Chapter 12

Individual Mobility Analysis Using Smartphone Data

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ABSTRACT

This chapter provides an overview of the capabilities and limitations of smartphone data for individual mobility analysis and choice modeling. First, the Lausanne Data Collection Campaign (LDCC) that yielded one of the richest smartphone datasets with respect to the assortment of the available data is introduced. Next, the opportunities and challenges associated with this type of data are assessed, and the resolved problems for each challenge are summarized. The objective of the present chapter is to share lessons and experiences related to the LDCC data to support future use of smartphones in mobility research and travel demand analysis. Specific attention is given to the exploitation of such data for the purpose of route choice modeling within the context of discrete choice analysis.

INTRODUCTION

Nowadays, efforts to ameliorate the operations of transport systems have shifted from a supply oriented to a demand oriented approach. The space and budget constraints for extending the current infrastructure has led to an attempt to better understand and predict the demand in order to subsequently enable optimizing the operations and management of the existing network. Understanding individual choices pertaining to the various dimensions of travel behavior, such as mode, destination and route choice, is important in achieving this goal. In this context, an increasing interest in human behavior at all scales arises. This fact has triggered the exploration of new types of models of decision-making, and new sources of data.

The availability of data about users’ behavior in the transportation network is the driving force of mobility analysis. Recent advances in data col-
lection based on GPS devices and GPS-enabled smartphones have revolutionized the acquisition of information, modeling and eventually the understanding of behavior. These methods become very popular as data collection tools in studying mobility patterns (González et al., 2008), and transportation network performance (e.g., Jenelius & Koutsopoulos, 2013). Choice data is traditionally collected by means of surveys where people are asked to describe their choices, such as the route they followed for a specific trip, or their mode of transport. Traditional surveys are conducted via mail, telephone or computer assisted tools and hence they entail complex logistics. In addition, these methods are costly, limited by accuracy of recall, reliability, and respondent compliance. Since the GPS technologies became available, the choice observations have been extracted by tracking users as they traverse the network (passive monitoring).

Table 1 provides a general comparative analysis between traditional surveys and GPS tracking by listing the main advantages and disadvantages of each approach with respect to sensing travelers’ behavior from the data acquisition point of view.

A comprehensive comparative analysis between GPS and travel survey data can be found in Bricka and Bhat (2006). Apart from the advantages with respect to data richness, the respondents’ willingness to participate in the survey is an additional asset of automated technologies. Carrying a GPS device is not a heavy burden and it is less tiresome than answering questionnaires. Murakami and Wagner (1999), Jan et al., (2000), and Wolf et al., (2003) provide numerical evidence favoring GPS data in quantitative travel behavior studies.

With respect to route choice modeling, the advantage of GPS tracking for the extraction of route data, in comparison with the survey methods, is apparent. Frejinger (2008) points out that both data collection methods have issues with respect to the acquisition of route choice data and she reviews previous route choice modeling applications focusing on the data collection issues. During the last decade, increasingly more route choice models have been based on GPS data. Examples include Broach et al., (2012) modeling route choice behavior of cyclists, and Murakami and Wagner (1999), Jan et al., (2000) and Li et al., (2005) modeling car drivers’ route choice behavior. On

<table>
<thead>
<tr>
<th>Desired [Undesired] Property</th>
<th>Traditional Surveys and Diaries</th>
<th>GPS Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of socio-demographic data</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Availability of trip context info (e.g. purpose) and user’s view of the trip</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Longer observation periods (panel data vs. dynamics and choice variability)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>High spatial precision and temporal accuracy (automated)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Continuous, automatic, real-time recording of all trips not relying on respondents memory</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Description of unchosen alternative</td>
<td>Sometimes</td>
<td>No</td>
</tr>
<tr>
<td>[High cost and complex logistics vs. small samples]</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>[Reporting errors]</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>[Need to reconstruct the exact paths]</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>[Selection bias]</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1. Properties of survey methods with respect to data acquisition
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