Mapping accessibility differences for the whole journey and for socially excluded groups of people

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Abstract

Accessibility measures and maps are useful in helping to identify social groups and locations with poor levels of access to services and facilities. These measures however fail to directly account for differences in physical capabilities and mobility levels of different social groups of people. Also, many of the access issues for the excluded groups of people such as the elderly are micro level such as the obstructions in pavements, while accessibility measures tend to be at macro level and do not include the whole journey.

To help do this a GIS-based tool, AMELIA, has been developed. This paper discusses the specific elements of accessibility incorporated in AMELIA such as the modelling of walk and public transport accessibility, the micro level data required, the capabilities of the different social groups considered and how these affect the accessibility measures. Public transport accessibility maps produced for the elderly people are compared to those of the younger people using St Albans in Hertfordshire, UK, as a case study area.

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1. Introduction

Accessibility analysis has an increasing role in policy making and evaluation, particularly for policies targeted towards social inclusion. Social exclusion occurs as a result of a series of problems which prevent people from being able to participate in activities which would be considered normal in their society. Some of these problems are related to issues of transport accessibility such as poor pedestrian infrastructure facilities to access public transport and inadeqaute public transport. Improving access to transport, and thereby opportunities, can help to overcome many of these problems (SEU, 2003). In the UK, local transport authorities are required by Department for Transport (DfT) to undertake accessibility planning and to develop accessibility strategies as part of the Local Transport Plan (LTP) process. Mapping of accessibility measures are useful in identifying groups of people and locations with poor levels of access to services and facilities, for policy formulation and monitoring progress (Department for Transport, 2004).

There are many different measures of accessibility that vary in terms of detail, parameters and perspectives. These measures have been reviewed elsewhere (e.g. Geurs and Van Eck, 2001; Geurs and Van Wee, 2004; Halden et al., 2005). Location based measures describing the level of accessibility to spatially distributed activities such as the gravity-based measures and contours or cumulative-opportunity measures are the most common (Vickerman, 1974; Gutiérrez and Urbano, 1996). Gravity-based measure (Hansen, 1958) estimate the accessibility of a particular location assuming decrease in accessibility as travel time increases. Contour measures, based on isochrones, indicate the number of opportunities reachable within a given travel threshold (distance, time or cost), 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, and 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 can be easily collected; availability of quantitative benchmarks (minimum standards of access) for authorities to compare the measures; they can be easily implemented in a geographic information system (GIS), and hence the measures and results can be better visualized and easily understood and interpreted by planners and policy makers (Halden et al., 2005; Geurs and Van Eck, 2001).

Within the UK, a number of accessibility planning tools are in use, which take a variety of approaches (Mackett and Titheridge, 2004). These measures are generally at a macro-level (e.g. country and regional level) and tend to be focused on motorized transport modes such as cars and public transport from transport access points (e.g. bus stops) rather than on the complete journey (Linneker and Spence, 1992; Martin et al., 2008). Where attempts have been made to include the whole journey, pedestrian ingress 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 (O'Sullivan et al., 2001; Accession GIS, 2006). Strategic or macro-level policies implemented without proper consideration of the whole-journey chain and micro level details such as the availability of pedestrian crossing points and the quality, widths and gradients of the footways, may be ineffective in improving access to socially excluded groups of people such as the elderly and people with disabilities (Mackett et al., 2007). Also, different social groups of people have different capabilities and face different barriers to movement and experience different levels of access (Smith et al., 2006; Church and Marston, 2003).

The maps produced in this paper arise out of work, currently being undertaken as part of a programme of research looking at Accessibility and User Needs in Sustainable Urban Environments (AUNT-SUE; http://www.aunt-sue.info), to develop a GIS-based tool - A Methodology for Enhancing Life by Improving Accessibility (AMELIA) - for assessing the extent to which transport policies address the needs of the socially-excluded by looking at the whole door-to-door journey (Mackett et al., 2008a;b). AMELIA required an area to be defined for testing the tool and local authority involvement in the design process. The County of Hertfordshire was chosen for this purpose and this research is being conducted in co-operation with Hertfordshire County Council. In this paper the methods developed for mapping accessibility for the socially excluded groups of people, in particular the elderly are discussed. This is described using public transport as the mode of transport. Also, the importance of modelling the accessibility by walk and the micro-level data required for this purpose and how it affects the overall accessibility by public transport is discussed. Accessibility maps produced for the elderly people are compared with younger people and illustrated using the St Albans city centre and the district of St Albans in the County of Hertfordshire.

2. Methods

A whole journey, or door-to-door journey, in public transport involves a walk from origin to a stop (bus stop or train station), the travel by bus or train, the walk between stops (for journeys that involve transfer) and walk to the destination from the stop. The sections below describe the modelling of these in AMELIA.

2.1 Walk access

Walk access is generally measured using road centreline in existing tools (London Transport, 1999; Accession GIS, 2006). This ignores impedances related to footway characteristics such as narrow pavements, steep gradients etc and availability of designated crossings points, which are important factors to be considered while measuring accessibility for people with limited mobility and disabilities (Handy and Clifton, 2001; Mackett and Titheridge, 2004). However, pedestrian network data of footways and crossings are generally not available. There is no nationally available pedestrian network dataset. A database with detailed representation of the pedestrian network has been set up for the city of St Albans in Hertfordshire as explained below.

Detailed micro-level data on the factors that influence pedestrian accessibility have been collected on the street. The aim was to collect data on all the physical barriers to walking through the network, including obstacles to movement (e.g. lamp posts, bollards), width (actual and usable width), the material (e.g. concrete, bricks), and its condition (good, fair or poor). Data collected on road crossings included the location, the width of the crossing, the width of the island, if there is one, the type of crossing, and dropped kerb gradients. Based on this data, a GIS database was compiled for St Albans. A detailed pedestrian network of footways and crossings was manually digitised using Ordnance Survey's Land-line Plus data as base map. The arcs representing footways and crossings were linked with the respective attribute information collected. These were then modelled as impedances such as the costs/barriers of traversing a particular arc. Using this database and ArcGIS Network Analyst tools, the accessible links and thereby accessible locations within a certain threshold from an origin, considering the barriers and different capabilities of people, could be mapped and thus measured. The methods are discussed in detail elsewhere (Titheridge et al., 2007) and illustrated in Section 3.

2.2 Public transport access

In the UK, public transport data are held by the National Public Transport Data Repository (NPTDR) managed by the organisation THALES (2008). The timetables are available in ATCO (Association of Transport Co-ordinating Officers) standard (Ness, 2000). The data specifically contains information on stops with location information, journey and schedules. Public transport accessibility measurement based on this data has been proposed (O'Sullivan et al., 2001; Accession GIS, 2006; Martin et al., 2008). The main advantage of modelling using timetable data is that published times reflect congestion variations at different times of day and thus reflect actual travel times experienced in public transport.

In AMELIA, a program was developed to import ATCO files to a Microsoft Access database containing tables of stops, services, journeys with arrival and departure time information and stored as related tables. This was used to import the public transport timetable data for the County of Hertfordshire which includes St Albans district. The database can be queried for the stops reachable from a particular origin stop within a certain travel time and for a specific time period of day (e.g. 30 minutes travel time on Sunday between 10 and 11 am).In addition to the timetable data, the spatial locations of bus stops are used in the GIS to find bus stops that are reachable within a specified walking distance of every bus stop in Hertfordshire and stored in the database as a table linked with timetables. This enables calculation of the transfer time for different groups of people. Hence in AMELIA, with the walk access method integrated, it is possible to capture the whole journey in a public transport accessibility measurement that includes the walk ingress and egress to/from bus stops, the waiting time at bus stops, the actual public transport travel time during different times of day, and the transfer time for the journeys that involve transfers.

3. Analysis

In order to demonstrate how AMELIA is used to map and measure accessibility for the whole journey and for socially excluded groups of people, the following analysis shows accessibility for the elderly and younger people from the St Albans city centre to Census Output Areas (OA) of St Albans district. Since detailed pedestrian network data is only available for the city centre, the measure is based from the city centre to illustrate the problems in accessing the bus stops by walking more clearly, and its impact on the overall accessibility by public transport. The OA centroid is chosen to be the destination as they represent the location of the highest concentration of population living in that area and is available from Census, UK.

The elderly group considered here are people who are aged 65 years or over with limited mobility and dependent on mobility aids. They face many physical barriers while walking such as lack of dropped kerbs, shortage of road crossing points and steeper gradients along existing footways. Some are wheelchair users and require wider pavements. These could be set as barriers in AMELIA while measuring accessibility for elderly people. Younger people are assumed to have no mobility constraints and thus no barriers are set and are used in the analysis mainly to illustrate the impacts of barriers that the elderly face.

Figure 1 shows the walk access to bus stops from the city centre for elderly people considering their barriers of mobility. The barriers considered for this purpose are crossings without dropped kerbs, dropped kerbs with gradients steeper than 5 degrees, pavement widths less than a metre and a maximum walking distance set at 400 m. The barriers and values are set based on the Inclusive Mobility Guidelines (Department for Transport, 2005). Footways that are accessible within 400 m and the bus stops that are reachable based on the above set criteria for obstructions are shown. In comparison, younger people (Figure 2) access more footways as they are not restricted by any mobility barriers and thus are able to reach more bus stops. Different bus stops in the city centre are served by different bus services. Thus, for the bus stops reachable for a particular group, different bus services are accessible.

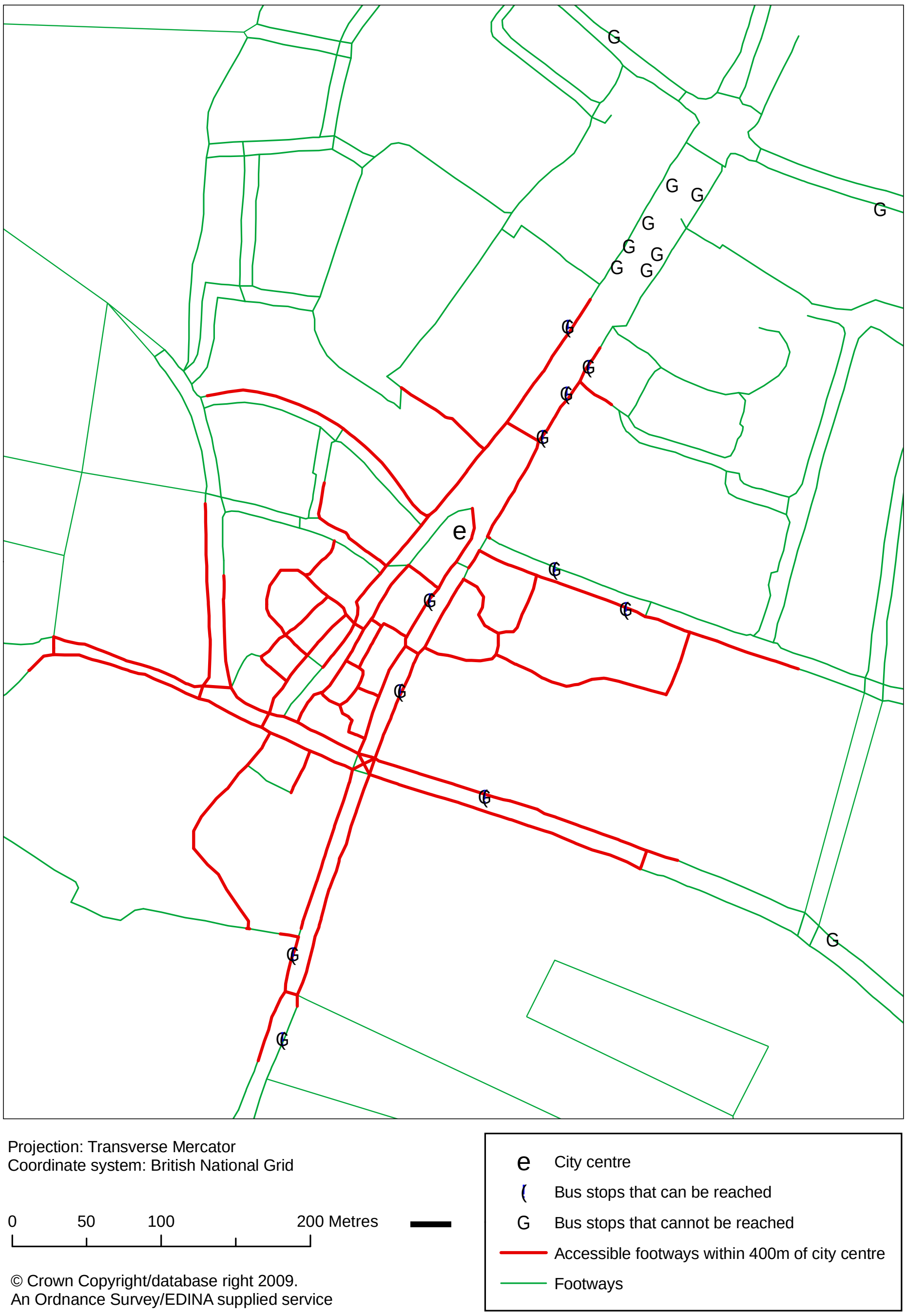

Figure 1. Walk access to bus stops (Elderly people).

Figure 2. Walk access to bus stops (Younger people).

Using the origin bus stops accessible for a particular group, AMELIA then determines the bus services and the bus stops that can be reached within a certain bus travel time. Footways that are accessible within 400 m of these destination bus stops are then determined. If a certain OA centroid is reachable by these footways then they are mapped as accessible OA. The accompanying map shows the OAs that are accessible from the city centre considering the whole journey for elderly and younger people. The whole journey includes 30 minutes bus travel time and 400 m ingress/egress walk from/to bus stops. The difference in accessibility levels shows the impact of micro-level barriers while walking, which affects the access to the number of OAs by bus for the elderly.

Similar accessibility maps could be produced based on important destinations (e.g. hospitals) and combined with population data to help identify the most excluded areas. Such maps could help in implementing policies targeted towards vulnerable groups' access to transport and for areas identified with lower levels of accessibility to encourage participation of them in social activities. The different barriers affecting different groups and their impact levels on their access could further be studied and transport infrastructure that provides the best value for money could be prioritised for investment.

4. Conclusions

This paper has discussed the development of methods to map and measure accessibility for different social groups of people. The effect of micro-level barriers in walking and their impacts on public transport accessibility measurement, particularly for the elderly people has been illustrated using St Albans in Hertfordshire as an example. The analysis showed that mapping accessibility based on capabilities of different social groups will help identify and prioritise targeted actions for vulnerable groups. It is recognised that capabilities of people, even within a particular group such as the elderly, tend to vary and assumptions have been made in doing this. Further work needs to be completed on capturing the capabilities of different social groups and their incorporation into AMELIA. This will add significant improvements to accessibility measurement and help address social exclusion.

Software

Microsoft Access 2002 was used as the database, with ArcGIS 9.2 was used to geocode the datasets. The maps were produced using ArcGIS 9.2.

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