Chapter 7
Multi-Week Travel Surveys Using GPS Devices: Experiences in The Netherlands

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ABSTRACT
Previous research has demonstrated that the value of GPS technology in collecting activity-travel data as an alternative to traditional travel surveys depends largely on the accuracy of data imputation and good survey management. In this chapter, the authors discuss experiences in the use of GPS-devices in a large-scale study aimed at collecting multi-week activity-travel diaries in two regions in The Netherlands. GPS devices were used to collect basic movement information, which was processed using Bayesian Belief Network to derive daily activity-travel diaries, and validated using a Web-based prompted recall instrument. The large-scale travel survey was administered across one year. The chapter addresses several issues regarding the design and management of GPS data collection. Reported experiences are expected to provide a useful source of reference for future multi-week travel surveys using GPS technology.

INTRODUCTION
Modeling the dynamics of activity-travel behavior is a research topic high on the agenda of the international travel behavior community. Understanding dynamics seems critical to avoid the inherent limitations of the current generation of operational activity-based travel demand models, which are invariably based on single-day data. Moreover, it is paramount to assess the temporal effects of various policies that affect the transportation system. To achieve such a step forward in modeling and behavioral analysis, activity-travel diary data that span more than a single day and even more than a week are needed. Geographic Position System (GPS) based technology is seen as very promising in terms of both accuracy and efficiency to collect activity-travel diary data, in particular during a longer period of time (Wolf et al., 2001; Stopher & Wargelin, 2010; Marchal & Pham, 2013). However, obtaining reliable activity-travel data is relatively complicated since

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it requires not only high-performance imputation algorithms to correctly detect activities and trips within GPS data streams, but also a follow-up prompted recall survey for respondents to validate their imputed data (Stopher & Collins, 2005; Moiseeva et al., 2010). Challenges such as the correct use of GPS devices, the efficient design of survey systems, post data processing, and quality control need further investigation (Bohte & Maat, 2009; Montini et al., 2013).

Similar to conventional travel surveys, one of the main goals of GPS data collection is to obtain valid and reliable activity-travel data for a specified period of time. Semi-automatic GPS-based travel surveys involve multiple essential components and stages. Respondents need to carry a GPS device for multiple weeks to record their travel. They also need to manage their activity-travel data through the survey system that is being used. In general, a data processing component (data imputation) is required to extract the activity-travel data from the GPS traces. Due to the fact that existing algorithms are not perfect in mapping GPS traces to valid real activity-travel patterns, a prompted recall survey instrument is needed to verify and validate these imputed patterns. It is extremely important to incorporate a prompted recall survey to ensure both data quality and data completeness. In addition to the validation of imputed data, prompted recall surveys provide respondents the opportunity to report any missing information. For instance, the recorded data may be incomplete because the battery ran out of power or the device ran out of memory. Respondents may also forget bringing the GPS device, implying that they need to provide information about the missing activity-travel diaries otherwise. Finally, prompted recall instruments are essential to ask respondents for any additional information that cannot be derived from GPS traces, such as, for example, expenditures.

Despite their essential role in the trip detection process, prompted recall surveys may also introduce additional error and/or add to respondent burden. Respondents may not clearly remember their past activities and/or trips, may not be able to differentiate start/end times between an activity and a trip, or may not be willing to systematically correct a complicated, mis-imputed activity-travel diary (Bonsall et al., 2011; Feng & Timmermans, 2013). In these cases, new errors will be introduced in the validated data. The amount of error will depend on different conditions, such as the length of time elapsed between the dates of travel and the validation task, and the efficiency of the survey system. In that sense, it is important to design the Web pages of prompted recall surveys in an easy-to-understand and comprehensive manner to assist respondents in validating their imputed data. A well-designed prompted recall survey needs not only be compact and user-friendly, but also responsive to capturing the status of user participation.

Traditional travel surveys tend to be administered typically for a limited period of time, ranging from one day to a maximum of one week. Such data is, however, useless for the analysis of repetitive choice behavior, behavioral adaptation in short-term decision-making process, and in particular for the development of the next generation of dynamic activity-based models of travel demand. Application of GPS technology in travel surveys may potentially offer a solution to measuring such dynamics by tracking respondents over a longer period of time. Unlike short-term GPS surveys (i.e., within a week), tracking respondents over a longer time period raises data processing and survey management requirements. Several issues regarding non-response, human error, trip omissions and drop-off need to be addressed. As Titheridge and Simpson (2011) argued, the survey system should, therefore, be designed in the least burdensome manner. For example, the data should be processed efficiently and the results should be as accurate as possible in order to reduce the amount of time and effort that respondents need to validate their imputed activity-travel diaries. The tasks in the prompted recall surveys should not