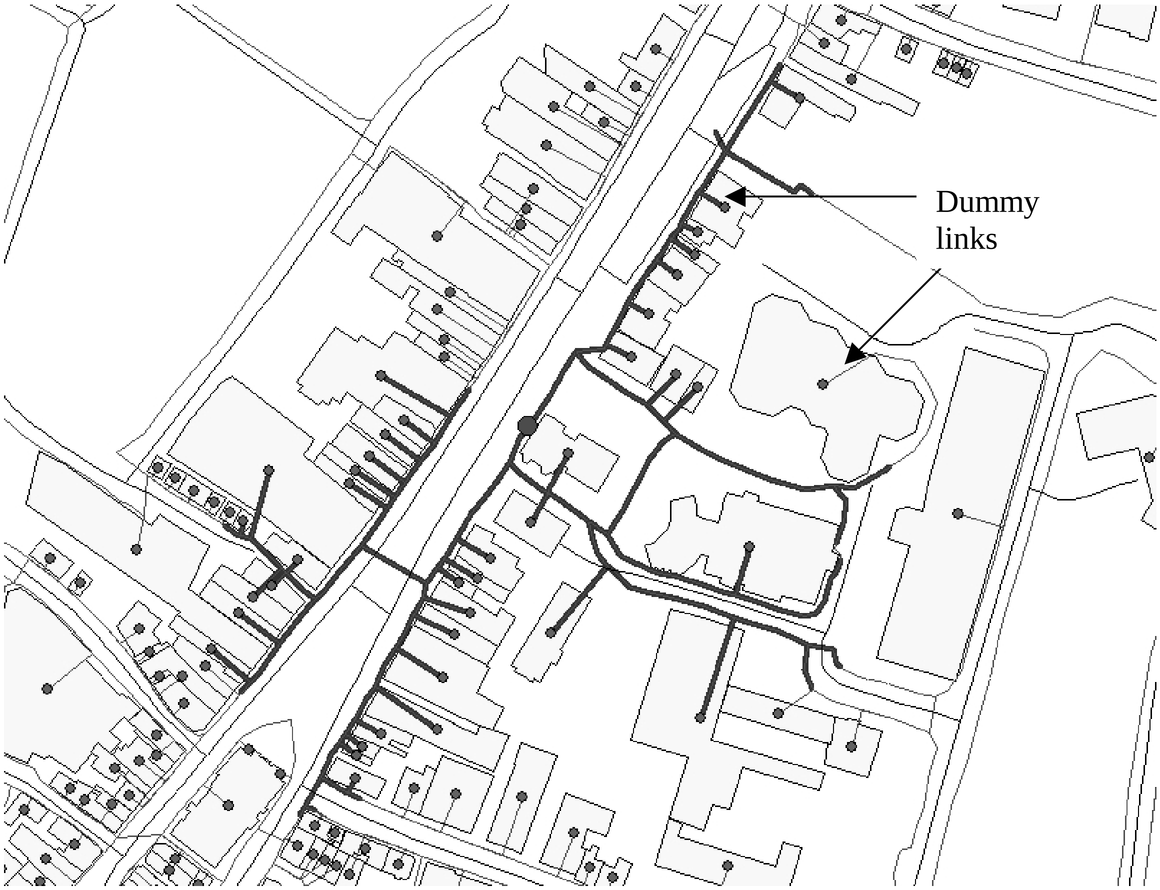

Figure 3. Network method

5. Conclusions

The paper discusses the methods of accessibility measures and problems of measuring pedestrian accessibility using existing methods. It also discusses the lack of availability of micro-level data for modelling pedestrian network and goes on to explain how these have been addressed in this project. Using a database, methods for measuring pedestrian accessibility are presented and discussed. A quantitative comparison of the methods in terms of the estimates and computation time is being carried out. The findings will be useful in informing those involved in accessibility analysis of the most appropriate methods for measuring pedestrian accessibility, whether these measures are being used solely to analyse the pedestrian environment or as part of macro-level location based accessibility measures.

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7. References

ACCESSION, 2006, Helping make places more accessible, available at http://www.accessiongis.com/

DEPARTMENT FOR TRANSPORT, 2004, Technical guidance on accessibility planning in local transport plans, available at: http://www.dft.gov.uk/stellent/groups/dft_localtrans/documents/page/dft_localtrans_033616.hcsp

HALDEN, D., JONES, P., and WIXEY, S., 2005, Accessibility analysis literature review. Working paper 3 available at http://home.wmin.ac.uk/transport/download/SAMP_WP3_Accessibility_Modelling.pdf

GEURS, K.T., and RITSEMA VAN ECK, J.R.,2001, Accessibility measures:review and applications. RIVM report 408505 006, National Institute of Public Health and Environment, Bilthoven.

GEURS, K.T., and WEE, B., 2004, Accessibility evaluation of land-use and transport strategies: review and research directions. Journal of Transport Geography 12, pp. 127-140

LONDON TRANSPORT, 1999, Calculator for Public Transport Accessibility in London (CAPITAL). Technical Note, July.

MACKETT, R.L., and TITHERIDGE, H., 2004, A methodology for the incorporation of social inclusion into transport policy, paper presented at the World Conference on Transport Research, Istanbul, Turkey

ROBBINS, N., 1999, Multimodal transport accessibility – the TRANSAM approach. Highways and Transportation, April, pp 16-18.

SMITH, M. J., GOODCHILD, M. F., LONGLEY, P. A., 2006, Geospatial analysis – A comprehensive guide to principles techniques and software tools, available at: http://www.desmith.eu/MJdS/output/

Biographies

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