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Automatic trip and mode detection with MoveSmarter: first results from the Dutch Mobile Mobility Panel

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Abstract

This paper describes the performance of a smartphone app called MoveSmarter to automatically detect departure and arrival times, trip origins and destinations, transport modes, and travel purposes. The app is used in a three-year smartphone-based prompted-recall panel survey in which about 600 smartphone and non-smartphone owners participated and over 18,000 validated trips were collected during two weeks. MoveSmarter is concluded to be a promising alternative or addition to traditional trip diaries, reducing respondent burden and increasing accuracy of measurement, but there is room to improve trip and mode detection rates and the efficiency of battery consumption.

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1. Introduction

In most countries, including the Netherlands, the understanding of people's travel behaviour is based on cross-sectional travel surveys where only one day is surveyed for each respondent in 'representative' periods when traffic flows are maximal (Ortuzar et al., 2010). This is not enough to gain a proper understanding of the dynamics in travel behaviour. More specific, cross-section data do not give any information to ascertain how choices will vary over time if the system changes. Moreover, multi-day travel behaviour data (collection using GPS-devices) show a

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strong variation in travel behaviour (Stopher and Zhang, 2011). It has been shown that people are to visit new places even after several months of monitoring (Schönfelder and Axhausen, 2010).

Dynamic information on travel behaviour can be obtained by asking respondents to register their trips during more than one day. Although this might be possible for small samples, it is not a realistic option for large national travel surveys as this implies a high respondent burden. In the literature, it is suggested that automatic detection of trips might be the solution for this problem, especially when GPS and GSM technologies in smartphones are becoming standard (Stopher, 2009, Nitsche et al., 2012). Kracht (2004), for example, showed the great potential of GPS and GMS in monitoring travel behavior. An additional advantage of automatic detection is the possibility of the registration of trips that respondents forget to report in traditional surveys. Survey-based methods have an inherent and downward bias in trip detection which can be significantly reduced using automatic detection. In the literature, underreporting of 10% up to 80% of car trips is documented, when GPS traces are compared with travel diaries (Schönfelder and Axhausen, 2010). At the same time, there are also errors and omissions in GPS and smartphone measurements. In addition, prompted recall surveys are also not necessarily error-free (Feng and Timmermans, 2014).

In the literature, a number of studies are described in which smartphone apps are used to detect trips and trip characteristics such as transport modes (e.g., Reddy et al., 2010; Nitsche et al., 2013; Shin et al., 2015). A number of other studies describe apps aiming to detect trips and provide users with feedback on their travel behaviour (e.g., Fan et al., 2012; Li et al., 2011; Bie et al., 2012; Prelipcean et al., 2014). These studies describe apps in the prototype stage and which have not (yet) tested the accuracy of the tool in large-scale field trials. One exception is the smartphone-based prompted-recall survey developed and deployed in Singapore as part of a subset of a national household travel survey (Cottrill et al., 2013). Furthermore, to the authors' knowledge, smartphones have to date not been used in longitudinal studies in travel behavior. This paper describes the first results from the Dutch Mobile Mobility Panel project. The project tries to answer two main research questions: (1) Are smartphones an effective and efficient tool for trip registration in order to monitor individual travel behavior during a long period of time? (2) What is the variation in travel behavior over time, and which external factors (such as weather) do influence this variation? To answer these questions, a field study is carried out with respondents recruited from the Dutch LISS (Longitudinal Internet Studies for the Social Sciences) panel. This is a non-commercial panel which can be only used by academic researcher and policy makers. For about 600 respondents from the panel, smartphones are used to detect trips automatically during several weeks in the period April – June in 2013, 2014 and 2015. The size of our study is quite unique compared to the studies in the literature.

This paper describes the data collection methodology of the Mobile Mobility Panel project (Section 2) and analyses the accuracy of trip rate detection (Section 3) and mode detection (Section 4), using the data from the 2013 wave. Furthermore, we describe the results of a user evaluation conducted after the fieldwork period (Section 5) Participants were asked to express their opinion about different aspects of the experiment, e.g. the app, accuracy of the trips and mode detections, smartphone use, accuracy of trip corrections, battery use and the prompted recall website. We use the results to explain biases in trip detection (Section 6). Finally, Section 7 presents the conclusions.

2. Methodology

2.1. Overview

The trip registration consists of three parts: (1) automatic trip registration with the smartphone application MoveSmarter (for iPhone and Android), (2) update of the detected trip characteristics on a back-end service, and (3) an internet-based prompted recall survey. In the prompted recall, respondents are asked to check, revise if needed, and approve the MoveSmarter trip detections. For each day of the fieldwork, they can adjust, add or delete trips on a webpage, after which they need to approve the trips for that particular day. In the remaining part of the paper, we call these *reported* trips (consisting of unadjusted MoveSmarter trips, adjusted MoveSmarter trips, and added trips). The automatically detected trips (after processing on the back-end server) are called *MoveSmarter* trips. In addition, after all trips of a fieldwork day have been approved by the respondents, they are asked if there were specific personal or transport related circumstances which affected their travel during that day, e.g. sickness or major disruptions in public transport.

Figure 1 visualizes this approach, and the next sections explain the approach in detail. Section 2.2 describes the automatic trip detection process. Section 2.3 the internet-based prompted recall survey, and section 2.4 the