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Route-recording on high resolution transportation network databases for National Transport Surveys: An option for valid and reliable distance measures?

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ABSTRACT

The aim of this study is to investigate the results of route-recording within the Swiss National Travel Survey in the year 2010. The research questions include the following: (1) What level of accuracy and quality of georouting between addresses can be obtained within Computer Assisted Telephone Interview (CATI)-based national travel surveys? (2) What are the differences between estimated and routed distances for stages? (3) Is it worth it to switch from self-estimated distances to technological solutions in national travel surveys with a comparison between GPS and route-recording? It was found that within the method of route-recording, a high share of address-precise geocodes is a necessity for a successful routing fulfilled by the Swiss National Travel Survey 2010. Secondly, route-recording provides reliable and valid distance measures and is one way to overcome the difficulty in participants distance estimates. Thirdly, in its current form, it is not yet an alternative to GPS in national travel surveys, if one is interested in the actual routes travelled by survey participants. Especially there is development work necessary in the routing of non-motorised travel regarding both digital networks and the survey method. The paper concludes by drawing on the findings of this examination and formulating opportunities for improvement and enhancement.

1. Introduction

Surveying travel distances is important within the field of transportation studies. However, the quality of distance measures varies according to the method applied. Recent methods use estimates of travel distances by respondents; route tracking using Global Positions System (GPS) (Stopher et al., 2007; Schüssler and Axhausen, 2009); mobile communication instruments to track routes (Asakura and Hato, 2004); or route-recording with a graphic information system (GIS) (Ohnmacht et al., 2011). There is growing literature within the field of transportation studies on the accuracy of those distance measures to characterise individual travel distances (see Walmsley and Jenkins, 1992; Chalasani et al., 2005; Witlox, 2007; Duncan and Mummery, 2007; Stigell and Schantz, 2011; Baldwin Hess, 2012).

To date, in most European and North American National Travel Surveys, self-reported estimated distance is the backbone of the official travel statistics (see Kunert et al., 2002; Cenicchiaro and Roux, 2009; Armoogum et al., 2007). The estimated distances of interviewees are used for statistical transportation figures, such as daily miles or kilometres travelled,

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particularly separated by modes of transport (modal split). Considering recent technological developments, such as position and route tracking with GPS or navigation software with high resolution road and rail network databases, one can argue that there are more promising technological methods to survey travel distances than estimated distances.

Route-recording technology is based on high resolution transportation network databases and promises to replace individual reported distances, especially in the case of large-scale national travel surveys (see Ohnmacht et al., 2011; Rosset and Kowald, 2013). While there is a considerable body of work on the issue of GPS and travel distances (Schüssler and Axhausen, 2009; British Departement for Transport, 2012), there are no comparative studies that examine the switch from estimated travel distances to objective measures created by route-recording within the context of large-scale national travel surveys. In order to fill this research gap, one source of analysis is the data on route-recording during a Computer Assisted Telephone Interview (CATI) survey that was applied within the context of the Swiss National Travel Survey in 2010. This novel method is a new approach to surveying travel distances in comparison to European and North American national travel surveys (see Zmund et al., 2013; Kunert et al., 2002; Cenicchiaro and Roux, 2009; Armoogum et al., 2007).

Based on the data of the Swiss National Travel Survey 2010, this paper focuses on three main research questions. (1) What level of accuracy and quality of georouting between addresses can be obtained within CATI-based National Travel Surveys using a GIS framework? (2) What are the differences between individual estimates on an aggregate level in comparison to the results stemming from route-recording based on high resolution network databases? (3) Is it worth it to switch from self-estimated distances to technological solutions in national travel surveys with a comparison between GPS and route-recording (see British Departement for Transport, 2012, for details)? Furthermore, the paper presents a digression factor for route-recording and perceived distance based on distance categories and transport mode. In fact, the digression factor measures the difference between routing and estimated distances according to mode of transport and distance classes.

The purpose of this paper is to address these three research questions based on the Swiss National Travel Survey in 2010. The remainder of the paper is structured as follows. Section 2 provides a literature review of previous research. It presents an overview of the debates on the often neglected issue in transportation statistics regarding perceived space and estimated distance and their comparability with actual distance. Section 3 reviews the methodology of the Swiss National Travel Survey 2010. It offers insights into the technique of the routing process within telephone interviews to transfer the knowledge and experience of the concept to other national travel surveys. Section 4 presents data and a research sample for a comparative study of the routing distances and the estimated distances and reports empirical findings. The final section presents conclusions based on the empirical findings. There is a general discussion of the design of national travel surveys and whether the switch from estimated reported distances to generalised routed distances with route-recording is a suitable alternative to recent research efforts using GPS for national travel surveys (see, for example Sneade, 2013).

2. Literature review

The association between physical distances and how people perceive and estimate those distances (termed cognitive distance) has long been studied. A multitude of academic disciplines have examined how this association varies based on different contexts. Generally, the issue of perceiving space and distance is an interdisciplinary field of research in cognitive psychology (e.g. Thorndyke, 1981; Yoshino, 1991; Kitchin, 1995), economics (e.g. Wuyts et al., 2005; Ankomah and Crompton, 1992), geography (e.g. Bailly, 1986; Pirie, 2009) and transport studies (e.g. Säisä et al., 1986; Baldwin Hess, 2012).

The research field of cognitive distance has been analysed in detail since the 1980s in the field of cognitive psychology. According to this field, information about distance plays an important role in human activity. This information is needed for orientation and to locate places while moving. In line with transportation, the research community of cognitive psychologists states that perceived distance is used to evaluate generalised costs of travelling in terms of time needed to overcome distances, and thus helps us to utilise resources efficiently (Montello, 1997). Knowledge about maps, road signs, odometers, and verbal directions provides sources of information about environmental distances and thus influences knowledge acquired via direct experience (Montello and Freundschuh, 1995). Perceived distance and place-based knowledge include decision-making and choices related to travel behaviour. Golledge (2005) found that spatial representations in humans are incomplete and fault-prone, producing distortions or fragmentations of spatial products. As an example, evidence is presented in the field of cognitive psychology that shorter distances are usually overestimated while longer distances are underestimated (Thorndyke, 1981).

In recent decades, there has been a substantial body of work in the field of transportation studies on estimated distance. According to Walmsley and Jenkins (1992, p. 288), cognitive distance is defined as 'the impression of distance formed in the mind'. Walmsley and Jenkins (1992) examined how cognitive distance differs from real distance. They state that locals in an area give distance estimates that are 'greatly at odds with real distances' and that homeward-bound journeys are estimated as shorter than outward-bound journeys (Walmsley and Jenkins, 1992, p. 288). Further evidence is presented by Chalasani et al. (2005). They compared the relationship between network-based distance estimates with self-reported distances based on large-scale surveys in Norway and Switzerland. They showed that the difference between reported distance and calculated distance on the basis of shortest path in public transportation on average has a factor of 1.32 for car drivers; 1.16 for car passengers; and 1.17 for human-powered mobility. They noted that people underestimate distances via public transport modes most. The detour factors researched by Chalasani et al. (2005) are often used in Switzerland as a 'rule of thumb' to correct average estimated distances. Similarly, Stigell and Schantz (2011) assessed the four methods of self-estimated