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Estimating pedestrian demand for active transport evaluation and planning

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ABSTRACT

This article presents a recently developed walkability-based approach to evaluating the built environment's relationship to pedestrian activity, as well as the application of this evaluation in generating a model of pedestrian demand across London derived from built environment indicators. The approach is novel in its integration of space syntax measures to evaluate network accessibility and the use of volume area ratios to measure land use intensity. It utilises high-resolution geographic data surfaces for the generation of the built environment variables. The advantage of using this method is that it allows greater analytical flexibility in transport policy and practice, where the ability to compare the analytical results to other social and spatial indicators is vital for decision-making. Pedestrian density data covering the whole of Greater London are used to test the performance of the variables. The best performing variables are then analysed to determine their weighting in a model of pedestrian demand for London based on the selected built environment indicators. Randomised testing shows that the model is capable of reliably predicting pedestrian demand. It can be used to estimate pedestrian demand both currently and for future scenarios by quantify future changes to the built environment, and thus enabling walking to be quantitatively assessed in the same way as motorised modes. The model can be applied to active travel infrastructure planning and policy evaluation, from the scale of the street or intersection, to larger administrative units. The model also has wider theoretical and policy implications that relate to the spatial structuring of London.

1. Introduction

This article presents an approach to estimating pedestrian demand in urban environments based on walkability study approaches that allows the inclusion of a range of field-based observations and spatial datasets, with the model functioning both as an exploratory research tool and as an application to be used in urban design and planning – whether to plan infrastructural or behavioural interventions, identify potential community severance, or to assess town centre vitality. The approach diverges from other walkability analysis in that the model is not constrained by geographic or administrative boundaries; instead, the spatial components of the model are interpolated as continually varying surfaces across the entire urban area being studied. This not only enables statistical cross-comparison between multiple datasets, but better visualisation – and so communication of the model to key stakeholders.

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Whilst there have been many studies (Van Holle et al., 2014; Moran et al., 2014; Hajna et al., 2015; McGrath et al., 2015; Leslie et al., 2007; Cerin et al., 2006) carried out that show how certain features of the built environment are associated with differentials in the level of physical activity, and associated health outcomes, that occur in a population living in a particular location, they do not generally seek to provide ways of evaluating the intensity of walking activity likely to take place in a specific location, nor do they provide methods of transferring this research into design tools that can be used by those engaged in transport planning. For example, planners might wish to identify areas that lack adequate pedestrian facilities on the ground in areas which could potentially be attractive to people on foot, or to maximise the active transport – either by improving the design of an area's walking and cycling network infrastructure – or through behavioural change interventions. Currently, there is a lack of evidenced-based tools to do such assessments.

In this article approaches to measuring walkability are examined, including the discussion of the impact of street network on walking activity levels. Four themes of built environment measures are explored: land use characteristics, street network structure, transport accessibility and residential population density. From these four categories, the highest performing built environment variables are selected based on their correspondence to a pedestrian activity dataset. These are then modelled against measured pedestrian activity in order to estimate a weighted model of pedestrian demand based on the built environment indicators. This paper ends with a discussion of the applicability of the model for pedestrian demand. This is then widened out to highlight the relevance to this work to theories of travel behaviour and urban spatial structure. The purpose of the presented research is to enable policy and practice to effectively understand and increase active travel, supported by robust quantitative pedestrian demand modelling.

2. Walkability and built environment characteristics

Measuring the walkability of urban environments by analysing and evaluating physical environmental characteristics has gained wide acceptance as a method for assessing the urban environment's potential for encouraging or inhibiting walking (Renalds et al., 2010; Feng et al., 2010), as well as other active transport modes. Walkability models are used widely in transport and health research domains (Freeman et al., 2013; Glazier et al., 2014), especially in North America and to a lesser extent in Europe (Sundquist et al., 2011; Van Dyck et al., 2010), but are now also being applied outside of these regions (Oyeyemi et al., 2016). In the transport domain, the focus tends to be on the potential and suitability for a street system to be used for walking (Moudon and Lee, 2003), whilst in the health domain, walkability models are used to assess dose-response relationships between the built environment and physical activity (Van Dyck et al., 2012). Walkability metrics of the built environment are often used as variables in studies which aim to ascertain the health outcomes of living in neighbourhoods with differing geographical and population attributes (Buman et al., 2010).

Walkability can be defined in several different ways (Lo, 2009), and therefore attempts to measure it do not necessarily coincide well with its theoretical or conceptual underpinnings. In the realm of public health studies, the focus is on an area's suitability for walking. Previous research has found that people walk more in neighbourhoods with multiple destinations and where the environment enables more opportunities for walking, with many street junctions as well as good connections to other forms of transport. Such studies also take account of reasons for walking, such as distance to shops and businesses (Frank et al., 2005; Giles-Corti et al., 2005; Song, 2005; Moudon et al., 2006). Their findings form the basis for a vast array of health studies, which audit neighbourhood walkability based on such parameters, where a neighbourhood's walkability is considered to be a proxy for the levels of physical activity within a population within a specific area. Such walkability frameworks examine a range of variables in order to ascertain which aspects of the environment or socio-cultural make-up correlate most significantly with health outcomes, and then these features are considered to be determinants of walkability.

Walking activity is often subdivided within walkability studies into different domains in order to enable the extraction of the environmental attributes that contribute to different types of walking activity, since different variables are likely to affect each activity type differently (Sallis et al., 2006). The most common subdivision of walking activities is between walking for transport and walking for recreation. Walking for transport includes walking to places of work, visiting shops and other services as part of daily routines. Walking for recreation is walking as a pastime or as part of an exercise routine. This article focuses upon walking for transport, which is classified as a form of active travel or active transport, alongside other modes such as cycling.

The literature on walkability tends to focus on walking as being beneficial to health. However another important aspect is the role of walking as a function of the vitality and liveability of cities. In the transport literature, work by Jones et al. (2007) points to the tension that can arise between routes being heavy trafficked by both pedestrians and motorised traffic (with the consequential impact on the pedestrian walking environment), whilst in the urban design literature there is an increasingly large body of work on how well-connected and spatially coherent town centres benefit from increased footfall as well as dwell time (Carmona, 2015; Karimi, 2012). Qualities of the walking environment such as lighting, pavements and street block size have also been found to correspond to higher rates of walking (Forsyth and Southworth, 2008; Frank et al., 2010).

There is also an argument that areas that are more walkable and where there is a greater level of street-based activity are more likely to become 'creative' hubs due to the type of individuals that will be attracted to work and live there (Florida, 2005). More prosaic analysis focuses on land and property values, demonstrating that walkable areas are more liveable and hence, more desirable when measured by property values (see e.g. Chiaradia and Koch, 2013), whilst recent work in the UK points to the importance of walkability for the long-term viability of smaller town centres (Vaughan et al., 2013).