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Same question, different answer: A comparison of GIS-based journey time accessibility with self-reported measures from the National Travel Survey in England

Angela Curl *, John D. Nelson, Jillian Anable

Centre for Transport Research, Department for Geography and Environment, University of Aberdeen, Elphinstone Road, Aberdeen AB24 3UF, United Kingdom

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ABSTRACT

Accessibility measures are usually designed to be objective representations of the 'real' conditions to provide a baseline for planning decisions and to track change over time. A wide range of approaches to measuring accessibility have been developed, usually based largely on quantifiable factors such as journey time. The simplest of these are based on the time taken to reach the nearest destination from an origin point. Destinations might include healthcare, education, employment or supermarkets, amongst others.

This paper posits that people's perceptions and experiences may differ from objectively measured conditions and crucially may be more important for understanding behaviour. An understanding of the difference between objective and subjective measures, and how they relate to each other is therefore vital before using either measure to inform policy decisions. This paper compares two approaches to measuring journey time accessibility to a range of destinations using objective measures of accessibility, calculated using GIS and individuals' self reported values, based on travel survey data.

Using two publically available datasets for England this paper explores the two approaches to measuring journey time accessibility to a range of destinations. Discordance between the two is found. Survey reported measures are found to be greater than objective measures in urban areas, but less in rural areas. This can be understood partly due to differences both between objective measures and reality and between perceptions and reality.

1. Introduction

This paper presents results of exploratory data analysis undertaken to understand differences between objective and subjective measures of journey time accessibility to a range of local destinations using two published datasets in England. The datasets used are the National Travel Survey (NTS) and the Core Accessibility Indicators (CAI) which are commissioned by the Department for Transport (DfT).

In the context of transport planning accessibility has generally been understood to be the ability of people to access places, or places relative to the population, with transport as the main means by which this accessibility is provided, even for very short journeys where walking is the mode of transport. Geurs and Van Eck (2001) define accessibility as "*the extent to which the land-use transport system enables* (*groups of*) *individuals or goods to reach activities or destinations by means of a* (*combination of*) *transport mode*(*s*)". The Social Exclusion Unit (SEU) defines accessibility as the "*ease with which people can access goods and services*" and by asking "*can people get to key services at reasonable cost, in reasonable time and with reasonable ease?*" (Social Exclusion Unit, 2003). This definition is increasingly adopted in more social studies of transport and is the one used to underpin a process of Accessibility Planning in the UK. Defining accessibility in this way presents a challenge in measurement as '*ease*' and '*reasonable*' will be interpreted differently depending upon the individual context. The process of Accessibility Planning in the UK represents one example of formalising an approach to measuring and applying the concept of accessibility within transport planning.

Considerable progress has been made in mainstreaming accessibility into transport planning in the UK through the local transport planning process and the development of national core indicators for accessibility against which local authorities in England can benchmark. Measurement of accessibility and development of indicators such as the Core Accessibility Indicators (CAI) used in this paper support this process alongside tools such as stakeholder consultation. This approach recognises that factors

* Corresponding author. Current address: Urban Studies, University of Glasgow, 25 Bute Gardens, Glasgow G12 8RS, United Kingdom. Tel.: +44 141 330 2093.
E-mail addresses: angela.curl@glasgow.ac.uk (A. Curl), j.d.nelson@abdn.ac.uk (J.D. Nelson), j.anable@abdn.ac.uk (J. Anable).

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other than spatial location are important and places importance on barriers to accessibility such as information, cost and safety and security as well as provision of transport services and journey times (Social Exclusion Unit, 2003).

In studies of accessibility, journey time is the basis for measurement and is usually calculated as travel time through the road or public transport network, often utilising GIS as a tool. Cumulative measures such as the origin and destination indicators reported in the CAI, are often used to give an indication of the number of people or destinations within certain time thresholds of a given point. These are used as targets against which performance is measured, for example in Local Transport Plan (LTP) "Accessibility Strategies". Whether or not such measures relate to individuals' experiences and/or perceptions of travel time remains relatively unexplored. This is problematic, particularly in the context of the focus of policy, such as Accessibility Planning, on individual experience and behaviour change which demand a focus on perceptions as well as the characteristics of the built environment, which objective measures seek to represent. This paper therefore presents a comparison of such GIS based journey time measures of accessibility with self-reported responses of journey time accessibility from the National Travel Survey (NTS). Although, as highlighted by the SEU, accessibility perceptions will rely on much more than journey time, this paper focuses specifically on understanding differences between objective and subjective *journey time* measures, and how these vary spatially and socially.

The paper is structured as follows: Section 2 provides a background to objective and subjective measurement of accessibility and also draws on examples from other fields. Reasons for expected differences between the two types of measure are explored theoretically and the implications of differences are discussed. Section 3 provides detail related to the datasets used for this analysis and then Section 4 outlines the methodology. Results are presented in Section 5 and discussed in Section 6. The final section draws conclusions.

2. Background

Accessibility is a fundamental concept in transport planning and over time it has been defined and measured in numerous ways but is generally understood to be the ability for people to reach destinations. Accessibility is measured, in spatial and transport planning, using a range of objective measures designed to assess the level of accessibility provided by the transport and land use system, usually with the aim of improving accessibility for the population. Geurs and van Wee (2004) categorised measures of accessibility into four types: Infrastructure-based measures; location-based measures; person-based measures; and utility based measures. Each of these relies to some extent on a measure of journey time between two points, an origin and destination. Within location based measures, contour (or cumulative) measures and potential (or gravity) measures are the two most commonly employed within studies of accessibility. A contour measure is based on the number of opportunities accessible from a given origin or the population that can reach a given destination within a given time threshold. A potential, or gravity, measure is based on the work of Hansen (1959) and expresses accessibility of one origin or area relative to another, with destinations having a diminishing attractiveness with distance. The Core Accessibility Indicators (CAI), which are analysed in this paper, report simple infrastructure measures of the journey time between origins and their nearest destination as well as cumulative and gravity measures. More detail is given in Section 3.

While these measures are designed to represent the accessibility provided by the transport and land use system, they may not relate to individuals' experiences of accessibility. Recognition of a schism between objective measures and subjective understandings of accessibility is clearly not a new issue – Morris, Dumble, and Wigan (1979) wrote that "*perceived accessibility and perceived mobility – the real determinants of behaviour – will be at variance with "objective" indicators of accessibility and mobility*." Despite this there is still little practical understanding of how and why they vary in transportation research. However, evidence from other fields suggests there is a difference between the two (e.g., Parks, 1984).

While it can be claimed that everything is subjective to some extent and therefore questionable whether true objectivity is possible (Muckler & Seven, 1992), the terms are widely used in social indicators research (e.g., Diener & Suh, 1997; Wish, 1986; Parks, 1984; Kuz, 1978), with subjective relating to citizens experiences, perceptions and evaluations of their own 'reality', and objective being the 'official reality' as measured by government agencies. For example, Van Acker, Van Wee, and Witlox (2010) give the case of low motorised traffic levels meaning a neighbourhood is objectively evaluated as pedestrian friendly but that certain individuals may not perceive it to be so. In this paper therefore, objective relates to a government indicator or measure designed to reflect the 'real' situation, and subjective is used to understand an individual perception or experience of that reality. This position is explained by Pacione (1982) for whom objective indicators are "*hard measures, describing the indicators within which people live and work*" whereas subjective indicators "*describe the way people perceive and evaluate conditions around them*". However, this is not to say that objective measures do reflect the 'reality' of the built environment. It is likely that the reality falls somewhere between objective measures and subjective measures, due to errors in calculation or modelling assumptions. There are two reasons why differences between objective and subjective measures are expected. GIS model-based calculations of accessibility are prone to error, dependent upon the accuracy of input datasets and parameter assumptions, which may not be an accurate reflection of travel behaviour. While some, including Krizek, Horning, and El-Geneidy (2012), cite perception "inaccuracy" as the primary reason for differences, it is important to recognise the limitation of model approaches and realise that these do not represent the objective "truth" although they may seek to do so.

Perceptions may differ from reality in two ways, firstly because of an individuals' constraint, such as limited mobility which means that they differ from the average, but that their perception is their lived reality. Secondly, perception may differ due to lack of knowledge about available options or distorted perceptions due to familiarity with particular modes of transport.

In a recent review Van Acker et al. (2010) explain that while most empirical studies *"use objective variables that refer to characteristics of each level or environment these objective variables are, however, perceived and evaluated by individuals with specific lifestyles. Nevertheless, almost none of these studies questions whether perceptions correspond to the objective reality"* (Van Acker et al., 2010). Exceptions include Lotfi and Koohsari (2009), Van Exel and Rietveld (2009), and Krizek et al. (2012). Lotfi and Koohsari (2009) use three objective measures (Infrastructure, Activity and Utility based) and compare these with a subjective approach based on interview and questionnaire data. They find that those areas with the highest "measures" of accessibility are not perceived as such by residents (in terms of satisfaction with access to facilities) due to issues of safety and security. Van Exel and Rietveld (2009) investigate transport choice sets for commuters, and found that the ratio of perceived to objective travel times strongly influenced modal choice. Car users over-estimated objective measures of public transport times by 46%. If more can be done to understand the difference between perceived and actual accessibility, then improvements in perceived accessibility, and therefore