

International Steering Committee for Transport Survey Conferences

Workshop Synthesis: Making the transition to new methods for travel survey sampling and data retrieval

Tobias Kuhnimhof^{a*}, Mark Bradley^b, Rebekah Straub Anderson^c

^a*Institute of Transport Research, German Aerospace Center, Rutherfordstr. 2, 12489 Berlin, Germany*

^b*RSG, 55 Railroad Row, White River Junction, VT 05001, USA*

^c*Ohio Department of Transportation, 1980 W. Broad St. #3280, Columbus, Ohio 43223, USA*

Abstract

Adopting new methods in large longstanding surveys, such as National Travel Surveys, is associated with specific challenges. Aside from methodological issues, the continuation of time series and data that is usable for many, are important concerns. Multi-mode surveys are becoming common place and new methods are run in parallel to established methods. This improves survey representativeness but there are new challenges, for example mode effects. The introduction and spread of smartphone use in surveys and emerging methods for recruiting survey participants will add to this complexity. As survey methods evolve, data post-processing and statistical methods have to keep up as well.

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1. Introduction

New methods are evolving for both sample selection and data retrieval methods in travel surveys. In sampling, there is a transition towards new methods to reach cell phone-only households and a new generation of respondents. In data retrieval, there is a transition towards web-based and GPS/smartphone-based response formats. In this context, there are specific challenges for survey series with a long tradition. Specifically, National Travel Surveys exemplify these challenges (Christensen 2013; McSaveney 2017): In their case, it is not only important to obtain a representative image of status-quo travel demand figures. Moreover, surveys with a long legacy have to provide comparable time series. In the case of panel surveys, the issue of continuity is even exacerbated (Eisenmann et al. 2017). In addition, such survey data sets are often used by a broad variety of researchers and consultants, e.g. to feed transport models. Hence, such surveys fulfill the task of providing reliable transport figures over time and data that is usable for many. For such surveys, transitioning to new survey methods represents a specific challenge.

* Corresponding author. Tel: +49 30 67055-168

E-mail address: Tobias.Kuhnimhof@dlr.de

This paper summarizes the findings from the workshop “Making the transition to new methods for travel survey sampling and data retrieval” conducted during the 11th International Conference on Transport Survey Methods. Different from other workshops and most research conducted in the area of new survey approaches, the focus of this workshop was not so much on new survey methods and their advantages and disadvantages as such. Instead, the workshop focused on transitioning to new methods, i.e. on the task of adapting surveys from using established methods to using new methods (or a combination of established and new methods).

The motivation to move on to new methods of surveying are manifold. It includes new options to address traditional and emerging challenges for travel surveys (e.g. recall error or increasing non-response) as well as budgetary reasons, or simply that richer data comes from new methods (Armoogum 2014; Sneade 2013; Bäumer et al. 2017). In this context, the motivation of researchers, practitioners, and funding agencies might differ substantially. Hence, it is of primary importance to understand these motivations in order to choose the most suitable survey format for a given situation.

Secondly, it is necessary to obtain a comprehensive account of suitable survey approaches, their strengths and weaknesses, and prior experiences with using them. In this context, it is also important to acknowledge that some very traditional methods still persist. Germany has re-introduced paper-and-pencil questionnaires in the National Travel Survey (NTS) and England and other countries still use face-to-face interviews (Gruschwitz et al. 2017; Lapanjuuri et al. 2017). With the broad variety of upcoming and established survey methods, it has also become more and more commonplace that various methods are being combined and run in parallel as part of the same survey (Ortúzar et al. 2011; Leeuw 2005; Kagerbauer et al. 2013; Wolf et al. 2013). Hence, experiences with moving to multiple, combined survey methods are an important facet of transitioning to new survey methods (Thériault et al. 2013; Kohla and Meschik 2013).

Thirdly, trends towards lower travel survey response rates and other developments in the data realm might also call into question fundamentals of travel surveying. Such developments may eventually require more than just a moderate methodological shift in the way we conduct surveys. They might require a more fundamental change in how we obtain travel data or how we combine travel data that was actively retrieved with data from passive data streams.

Table 1. Sampling, recruitment and data retrieval methods applied in the surveys presented by the workshop papers.

Authors	Area/Region	Survey subject	Sampling & recruitment					Data retrieval			
			Landline RDD	Mobile RDD	Address-/Register based	Online	Telephone	Paper & pencil	Face-to-face	Tracking	
Lo et al, 2017	Toronto Metro Area	Travel	X		X	X	X				
Eisenmann et al., 2017	Germany	Travel	X	X		X		X			
de Abreau e Silva & Papaix, 2017	Lisbon Metro Area	Commute mode choice			X	X			X		
Bäumer et al., 2017	Germany	Vehicle km			X	X		X			
Gruschwitz et al., 2017	Germany	Travel	X	X	X						
Bayart & Bonnel, 2017	Rhône-Alpes Region	Travel			X	X	X				
Straub Anderson et al., 2017	Ohio	Travel			X					X	
Aschauer et al., 2017	Austria	Travel, time use, expenditure (3 surveys)			X		X	X			
McSaveney, 2017	New Zealand	Travel			X	X				X	

These three dimensions: a) motivation for transitioning, b) toolkit of surveying approaches and their properties, and c) position of traditional active travel data retrieval in the emerging travel data-scape, formed the guiding questions of the workshop discussion. The papers presented in the workshop drew on a broad range of experiences with various survey formats as compiled in Table 1. These experiences represented the starting point for the workshop discussion during which four topics evolved which were discussed in breakout groups. The remainder of this paper is structured along these four topics: (i) new sampling and recruitment methods, (ii) combining established data retrieval methods, (iii) moving toward GPS- and smartphone-based data retrieval methods, and (iv) optimizing survey design to increase respondent motivation. We make reference to the workshop papers in these four sections in order to clarify how the

contributed papers fed into the discussion of these four topics. The final section of the paper draws general conclusions from the workshop discussion and implications for future research and practice.

2. New sampling and recruitment methods

The background context for this breakout topic is that, in many countries, the main sampling method used for household travel surveys has changed from random digit dialing (RDD) to address-based sampling (ABS). Because many RDD telephone lists do not include cellphone numbers (and thus do not include cellphone-only households), and because many people do not answer telephone calls from unknown callers, the response rates from RDD methods have gone down while non-response biases have increased. In the workshop, Lo et al. (2017) presented an example of how multiple sample frames (address/phone, address-only, and phone-only) were applied in the 2016 iteration of the Travel Tomorrow Survey in the Greater Golden Horseshoe Area. The experiences from this sampling approach confirmed the great difficulties of recruiting through phone-only contacting. With a similar intention of increasing sample representativeness, the German National Travel Survey (“Mobilität in Deutschland”) uses a triple sample-frame (address-based, landline RDD and mobile RDD) (Gruschwitz et al. 2017). Also in this case, the address-based recruitment led to the best outcome with regard to response rates.

However, response rates from ABS methods are also declining over time in many countries. In the USA, response rates for household travel surveys using ABS without offering incentives are often below 3%, while the use of monetary incentives can bring response rates up to 10% or more, depending on the level of incentive offered. The declining response rates and increasing costs of using ABS have left practitioners wondering what the alternatives are to the use of random address-based sampling. Are there more targeted methods available that can obtain samples at a lower cost (although this topic was not addressed directly in any of the papers in this workshop, it was a topic of great interest to some of the workshop participants, and it is very relevant to the overall theme of transitioning to new methods)?

Some of the methods discussed include the use of commercial survey panels, of social media for recruitment, having employers or schools distribute invitations to their employees/students, or intercepting respondents at transit stops, shopping centers or other public locations. These methods all come at the expense of no longer having a random “probability sample” (“probability sampling” means that the probability of any particular household being invited to participate can be calculated and then used in expanding the data to obtain a representative weighted sample). While the use of non-probability samples is more common in other fields, there is very little experience in using them for household travel surveys. Adapting to such methods would require developing and demonstrating methods for expanding and weighing the data to be as representative as possible. Such weighing methods are most likely to be successful in mixed approaches that use ABS for some or most of the sample, supplemented with an additional sample from non-probability methods.

There was some skepticism towards the use of commercial respondent panels, as the methods that are used to recruit and retain respondents for such panels are not always transparent. Even if such panels can be weighed to be seemingly representative along socio-demographic dimensions, there may be biases in other sample characteristics that are important in travel behavior, such as the sensitivity to the expenditure of time and money (it should be noted that address-based sampling methods may be subject to such subtle biases as well).

A second topic for discussion was how to make it more attractive for people to participate in travel surveys, and thus counteract the trend towards declining response rates. While offering monetary incentives is a common and effective method, perhaps other methods would be less expensive while engaging different segments of the population. There was some discussion of using individualized, targeted recruiting via electronic media. Such targeted advertising is becoming ubiquitous, but there was no clear vision of how it could be used for travel surveys, or what types of sampling biases it might introduce.

The provision of individualized information to respondents was discussed as a means of making participation more attractive. Particularly with newer smartphone-based data retrieval methods, respondents could be provided with feedback about their travel patterns, distance walked and biked, calories burned, “carbon footprint”, time spent in various activities, etc., and how their travel characteristics compare to others in the (sampled) population. Since the purpose of most surveys is to objectively measure travel behavior rather than to prescribe or influence it, there is a concern that providing informational feedback might influence respondents’ travel behavior over time, particularly in multi-day travel surveys (see section 4 of this paper).

A final topic discussed in this group was the possibility of using person-based rather than household-based sampling. While we may still use households as the most convenient sampling frame for address-based sampling, is it necessary to obtain travel diary or trace data from all household members, or is it sufficient to obtain such data for a

single household member? Requiring complete travel data for one household member would certainly increase effective response rates in terms of the percent of “completed households”, although the response rate in terms of complete person-days of travel collected may not increase. This topic brings up a range of related issues such as the use and accuracy of proxy reporting for other household members, and the usefulness of the resulting data for various types of modeling and analysis. While those issues could not be tackled in this workshop, it was suggested that this topic (surveying persons as opposed to complete households) could be a useful workshop topic for future conferences.

3. Combining data retrieval methods

Most of the surveys presented in the workshop combined different data retrieval methods, i.e. they provided different options for respondents to collect and submit their travel information. Aschauer et al. (2017) discussed different variants of designing travel / activity diaries including time use survey formats. Based on a comparison of results surveyed with these survey formats they can confirm earlier findings that participants of traditional PAPI household travel surveys tend to underreport trips and show a large share of immobile persons. However, in most cases, workshop contributions discussed various ways of retrieving travel diary information, i.e. online, phone, paper and pencil and tracking (see Table 1).

The trend of combining various data retrieval methods within one survey was confirmed by the workshop participants' general experience. In many cases, very traditional data retrieval methods such as paper and pencil run in parallel with more recent approaches. The very likely consequence of this is that, transitioning to new methods actually means including new methods and running them in parallel with established methods. Hence, for large future travel surveys, it appears likely that modern modes, such as tracking, will be combined with established survey modes, even if smartphone tracking emerges as the dominant future mode of data retrieval. Against this background, the group discussed the advantages and disadvantages of combining different data retrieval methods. The focus of this discussion was on established data retrieval modes because there is existing experience on such mode combinations.

The general motivation behind including various data retrieval modes in surveys is the experience that different modes appeal to different types of respondents (Gruschwitz et al. 2017). Different data retrieval modes might even be necessary in order to reach specific groups of the population, e.g. if landline telephone access is not possible. Hence, in order to obtain the best possible coverage of different segments of society, surveys offer different modes of data retrieval. Thus, because it improves coverage, combining different data retrieval modes is very likely to improve overall data quality. Moreover, respondents expect modern surveys to work with survey modes which they consider up-to-date. This might even be true for respondents who, for practical reasons, choose to respond to the survey by an established mode such as paper and pencil. Eisenmann et al. (2017) found, for the German Mobility Panel, that the mode of data retrieval (online versus paper-and-pencil) did not influence survey attrition. However, respondents who submitted their travel information during year one of the panel participation via the online questionnaire tended to switch to paper-and-pencil for year two. This confirms the experience, that some traditional modes (e.g. paper-and-pencil) work well for the respondents in practice; however, modern modes should be offered to the respondents in order to make it appealing for a broad range of possible respondents. Hence, providing different options to answer the survey, including modern modes, might in itself increase the appeal of the survey even if there is a dominating survey mode that covers the broad majority of respondents.

At the same time, each mode comes with its specific mode effect, i.e. it causes respondents to report in specific ways influencing the survey result (Bayart and Bonnel 2017; Gruschwitz et al. 2017). For example, online respondents are found to report fewer trips, but similar or longer time and distance daily than those reporting by telephone or face-to-face interviews (Bayart and Bonnel 2017). However, the objective of large travel surveys is travel data that reflects ground truth as well as possible and is comparable across different groups of the population. Substantial mode effects contradict this objective and must therefore be minimized. This can be achieved through ex-ante measures as well as ex-post measures. An ex-ante measure, for example, might be that CATI-interviewers use the same software as implemented in a corresponding CAWI-interview. The most common measure to compensate for mode effects ex-post is weighing. Therefore, weights must be established through appropriate regression analyses which separate mode effects from possible socio-economic selectivity associated with the different data retrieval modes. However, such weights should not be considered a panacea for mode effects. This is because there are many applications of widely used travel data sets that work without weights. This for example applies to agent-based travel demand models or to specific multivariate analyses.

4. Tracking by GPS and smartphone

While the use of passive tracking of (a subset of) survey respondents' travel via GPS devices has been a component of many household travel surveys over the last decade, the use of respondents' own smartphones for such tracking is a relatively new trend. The trend appears to be most advanced in the USA, where the majority of household travel surveys carried out in major metropolitan areas in 2017 were smartphone-based (and the same is true of those planned for 2018). Straub-Anderson et al. (2017) presented findings from a smartphone-based survey carried out in the Columbus, Ohio region in 2016 and 2017.

Evidence to date is that smartphone-based methods provide more complete data, in terms of the number of trips captured, than either self-reported diary-based methods or prior surveys using non-smartphone GPS devices. While trips are recorded passively by the smartphone application running in the background, all additional questions about the respondents' trips (mode used, trip purpose, who travelled together, etc.) are completed actively by respondents in the same application, eliminating the need for a separate on-line prompted recall survey. Since most smartphone owners tend to keep their phones charged and with them at all times, the potential for missed trips is low. Further evidence is that most people provide the requested details about their trips in the application within 2 hours of completing the trip, reducing the potential for recall error. Most respondents who begin the smartphone-based data collection end up providing full travel data for seven consecutive days.

Discussion around smartphone applications and how they are implemented, highlighted the fact that the ease of use of the application is very important. It is important that respondents know how to split, merge, and otherwise correct trips in the application in the event that the application has not identified the trip ends correctly. The ease and experience of using the application can affect response rates and attrition rates across multi-day surveys, as well as affect the quality of the data obtained.

An important topic for discussion was the fact that not all adults own smartphones, so smartphone-based surveys are by necessity mixed-method surveys in which most non-smartphone-owners participate via more "traditional" diary-based methods, usually on-line or over the telephone. The Columbus, Ohio survey was rather unique in that non-smartphone owners were loaned smartphones to use for the survey and then sent back, similar to how GPS devices were sent to respondents in past surveys. In addition to the high cost of loaning smartphones, it was found that the respondents who used the loaned smartphones tended to have more "missing days" of data in which they forgot to carry the smartphone with them and/or keep it charged (this was also a common issue with the older GPS survey devices).

Given the fact that smartphone-based surveys will use mixed methods by necessity (until everyone owns smartphones), it seems that we can measure the method-related effects of shifting to smartphone-based methods by simply comparing the data retrieved by smartphones against the data retrieved from diary-based methods. The data may not be directly comparable however, since the two subsamples are not randomly selected and smartphone-owners may have different travel characteristics than non-owners. Some recent surveys however, have used a random selection method whereby some smartphone owners are asked to participate using the smartphone application, while others are asked to participate using a self-reported diary-based method. This approach has two possible advantages. One is that it allows a more direct analysis of the method effect, because randomly assigned smartphone-owners are using each method. In such analyses, smartphone-based methods tend to provide 15 to 20% more trips per person-day than diary-based methods, including only about half as many zero-trip ("no travel") days, some of which may actually be "soft refusals" in self-reported diary data. The second advantage is that the random split-sample approach facilitates trend analysis over time. If a random subsample of respondents (including smartphone owners) is using the same diary-based method that was used in the previous household travel survey, then the trend effect can be measured by comparing the diary-based data from the two surveys, while the method effect can also be analyzed by comparing the data from the two methods in the current survey. This split-sample approach can be applied over time, gradually increasing the fraction of respondents invited to participate by smartphone, although in theory it only needs to be used for one transitional wave of the survey.

There was a consensus among the group that passive smartphone applications will soon completely replace the use of GPS "black boxes" and also replace the use of smartphone applications that require users to actively indicate when they are beginning and ending each trip. This view then begged the question of whether any active data collection in the application is necessary at all, if the data collection is fully passive, in which case we could just as well use passive "big data" already available for purchase (from providers such as AirSage, Cuebiq and StreetLight in the USA). There was a consensus that the extra information that respondents provide actively in the smartphone applications regarding mode, trip purpose, car occupancy, and other details is valuable, and that we cannot yet impute such data items very accurately from purely passive data streams. Particularly for disaggregate analysis of travel behavior, the extra self-

reported information provided by the respondents about their trips is critical. As we enter the era of passive “big data”, it will be important for travel survey researchers to demonstrate that the depth of information gained from (partially) active travel surveys is important and still worth investing in. At least in the next decade or so, passive “big data” can more constructively be viewed as a valuable complement to travel survey data, rather than as a replacement for travel surveys.

5. Optimizing survey design to increase respondent motivation

It is widely acknowledged that respondent motivation is key for satisfactory response rates, the quality of reported data and thus for overall survey data quality. Hence, survey design should be optimized to increase respondent motivation. There are numerous established methods to achieve this, including incentives or explanatory letters by government officials strengthening the importance of the survey. Similarly, the design of survey elements such as web questionnaires should minimize the burden of filling them. Bäumer et al. (2017) present an example for how surveys in the field of transport (here: odometer reading survey) can achieve very good response rates (about 50%) when the questionnaire design is very simple and quick to answer.

However, for most travel surveys, such simplification is not an option and other ways of motivating respondents are sought. “Gamification” has emerged as a new keyword in this context. This refers to the introduction of game principles and design elements in non-game contexts. For example, smartphone applications monitoring fuel efficiency may motivate drivers to drive more fuel efficiently by comparing themselves with other drivers.

Such gamification elements have inspired travel survey designers to modify surveys along these lines in order to increase respondent motivation. However, traditional travel surveys aim at capturing travel as a neutral observer without actually influencing dimensions of travel such as the number of trips or mode choice. Hence, gamification elements in travel surveys should increase respondent motivation and thus data quality, e.g. because respondents aim to report travel behavior as reliably as possible, without affecting travel as such.

While it is perceivable that gamification elements for travel surveys which achieve this are being developed, there are, to the knowledge of the workshop participants, no best practice examples to date. There is the expectation that the introduction of smartphone applications and tracking inspires new survey methodological innovations that allow for gamification or similar elements that increase respondent motivation. For example, the automated collection of trip origins and destinations might help to substantially lower respondent burden and thus possibly open up a way to gamification.

Moreover, key challenges for travel surveys are low response rates arising from contacted potential respondents dropping out at very early stages of the recruitment process. Hence, the first contact with potential survey respondents is the survey stage for which new ideas such as gamification or other approaches to increase motivation matter the most. Also with respect to this matter, the need for new ideas was emphasized in the group discussion without being able to refer to existing good examples.

The discussion around gamification also lead to questions if travel surveys should intentionally influence travel behavior and stop aiming at just observing travel from a neutral position. The workshop paper presented by de Abreu e Silva and Papaix (2017) explored the effects of presenting information in various ways on travelers’ choices, e.g. on CO₂-emissions and calorie consumption. The paper illustrated that the way of presenting information was influential on respondents’ stated choices. Hence, in the case where surveys are at least partly aiming to change behavior, the way of addressing respondents and presenting information will matter. Specifically, in such surveys or campaigns, gamification has great potential. This opens up new possibilities of influencing travel behavior much beyond traditional engineering approaches. After all, one of the objectives of transport planning, which travel surveys feed into, is to change travel behavior. Hence, the question came up if travel surveys should motivate respondents to alter their behavior, e.g. through switching to more sustainable modes. This, however, would represent a fundamental shift in the role of travel surveys.

6. Conclusion

This paper summarized key insights from a workshop conducted during the 11th International Conference on Transport Survey Methods focusing on the task of adapting travel surveys from using established methods to using newer methods. This workshop primarily addressed travel surveys with a long tradition such as National Travel Surveys. In addition to the requirement of delivering reliable status quo figures on transport, these surveys are challenged with the task of maintaining comparable time series and providing data that is usable for many data users

in many different contexts. As a consequence of the latter, in such surveys, often a variety of different stakeholders ranging from administrative officials, consultants and researchers with a broad range of motivations and requirements are involved. In addition, potential survey participants see travel surveys in the context of their broader knowledge and perceptions of technological trends. For many of these non-experts, travel surveys today might seem outdated and it is getting harder to argue why travel data is being elicited as it is today.

This situation makes transitioning to new methods a specific challenge beyond understanding the advantages and disadvantages of survey formats. Many considerations beyond technical or methodological survey properties have to be taken into account such as psychological ones. In this context, diversifying survey methods has helped to address the manifold requirements for travel surveys today and emerging challenges such as declining response rates.

Against this background, the workshop participants identified a general trend that was observed for both recruitment methods as well as data retrieval methods: in most cases moving to new methods does not mean replacing established methods but running new methods in parallel with established surveying approaches. This is also true for the most substantial change in travel surveying that has been going on for some years, the introduction of tracking, mostly by use of smartphones. As there remain population subgroups without smartphones or who are reluctant to be tracked, smartphone surveys are also mixed-mode surveys. It appears likely that future travel surveys will be increasingly characterized by a multiplicity of recruitment and data retrieval modes.

Such combination of methods improves overall quality of results, as different recruitment and data retrieval methods help to get a broad variety of travelers into the survey. However, it also raises two interlinked challenges: firstly, mode effects within individual surveys must be minimized; otherwise, results are likely to be biased, e.g. when comparing travel behavior across different groups of the population that tended to prefer different survey modes. Secondly, mode effects also call into question the comparability of time series that are essential to monitor changes in travel trends. In this context, random split samples, e.g. splitting the survey sample into a smartphone and traditional survey design sample, is a promising way to manage the transition to new survey methods smoothly. Such samples can help develop weights which can be used to correct mode effects.

As for research needs arising from these insights, it appears necessary that experiments and analyses of mode effects as well as ways to minimize them in survey design and ex-post, e.g. by weights, continue. However, there are also broader questions beyond the methodological issues of active travel data retrieval. As data that is passively recorded by smartphones becomes more and more available and similar to actively retrieved data, the question arises how this affects the need for active travel surveys altogether or at least their focus and the way they are conducted. In the future, the role of active travel data retrieval may be less on obtaining a comprehensive unbiased image of travel. Instead, the task of active travel surveying might be to close gaps in between the knowledge provided through passively collected travel data. This again could represent a fundamental shift for travel surveys and the methods currently being developed and applied.

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