Transportation Research Part C 88 (2018) 74–86

Contents lists available at ScienceDirect

Transportation Research Part C

journal homepage: www.elsevier.com/locate/trc

Perspectives of the use of smartphones in travel behaviour studies: Findings from a literature review and a pilot study

Jędrzej Gadziński

Institute of Socio-Economic Geography and Spatial Management, Adam Mickiewicz University in Poznań, ul. Bogumiła Krygowskiego 10, 61-680 Poznań, Poland

ARTICLE INFO

Keywords:
Travel behaviour
Travel survey
GPS-enabled mobile phones
Smartphones
GPS devices
Poznań

ABSTRACT

Human travel behaviour has recently been one of the most popular topics in transport studies. Therefore, the ability to obtain valuable sets of data has become one of the key challenges for researchers. Traditional mobility surveys have many important limitations. In this situation, the potential of the use of smartphones and dedicated applications in the identification of individual travel behaviour seem very promising. We set ourselves a goal to indicate strengths and weaknesses of data obtained with this method and assess the perspectives of its use for the needs of public policies. For these purposes we prepared a low-cost mobile application and conducted a pilot study among students in Poznań (Poland). In effect, trajectories of more than 100 people with almost 3 billion of location data were collected. Based on a literature review and our results we discuss the main problems, limitations and challenges of the broader use of the data obtained with smartphones. In the conclusion, we argue that there is a huge and increasing potential connected with mobile phones, but still some important barriers exist including sampling problems, limitations in big data analyses and technological issues. Therefore, a broader use of smartphones in travel behaviour surveys seems to be rather a distant perspective.

1. Introduction

The appearance and development of time-geography popularised by Torsten Hägerstrand (1970, 1985) changed the perception of transport systems. As a result, since the 1970s analyses on human travel behaviour (an activity-based approach) have become one of the most popular topics in transport studies (Jones et al., 1983; Fox, 1995; Buliung and Kanaroglou, 2006). Until now a plethora of studies concerning individual travel behaviour and connecting them e.g. with housing decisions, land use (or neighbourhood) characteristics, the level of accessibility of transport infrastructure and so on have been undertaken. Moreover, we should also notice the increasing role of travel behaviour studies in public policies (Fox, 1995). According to Marshall (2001), in the last decades there has been a shift from a conventional approach to transport planning where the focus was on traffic and 'travel as a derived demand' to a new approach in which people are in the centre of interest and travel is treated also as a valued activity. Therefore, nowadays the identification of travel behaviour (e.g. such elements as travel motivations of inhabitants, popular destinations, movement directions, a mode selection) is often the starting point for the reflection on the future development of transport systems. This information could be used to identify current and to predict future travel demand for infrastructure investment and policy decisions (Kitamura et al., 1997, 2000; Pendyala et al., 1997). This is particularly important in densely populated areas where travel patterns are very complicated – this usually causes numerous problems and challenges (congestion, pollution, noise, accidents – see Banister, 2011).

But still – since the 1970s – one of the key challenges to studies on human travel behaviour has been the ability to obtain valuable

E-mail address: jedgad@amu.edu.pl.

https://doi.org/10.1016/j.trc.2018.01.011
Received 16 July 2017; Received in revised form 13 January 2018; Accepted 13 January 2018

sets of data (McNally and Rindt, 2007). Until now the basic sources of data in many studies are surveys with the use of travel diaries and questionnaires (paper-and-pencil or web-based). However, we should note that these traditional surveys have some important limitations. First of all, travel diaries are not a very efficient method of collecting data. They require a lot of commitment from the participants (Duncan and Mummery, 2007). Relatively high is the risk that a respondent can forget to provide some information (Gould, 2013). Data accuracy can be also relatively low (especially when the information about a trip is entered in a travel diary several hours after the trip) and finally, it is hard to retrace actual travel routes and some precise information (e.g. the speed of travel). In the case of surveys with questionnaires, a common problem is that they generally contain data on regular travel behaviour. Moreover, the meaning of 'regular' is very subjective and very often the number of questions has to be limited (due to the costs and to shorten the time needed to fill the questionnaire). Therefore, the identification of very detailed travel behaviour of an individual with the use of traditional questionnaires is quite difficult (Clifton and Handy, 2003). On the other hand, the main advantage of this method is its easiness and the possibility to collect the opinions of many respondents in a relatively short time and at a reasonable cost. Therefore, surveys with traditional questionnaires remain the basic method used in mobility studies. Unfortunately, they usually provide highly generalized information on travel behaviour and are not sufficient for in-depth studies (Wolf, 2000; Shen and Stopher, 2014).

These limitations of traditional mobility surveys caused the increasing interest in the studies with the use of new automatic and more efficient methods of data collection in recent years. The use of data from GPS devices, mobile phones, smart cards, social media are becoming more and more popular. Their main advantage is the automatic collection of a huge amount of data (big data) on spatiotemporal trajectories, popularly selected locations, travel origins and destinations, and so on (Vij and Shankari, 2015; Chen et al., 2016). They allow gathering large sets of data without time-consuming and expensive surveys. Yue et al. (2014, p. 72) conclude: "these data help us to understand human travel behaviour better by zooming more closely into individuals than ever". Therefore, in the last years a great number of studies from different scientific disciplines have appeared. We could find examples of papers on tourism (Kotus et al., 2015), sociology (Eagle et al., 2009; Picornell et al., 2015), or even ethnography (Christensen et al., 2011) where big data were used to identify behaviour of humans. No doubt, the use of this type of data in transport studies is the most common.

The most popular automatic method of obtaining big data on travel behaviour of individuals seems to be from GPS devices (Yue et al., 2014). In our opinion, however, a huge and still increasing potential is connected with mobile phones, now commonly equipped with GPS modules and other sensors (providing so-called assisted GPS data). Therefore, in this paper we would like to assess the potential of the use of smartphones and dedicated applications in the identification of individual travel behaviour. We set ourselves a goal to indicate strengths and weaknesses of data obtained with this method and to discuss the perspectives of its use in travel behaviour studies. For this purpose we prepared a low-cost mobile application and conducted a pilot study among students in Poznań (Poland).

The construction of the paper is as follows. After the introductory part, a literature review is included. In this section we focus on advantages and disadvantages of both GPS devices and mobile phones and also present a few transport studies concerning the use of applications dedicated to smartphones. In the next part the construction of the pilot study is presented. We describe our mobile application, the study area and some problems with sampling. Then we present our experiences related to the research organisation and observations of the participants. The final part consists of a discussion and a short summary.

2. Literature review – The use of GPS devices and mobile phones in transport studies

2.1. GPS location data

The first studies in transport geography with the use of GPS devices appeared in the mid-1990s. One of the precursor studies was conducted by the researchers from the University of South Australia (Zito and Taylor, 1994; Zito et al., 1995) who propose methods of locating and monitoring vehicles in real time across a road network with the use of GPS data. The first studies on a broader scale concerning human travel behaviour were conducted in Lexington, Kentucky in 1996 (Wagner, 1997) and Austin, Texas in 1997 (Pearson, 2001). In the next years, the popularity of GPS data in such studies increased rapidly (e.g. Murakami and Wagner, 1999; Sermons and Koppelman, 1996). Nowadays GPS devices have become the most widely used sources of trajectory data (Yue et al., 2014). One of their main advantages is a high quality of locational data, which are very precise (to within a few metres), offer high recording frequency and could be used to assess the speed and direction of an equipped individual or vehicle (Duncan et al., 2009; Smoreda et al., 2013). Therefore, GPS devices are commonly used in studies on traffic demands, travel chains, sustainable mobility, traffic safety, route choice and residential selection (Shen and Stopher, 2014). In some cases they were also used as supplementary surveys to measure the accuracy of traditional ones.

According to Vlassenroot et al. (2015), the great popularity of GPS data in transport studies was caused also by the fact that GPS devices are commonly installed in public transport vehicles. Their role is to provide real time information on the location of buses, trams or trains and they are commonly employed in passenger information systems. Based on GPS data from public transport vehicles several studies concerning speed diagnoses (Tantiyanugulchai and Bertini, 2003; Cortés et al., 2011), path and travel time (Hunter et al., 2009) or service reliability (Mazloumi et al., 2009) were developed. In the last years, there have also appeared bike-sharing systems in which the location of a particular bicycle is provided by the GPS tracking system. Such data enables complex analyses on cyclist behaviour (e.g. Reiss et al., 2015). Unfortunately, GPS devices installed in vehicles show the movement behaviour of individuals only when a vehicle is used. Therefore, only a unimodal part of an individual's trip behaviour can be covered (Vlassenroot et al., 2015).