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Origin-Destination Trip Matrix Development: Conventional Methods versus Mobile Phone Data

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Abstract

Conventionally, trip matrices have been derived by a combination of roadside interviews (RSIs) and the application of trip-end and gravity models (to extrapolate and infill unobserved movements), followed by matrix estimation methods to incorporate evidence from supplementary traffic counts. More recently, mobile phone positioning data are being used increasingly by the transport planning community to develop 'prior' demand matrices as an alternative approach to RSI data or synthetic methods. There are a number of known strengths and weaknesses associated with each of these approaches. However, there is lack of robust evidence to suggest whether use of any of these approaches results in a matrix that performs better (or worse) overall. This study provides such evidence through a structured and systematic comparison of trip matrices developed using mobile data, RSI data, and a gravity modelling approach (i.e. synthetic matrices). In addition to comparison of assigned flows with traffic counts across a range of independent screenlines, the following aspects of the matrices are also compared with independent observed data: 1) correlation of trip-ends with estimates based on the UK National Trip-End Model (NTEM); 2) consistency of trip rates with estimates based on Great Britain National Travel Survey (NTS) data; and 3) comparison of trip length distributions with estimates from the NTS. The results suggest that, overall, the outcome of using the mobile phone data, when systematically refined and adjusted using independent data sources to address various known limitations and biases, does not seem to be either biased or less accurate than conventional methods. It has also been observed that areas of the model where no RSI data or other similar observed data are available, use of mobile data could result in a more consistent estimate of trips, benefiting from a significantly larger sample size.

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Keywords: Trip matrices; RSI data; mobile phone data; Gravity models

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1. Introduction

Conventionally, trip matrices have been derived by a complex process involving a combination of methods. This includes the use of roadside interviews (RSIs) to observe movements across defined screenlines, the application of trip-end and gravity models to extrapolate and infill unobserved movements, followed by matrix estimation methods to incorporate evidence from supplementary traffic counts. This process is widely accepted as the preferred approach to using synthetic matrices. More recently, mobile phone positioning data (referred to as 'mobile data' in this paper) are being used increasingly by the transport planning community to develop 'prior' demand matrices as an alternative to the RSI and synthetic matrix development approach.

There are a number of known strengths and weaknesses associated with both RSI data and mobile data, which have been documented in detail in a number of recent studies (for example, see Tolouei, et. al., 2015). However, there is lack of robust evidence to determine whether the use of mobile data results in matrices that perform better or worse overall than matrices developed using alternative, conventional methods (i.e. RSI data or synthetic methods based on gravity modelling). In this study, we provide such evidence through a structured and systematic comparison of two sets of trip matrices: matrices developed using mobile data, and matrices developed using a combination of RSI data and a gravity modelling approach (i.e. synthetic matrices).

Origin-Destination (OD) matrices estimated from mobile phone data have potentially certain strengths compared to conventional sources of OD information such as RSI data. These mainly include wider geographical coverage, higher sample size, capturing day-to-day variability of trips, and potential time and cost savings for data collection and processing.

However, this is a relatively new type of data which are not collected exclusively for the purpose of transport planning. There are therefore key weaknesses and uncertainties associated with OD matrices derived from mobile phone data which should be recognized and addressed. These include definition of trips and trip-ends, spatial resolution and data accuracy, identification of short trips, identification of vehicle types and vehicle occupancy, identification of trip purpose and mode, and expansion of mobile data. A comparison of the characteristics of RSI data and mobile data, sourced from an earlier paper (Tolouei, et. al., 2015), is shown in Table 1.

Table 1: Possible Drivers of Trends in Trip Rates

Attribute / Consideration	RSI Data	Mobile Phone Data
Type of raw data	Cross-sectional (a sample from a single day)	Longitudinal (cross-sectional data collected over a period of time)
Sampling approach	Specified locations for selected roads; Random sample of drivers at these locations	Full population of Operator's subscribers
Sample rate (for a given road)	10% to 20% (individual sample)	~30% (repeated sample over several days)
Variation of trips observed in the data	Spatial variation	Spatial and temporal variation
Data bias	Potential for response bias, this could be minimised through careful survey design and sampling strategy	Potential for bias towards the profile of 'subscribers' if different, bias could be corrected largely if identified properly
Expansion of data	Relatively straightforward using count data and statistical analysis where journeys traverse more than one sample site.	More complicated, requiring information on how the mobile phone users relate to total population
Identify trip purposes	Straightforward; survey question	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Identify vehicle type	Straightforward; survey observation	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Identify vehicle occupancy	Straightforward; survey observation	Need to be inferred through assumptions/rules/other data sources (including RSIs if available).
Geographical scope of data	Only those movements intercepted by screenlines / cordons (see Figure 1)	In theory all movements, though short trips may be omitted
Proportion of unobserved OD trips in the matrix	Relatively large, depending on number of RSI sectors	None or very low (short trips)

The main objective of this study is to compare the performance of trip matrices that are developed using conventional methods (i.e. using RSI data) with those based on emerging techniques using mobile phone data.