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Comparison of travel diaries generated from smartphone data and dedicated GPS devices

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Abstract

This paper provides further insight into the usefulness of smartphones and dedicated GPS devices for collecting current travel survey data. GPS and accelerometer time series for 33 European research project PEACOX study participants are available for analysis; these were tracked simultaneously with smartphones and dedicated devices for 8 weeks. Meaningful diaries can be extracted from both data sources. However, if high resolution data is needed, results suggest that dedicated GPS devices are still relevant; they have no battery issues, meaning that more data is recorded and that data quality is more stable.

1. Introduction and related work

In transportation research, GPS traces are used, along with other data sources, to construct travel diaries. This data is primarily collected using dedicated GPS devices that respondents must carry with them during the tracking period. Smartphones are a promising source for GPS data (see e.g. Gould (2013)), as they have been equipped with good-quality GPS, accelerometer and other potentially useful sensor functionality during the last years and, as

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opposed to dedicated devices, are often anyway carried by participants. A recent review of GPS-based travel studies and the required processing tools is given in Shen and Stopher (2014), who list representative studies using dedicated devices from 14 different countries, as well as four smartphone studies. The first GPS studies were undertaken in the late 1990s (Wagner, 1997). GPS devices were at first attached to cars. Later on, hand-held devices were used to capture all modes of travel (Wolf, 2004). Initial solutions for mobile phones were implemented in the mid-2000s (Asakura and Hato, 2004; Ohmori et al., 2006). By now, the smartphone-based travel data collection is growing rapidly, as evidenced by several new applications implemented over the last few years by the research community (Nitsche et al. (2014), Quantified Traveler (Jariyasunant et al., 2012), UbiActive (Fan et al., 2013), Future Mobility Survey (Cottrill et al., 2013), CONNECT of the MOVE project (Vlassenroot et al., 2015), SmarTrAC (Fan et al., 2015), SITTS (Safi et al., 2015)). Already, commercial tools designed to be used in different mobility studies are implemented, e.g., rMOVE (Resource Systems Group (RSG), 2015) and Studio Mobilita (2015) (used in Becker et al. (2015)).

A clear advantage of smartphones is the large number of potential participants who do not have to be provided with devices. Further, smartphones are less likely to be left at home than dedicated GPS devices and the possibility to provide immediate feedback, e.g., on emissions, can increase the willingness to participate for longer time periods (Jariyasunant et al., 2012). But, using smartphones as a survey tool - in addition to normal usage - also implies an important challenge: battery life. Another difficulty for survey use of smartphones is a large variety of different operating systems, brands and types, with antennas of differing quality that must be covered.

The goal of this paper is to provide further insight into the current usability of smartphones and dedicated GPS devices for collecting travel data. Data quality and usage of the two device types are compared, as are travel diaries generated from the two data sources. GPS and accelerometer time series of 33 study participants are available; these were tracked simultaneously with smartphones and dedicated devices for 8 weeks. The data was collected as part of the PEACOX project (www.project-peacox.eu), where a personalised journey planner application for smartphones to encourage ecological behaviour was developed. In the app, position data is collected to generate travel diaries; this is then used to personalise route suggestions. In this paper, data collected in the second field trial of the app (Vienna and Dublin from August to October 2014) is analysed.

The paper is structured as follows. First, smartphone applications used in the PEACOX project (journey planning app, as well as a prompted recall app) are presented. In the next section, the field trial is described. Section 4 outlines differences in travel diary construction for the different device types. In Section 5, results are reported, including quantitative analysis, as well as users' subjective perceptions. An interpretation of results and an outlook on continuing work concludes.

2. Study context: the PEACOX project and applications

PEACOX focuses primarily on the potential influence of the journey planning application, including its persuasive elements and how they affect users' travel behaviour and attitudes towards mobility. As part of this effort, GPS and accelerometer data was collected to inform users about past travel behaviour and CO_2 emissions. The application is a prototype and was tested in field trials, enabling us to enhance the data with questionnaires, a prompted recall tool and by giving participants dedicated GPS loggers (MobiTest GSL). In the following the journey planning, as the prompted recall applications are also introduced.

2.1. Journey planning app

The PEACOX journey planning app allows the user to perform a multi-modal search for a route tailored to the user's individual preferences and behaviour patterns. In general, it works like a common journey planner; an origin and a destination are specified and possible routes are then suggested. When routes are requested in PEACOX, available alternatives are enhanced with emission information (Alam and McNabola, 2012). The enriched results are then ranked and personalised by the recommender engine (Bothos et al., 2012). Recommendations are partially based on the trip history gathered from recorded GPS and accelerometer data. Selected eco-friendly route options are promoted by adding a persuasive message (Fig. 1(a)). Other persuasive elements were implemented: challenges where users competed against each other, as well as comparing themselves on emissions rankings and, finally, a