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An empirical comparison of four technology-mediated travel survey methods

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HIGHLIGHTS

- Compare the performances of GPS-assisted and web-based travel data collection methods.
- GPS data collected by handheld GPS, smartphone GPS and a smartphone travel survey app.
- The data were collected in a trial of New Zealand Household Travel Survey 2014.
- Shows the necessity of combining different methods to ensure representativeness.
- Smartphone travel surveys increase the likelihood of recording non-motorised trips.

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ABSTRACT

The increasing demand for advanced modelling methods, which can reflect complex travel activities of individuals, requires enhanced travel data collection methods. The introduction of GPS-assisted data collection methods has provided an alternative to the conventional methods of travel data collection. GPS-assisted data collection methods improve the accuracy of data collection and enable capturing more details of individuals' travel behaviour. Recent technological advancements in smartphone-based positioning technologies and communication facilities have opened up new opportunities to apply smartphones as the media of GPS-assisted data collection. Although, different GPS-assisted methods have been employed recently, their performance has not been widely evaluated in real-world experiments compared to traditional data collection methods. Accordingly, this paper evaluates the performance of three GPS-assisted methods, namely handheld GPS tracking, smartphone-based GPS tracking and smartphone-based prompted-recall data collection methods, in conjunction with the web-based data collection to shed light on different aspects of GPS-assisted data collection methods. These methods are compared in terms of the quality and accuracy of the collected data, the demographic attributes of participants and the specifications of labelled trips. The results show that an appropriate employment of smartphones enhances the accuracy of data collection. It is also found that putting an extra burden on participants during a travel data collection survey results in lower trip-rates and poor data

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quality. Finally, it is found that the application of smartphone-assisted data collection methods help reporting non-motorised trips more accurately.

1. Introduction

In recent years, data intensive travel demand modelling methods have been developed to reflect the increasingly complex travel activities of individuals. These modelling methods have caused a growing demand for enhanced methods of data collection. Conventional data collection methods require individuals to recall their travel activities during a day or more, and report them in the form of a travel diary through paper forms, phone calls, computer tools or interview-assisted methods (Bohte and Maat, 2009). These diary-based methods, however, are no longer able to effectively address the new modelling demands, mainly because of strong reliance on the memory and judgment of participants and high implementation costs (Auld et al., 2009; Cambridge Systematics, Inc., 2007; Forrest and Pearson, 2005; Wolf et al., 2004). Those methods impose a significant burden on participants, as they have to remember their travel behaviour, recognise their trip attributes and report them often without any supplementary support. This adversely impacts on the quality of collected data (Bohte and Maat, 2009). Thus, the quality of these data is often questionable, with having an inevitable under-reporting rate of up to 35% (Wolf, 2004).

The introduction of new technology-mediated surveying techniques, especially GPS-assisted methods, has provided researchers and surveying authorities with alternatives to improve the accuracy of data collection, while capturing more details of individuals' travel behaviour (Gonzalez and Ye, 2014; Gonzalez et al., 2010; Stopher et al., 2008). Accordingly, GPS devices have been increasingly used as the media of data collection in travel surveys. However, the employment of these devices usually requires considerable financial and human resources and imposes some burden on participants. Participants in such surveys are required to carry an extra device (i.e., a handheld GPS device) during their everyday travels and label the collected data through a separate medium (i.e., a web application) (Barbeau et al., 2009; Calabrese et al., 2013; Cottrill et al., 2013; Feng et al., 2011; Gonzalez et al., 2010; Itsubo and Hato, 2006; Nitsche et al., 2012).

Recent technological advancements in GPS-based positioning technologies and communication facilities on smartphones have opened up new opportunities to apply them as the media of travel data collection. While the employment of smartphones for travel data collection has been increasingly reported over the past years, most of previous studies have had limitations in terms of the applied sample sizes and experiment timeframes.

Accordingly, this paper aims to empirically compare the performance of four technology-mediated travel data collection methods (including a smartphone-based method) in a real-world experiment and provide a series of guidelines for the future implementations of technology-mediated data collection methods using GPS and smartphones. In a unique experimental study and as a trial of the national household travel survey in New Zealand, four different technology-mediated travel data collection methods were employed and evaluated in this study, including: web-based method, handheld GPS tracking method (H-tracker), smartphone GPS tracking method (S-tracker) and smartphone-based prompted-recall data collection method (Advanced Travel Logging Application for Smartphohes II (ATLAS II)). These methods are compared in terms of the quality and accuracy of the collected data and the demographic attributes of the participants.

The remainder of this paper is structured as follows. Section 2 introduces the employed methods and the corresponding data collection procedures. Section 3 describes the methodo logy used in this experimental study through which, the performance of the employed methods is evaluated and compared. Section 4 discusses the results and main findings of the study. Finally, Section 5 summarises the paper with discussing the implications of this study for both academics and practitioners along with future research opportunities.

2. Travel data collection methods

As a pilot for the national household travel survey in New Zealand (conducted during February–April, 2014), four different technology-mediated individual travel data collection methods were used to evaluate their performance. These methods included a web-based data collection method, H-tracker data collection method, S-tracker data collection method and ATLAS II data collection method. These methods are briefly described next.

2.1. *Web-based data collection method*

This data collection method was mainly based on a self-administered diary-based survey. During the data collection, the participants were provided with a link of a web-based questionnaire to report their travel activities in each travel day. In order to improve the accuracy of data collection, the participants were provided with a simple paper-based form to record their travel behaviour during their daily activities and to complete the web-based form based on their records. The participants were requested to report their travel activities by labelling the mode, purpose and accompanying persons, start and finish times, as well as start and finish locations of each trip.