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10th International Conference on Transport Survey Methods

## Workshop Synthesis: Comparing and combining survey modes

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### Abstract

This paper summarizes the discussions held during an in-depth six-hour workshop on the challenges of combining data from different survey modes with the anticipated aim of identifying current research needs. The main theme of the workshop was mixing survey modes as a way to meet the challenge of low response rates. However, the use of multi-mode surveys introduces new sources of bias: not all households have access to certain survey media (coverage bias); the response rate using one or another of the survey modes is correlated with social demographics (non-response bias); the sampling frame is dependent on the mode (sampling bias) or the instrument itself may affect the responses (measurement bias). The aim of this report is present the workshop's discussion on the identification of research needs with related to combining data from different survey modes.

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*Keywords:* survey modes; combining survey data; travel survey; face-to-face survey; telephone survey; web survey

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### 1. Introduction

This paper summarizes the discussions held during an in-depth six-hour workshop on the challenges of combining data from different survey modes with the anticipated aim of identifying current research needs. The workshop benefited from the participation of 22 individuals from 12 countries all around the world. As a result there was a good coverage of contexts and experiences in combining data from more than one survey mode.

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The paper opens with a short overview of the papers which were presented in the workshop (Section 1). The sources of biases due to the choice or mixture of survey modes are discussed (Section 2) and the research needs are identified (Section 3).

## **2. Presented papers**

Bayart and Bonnel (2014) presented comparisons of data collected from three different survey media in two separate household travel surveys. In each case web surveys were administered to those who refused to respond or could not be contacted for a face-to-face or telephone interview. A systematic socio-demographic bias was noted for respondents who eventually filled out the survey online. After applying corrections for these biases, web based respondents were still found to report lower mobility as compared to the face-to-face or telephone interviews. The paper goes on to apply a method to detect under-declarations for each specific mobility indicator.

Assessing the impact of new bicycle track on the prevalence of cycling and perceptions of safety, the second paper from Dill et al. (2014) compared data obtained from traditional survey methods with on street video surveillance. Two modes of self-reported surveys – mail-out/mail-back and web surveys – were augmented by ongoing video observations and traffic counts along the cycling route. The authors focused on controlling for the desirability bias.

Searly et al. (2014) reported on a computer-aided software field trial for face-to-face household travel surveys. They note that results from the computer aided collection were consistent with their ongoing pen and paper survey instrument. The migration toward computer-aided surveys seems therefore desirable, but the authors insist on the need to investigate the usability of the software and to take advantage of mapping tools for address geocoding. The last paper from Hess et al. (2014) discusses the potential of combining “simple” stated preference surveys with simulator experiments.

Three posters were also presented. Christensen et al. (2014) outlined the process of post-harmonization of eleven National Travel Surveys and the results in terms of data comparison. Tebar et al. (2014) presented the test of two survey media (web and postal) for the realization of a panel survey. Lastly Fifer and Rushton (2014) investigated the impact of survey media (face-to-face vs. web) in scale measurement for customer satisfaction surveys.

All papers and posters provided useful input for the workshop discussions.

## **3. Main biases related to survey media**

The main focus of the workshop was how to achieve representativeness of the targeted population even when multiple media was employed to recruit respondents and collect data. The workshop adopted standard classifications of biases (e.g., Groves and Lyberg, 2010; Alsnih, 2006). These divide the sources of bias into coverage bias, sampling bias, non-response bias and measurement bias. The discussions on each source focus on the contribution towards the bias of survey media.

### *3.1. Coverage bias*

In theory coverage biases are lower for face-to-face surveys in part because they do not rely on access to a telephone or to the internet. However, in practice the availability of an accurate and up to date database of households affects all survey modes. Sampling methods should be based on a frame which covers the whole targeted population, but the quality of the databases used as the sampling frames varies greatly. Typical registries are the census, telephone listings, public utility billing data and the post office’s households address listings. No matter which frame is chosen limitations exist. The database will contain errors, not be completely up to date or omit a segment of the targeted population (e.g., homeless people or an individual in institution). It is necessary to assess the limits of each database and to evaluate the risk of biases being introduced and how they will impact the objective of the survey.

Practically for telephone surveys, the main concern is not related to telephone equipment but rather to the completeness of telephone directory. A lot of individuals or households decide to be unlisted. Clearly, the rate of unlisted people is not uniformly distributed over the territory. This can be controlled and corrected through stratification or weighting factors. However, it appears the decision to delist may correlate with certain socio-demographics which in turn may be a source of coverage bias. The Lyon, 2006, household travel survey sort to lessen the bias due to unlisted numbers in a telephone directory by using a sample of randomly selected neighbors. A primary sample was generated using the directory but it was the secondary sample of randomized near-by households that was used to recruit respondents. The aim was to draw households independently of whether they were listed in the directory. The method also maintained the desirable geographic stratification of the sample.

Whilst most households have some form of telephone (mobile or landline) service, an increasing number of mobile-only households have caused challenges to transport surveys. Son et al. (2013) reported that mobile-only households are more likely to be single occupant, younger and from an ethnic minority. Dual-frame surveys using landline and mobile numbers have been proposed for health surveys (Link et al. 2007; Hu et al. 2011). However, multiple listings in each registry are possible due to a single individual having several devices, say for professional or personal use. Relevant to this discussion is that the dual-frame approach applied in health does not pay particular attention to the need for transport surveys to be supported by geographically stratified samples. Another challenge to incorporating mobile-phones into telephone interviews is that these devices generally belong to the individual but landline telephones are usually shared by the household.

The penetration rate of internet access at the household level is not as high as it is for access to a telephone. Table 1 reports the latest statistics on the proportion of populations with access to the internet.

Table 1. World Internet Usage and Population Statistics June 2014.

Source: <http://www.internetworldstats.com/stats.htm>.

World Regions	2014 Population Est. (Mil)	2014 Internet Users (Mil)	Penetration (% Population)	% of world internet users
Africa	1,126	298	26.5 %	9.8 %
Asia	3,996	1,386	34.7 %	45.7 %
Europe	826	582	70.5 %	19.2 %
Middle East	231	112	48.3 %	3.7 %
North America	354	310	87.7 %	10.2 %
Latin America / Caribbean	612	320	52.3 %	10.5 %
Oceania / Australia	38	27	72.9 %	0.9 %
<b>WORLD TOTAL</b>	<b>7,182</b>	<b>3,036</b>	<b>42.3 %</b>	<b>100.0 %</b>

Recent surveys have found households responding over the internet tend to have higher levels of education, higher incomes, higher job positions and higher car ownership; all of which correlate with travel behavior (Bayart and Bonnel, 2014; Christensen, 2013). For this reason household travel surveys (Bayart and Bonnel, 2012) and, even, web national travel surveys (Christensen, 2013) generally make use of other survey modes. To the best of our knowledge, national internet account registries do not exist. Other sampling frames and media would need to be used to recruit internet users into a representative sample in order to use inference techniques to expand data to the whole targeted population.

### 3.2. Sampling Bias

The quality of any statistical sample is firstly dependent on the availability of an accurate population database. Inferences on population statistics require a known probability of inclusion of each statistical unit within the targeted population. When the target population and the population frame differ the inference about the statistic is subject to an increased sampling bias.

On the face of it, the impact of survey media on sampling bias should be relatively small as the difference between the frame and the target is relevant to all survey modes. However as travel surveys generally apply

geographical stratification the role of the survey media may contribute to sampling bias because some survey modes are associated with geographically known information while others are not. Geographical stratification using street addresses, postcodes or (landline) area codes suits face-to-face, mail-out and traditional phone surveys. The sampling exercise is made easier because sampling and the method of recruitment rely on the same primary code (the household address or telephone number). This is not the case when conducting surveys where the mode of recruitment is the mobile telephone. The first digits of the mobile number are more likely to be associated with the provider, however with the advent of number portability even this is a weak association. Email recruitment is unlikely to offer any control over geographically stratified sampling. A similar issue is faced with applying online registries – including online panels -- to recruit respondents. The quota sampling applied to geographical locations and other socio-demographic variables do not allow the use of inference techniques as the probability of inclusion of each statistical unit within the targeted population is unknown. Quota techniques are therefore not recommended when data have to statistically represent a targeted population.

In summary survey modes that use residential addresses as the primary means of contact are much more readily applied to geographically-stratified sampling techniques. This does not preclude the use of other survey modes, but additional steps must be taken to ensure the population sampling is accurate. One possible solution is to use one mode (mail-out, face to face or landline telephone) for recruitment and another (mobile telephone or the web) for data collection.

### *3.3. Non-response Bias*

Non-responses are assigned to households/individuals that have been selected at the sampling stage but for some reason have not responded or have not returned a valid response. A non-response bias results if these households/individuals differ systematically from the households/individuals that do complete the data collection phase. Survey response rates are decreasing over the world (Atrostic et al., 2001; Curtin et al., 2005). Even when effort is made to increase response rates —by improving the questionnaire design, reducing respondent burden and increased reminders – particular attention needs to be given to bias due to non-responses. Correcting non-response bias through the application of expansion weight adjustments for under or over represented socio-demographic groups presupposes that the travel behaviors are the same for respondents and non-respondents. However, this is not always the case (Richardson, 2000). The challenge for accounting for non-response bias lies in the fact that the difference between non-response behavior and travel behavior is unknown. This report concentrates on the issue of higher or lower proportions of non-response due to the selection of survey mode and in particular if this has a bearing on non-response bias (see Bonnel, 2003; Curtin et al., 2005; Dillman et al, 2009; De Leeuw, 2005).

It is generally agreed that non response rates are highest for self-administered interviews delivered via the post or over the web postal. The presence of interviewer in face to face surveys tends to minimize the effect of non-response bias. It is also the case of telephone even if the effect of the interviewer seems to be slightly lower on non-response reduction (De Leeuw, 2005). Furthermore the nature of biases might be different in relation with survey media. They are also strongly correlated with country cultural specificities.

A proven way to reduce the non-response bias is to have an interviewer present. Face-to-face interviewers offer encouragement to respondents to work through the survey, appealing to their sense of community contribution. However, face-to-face surveys raise some challenges that do not necessarily relate to other survey modes. In some countries closed gate sectors or private buildings restrict personal access to households. This is especially relevant in countries that have locked communities for their wealthier citizens. On the other hand safety concerns may prevent the interviewer from entering the poorest zones within some cities. In either case restricted or unsafe access presents a source of bias because income is correlated with mobility. Another drawback of face-to-face interviews is that it is the most costly of the standard survey modes because of the training, coordination and wages needed to put a team in the field. Initial telephone contact is often used to avoid wasted travel by interviewers looking to recruit the sample.

Telephone surveys have increasing lower response rates because the medium is crowded by cold-calling sales contact and commercial market research. However, one of the main sources of non-response bias when administering telephone surveys is the increased use of the mobile phone and the rise of mobile-only households. As

mentioned earlier this impacts coverage bias through database limitations, but even when mobile registries are available, mobile-users rely on number recognition to screen and are often engaged in other activities during their interview.

In the absence of an interviewer web or postal surveys provide the least amount of motivation for the interviewee to respond the survey. There is a particular need in these survey modes to reduce the burden on the respondent through, short, comprehensible and attractively designed questionnaires. Instruments delivered over the internet can take advantage of computer assisted web interviewing (CAWI) design principles which allow respondents to navigate through the survey without having to judge which questions are relevant to them and which are not. However, without the presence of an interviewer the respondent is free to interrupt the survey at any stage. Some respondents may return, but with a different level of engagement and others may simply choose not to complete the survey.

On the other hand the freedom to complete the survey in the respondent's own time may have a positive effect on reducing non-response bias. Surveys conducted by an interviewer take place at times initiated by the interviewer. However these times are not convenient for all segments of the population, particularly those conduct busy lives during the evenings. It appears that a significant part of web travel surveys are conducted at the time of work (and most probably at work) by active people (Bayart and Bonnel, 2010). Furthermore individuals can return to the survey several times if they really need to.

Respondent burden contributes to total non-response or partial non-response (Ampt, 2003; Madre et al., 2007). This sends a clear message that response burden needs to be considered when designing survey instruments. Axhausen and Weis (2010) proposed the use of the rate of non-trip makers in the survey to measure the degree of respondent burden as the strategy is most likely to be as a shortcut by respondents to avoid burdensome data completion. Web based surveys allow the collection of partially completed surveys as well as the analysis of log files to detect the different patterns of interruptions. These can also be used to identify when the interviewee stops the survey in order to measure the degree of respondent burden. Both these actions may help explain and ultimately correct for at least part of the non-response bias.

### 3.4. Measurement Bias

Measurement bias results from wrong or inexact recording of the indicators being measured (Hammer et al., 2009). Sources of measurement errors are diverse and their impact is difficult to assess. A large body of literature discusses the advantages and limitations of survey media in relation to measurement bias (De Leeuw, 2005; Dillman, 2007; Lozar Manfreda et al., 2008; Zmud, 2003). De Leeuw (2005) identifies media-related factors, information transformation factors and interviewer effects as the broad classifications of the ways in which the survey media can affect the degree of measurement bias.

Having an interviewer present in the face-to-face or telephone modes allows for prompts to be used to jog the respondent's memory and control for trip coherence (for example that a tour or a day generally finishes at home). Comparisons of survey media indicate that trip rate declarations in web or postal surveys are lower by 0.5-1 trips than those reported in face-to-face or telephone surveys. In case of web surveys, differences were mainly found to be for short walking trips or for less constrained purposes (Bayart and Bonnel, 2014).

The workshop raised the importance of interviewer training and interviewer quality control to reduce measurement errors and the possibility of interviewer bias (systematic errors due to the presence of a particular interviewer).

An interesting point made by Fifer and Rushton (2014) is that the presence of interviewer generally increases the level of social desirability bias which is in line with other authors' results (Couper et al., 2001; Krosnick and Alwin, 1991). Although this phenomenon is more likely to occur in opinion survey, it is not irrelevant to travel surveys as transportation is a sensitive field (the survey being financed by public transport authority, individuals may favor public transport). This bias is strongly reduced in the case of a web survey, since the interaction between the interviewer and the respondent is virtual. Moreover, when a list of items is read by the interviewer, respondents often select the last one ("recency effect"). But when the questionnaire is self-administrated, respondents tend to

prefer the first item (“primacy effect”). So, a mixed modes survey, using the web and telephone or face-to-face interviews generates comparability issues (Dillman and Browker, 2001).

The way in which the information is transferred is clearly more flexible in face-to-face modes than in all other modes. Here the interviewer can use visual or oral channels or a combination. They also can use non-text prompts such as tone of voice and body language. In postal and interview surveys the way in which complex information is presented may be aided by visual aids such as diagrams (Couper et al., 2001). However, computer based instruments have a distinct advantage over paper based tools as there is opportunity for the program to accommodate different ways in which the respondents comprehend the question (i.e. through maps or images, recorded instructions or text). In the workshop paper presented by Seary et al. (2014) no significant difference was reported on the survey quality indicators for interviewers using paper based or computer aided survey instruments. The authors note that is most likely because the interface design of the CAPI tool mimicked the traditional paper survey and that there was an opportunity missed to make use of the CAPI’s flexibility to help respondents recall their travel day’s itinerary.

#### **4. Recommendations for future research**

This section identifies some directions that research may take to improve sample representativity and reduce the bias due to the choice of survey mode.

An issue facing both public agencies and private market research organizations is that the crowding of the survey space has meant that potential respondents are hesitant to participate beyond the initial recruitment contact. This is evident in the declining response rates across all survey modes. There is a clear need to develop and test strategies that motivate the interviewee to engage with the data collection process. Strategies that appeal to individuals’ senses of civic duty appear to work for some but not all. A comparison of public transport shares from household travel survey and smart card records in Montréal, Canada indicated that public transport users tend to respond to a household travel survey at a greater rate than non-users. The workshop highlighted the importance of finding new ways to encourage participation beyond the traditional expectation that people will respond to official surveys:

- A greater emphasis is placed on the initial contact and respondent conversion in interviewer training procedures. It was also suggested that the interviewer training process focus on sustaining the respondents’ interest in the survey to maintain the data quality throughout the survey. The ergonomics of the survey instrument must be given greater attention. This is particularly true for postal and web surveys where the respondent has control over the process. One way to think about the design process is to transfer the respondent’s burden to the questionnaire designer. An example for travel survey design is that the respondent should be able to pinpoint the location of a stop in a way that is suitable for them. The instrument should be flexible enough to record an address, a point on a map, a nearby point of interest, or a public transport stop. Incorporating this degree of flexibility clearly points to the continued adoption of computer based instruments whether they are used in face-to-face, telephone or web only modes (we expand on this point below);
- Surveys need to become more fun. This is another way of thinking about transferring the burden from the respondent to the designer. Bricka and Murakami (2014) proposed the development of gamification as an emerging survey technology. The workshop agreed that this was a promising direction for travel surveys to explore.

Computer-aided personal interview software can be improved for the purposes of better data quality. The ergonomics of the instrument requires greater attention. It appears that the currently available tools are far too rigid and differ little from the traditional paper and pencil or text based surveys. Whilst the web affords a higher degree of question relevance in that the respondent does not need to wade through all the possibilities, the presentation of the relevant questions does not differ from paper surveys. The workshop identified a number of functionalities that could be incorporated in computer based tools:

- The tool should be able to handle trip duplications without all members of the household responding as if they are individuals. Shared trips should be noted for the first respondent and then incorporated in the second respondent’s itinerary. This does raise the issue of disputes between household members on the accuracy of the information.

- The software should be able to identify inconsistencies and alert the survey participants. Ultimately the software may need to modify, insert or delete trips to maintain the coherence between successive trips;
- Automate geolocation of stops;
- Test of coherence using external sources like for example in origin-destination surveys in Montréal, Canada where transit interchanges are controlled in terms of feasibility and coherence with trip origin and destination.

The workshop noted that continued research into the mobility bias introduced by non-response is needed. Using socio-demographics to reweight the responses is ineffective because the travel behavior of non-respondents differ from respondents regardless of socio-demographic class (Ampt, 1997; Sammer 1997)

Incentives offer an opportunity to improve survey response rates and data quality. At the very least incentives increase survey participation and are most likely to decrease the bias generated by non-response. However, participation (completion) incentives may affect the data quality adversely in that the respondents are motivated by the reward for submitting their responses and rather than to complete the collection accurately. For example in the US citizens are offered payment to participate in travel surveys, whilst in France incentives are seen more as ‘thank you’ courtesy and only given at the end of the survey.

Comparisons of survey modes tend to concentrate on the differences between interviewer present modes (telephone and face-to-face) and interviewer absent modes (postal or internet). There appears to be less dedicated research on the specific comparisons of web based and postal surveys. A concentrated effort here removes the impact of interviewer presence and allows a greater focus on the ergonomics of the survey instrument.

Reduction of respondent burden appears has one of the most important objectives that all researchers should look for. Following Axhausen and Weis’s (2010) lead on developing a practical method to measure respondent burden for postal surveys, there is a need to develop practical indices for all survey modes. Using the non-trip making rates provides a convenient index but that would require a coordinated effort to publish non-trip making rates for future comparisons. We also need to better understand the factors which may encourage non-trip declaration. Web surveys offer an interesting perspective as it is possible to analyze questionnaire log details in order to identify web respondent behavior while filling the survey and when they interrupt a survey probably because the burden is perceived as too high.

The workshop recognized the need to use a mixture of media rather than just one survey mode. This is in response to the evidence that the non-response bias varies across the media. This may come down to the fact that different households have a preference for different media or even more puzzling is that this preference may be fleeting and depend on current circumstances (Brög, 1997). For example Bayart and Bonnel (2014) have shown that a proportion of non-respondents to a telephone or to a face-to-face survey are likely to respond through the web during work hours. Combining media across the recruitment and data collection phases is seen as a way to reduce non-response rates and therefore to increase representativity (Couper and Bosnjak, 2010; de Leeuw, 2005).

The main issue discussed in the workshop is that the utilization of different survey media may impact mobility indicators. These differences should also be considered for data processing, in order to produce representative results (Bayart et al., 2009). Researchers and practitioners must first analyze the differences in terms of declared mobility between survey media and then combine the data as a unique database to be used for different purposes -. To assist with the analysis of the effect of survey mode on declared mobility, methods exist. Heckman’s sample selection bias method (Heckman, 1979, 1990) or propensity score method (Rosenbaum, Rubin, 1983). Using these methods it is possible to measure survey media effect on one ‘dependent’ indicator (number of trips, trip distance or time budget). Bayart and Bonnel, (2014) note in their comparison between web and face-to-face or telephone surveys that the correction factors are likely to be different for each indicator. This limits the potential to simply combine the databases. They note, further, that the differences are mainly concentrated on short trips, walking trips or less constrained trips, making it impossible to incorporate a simple correction factor for all trips. It would be necessary to develop new multidimensional methods to incorporate simultaneously all dimensions (transport mode, purpose, trip duration and distance...) in the analysis of selection bias.

When differences are not too important databases are generally merged without correction factor in order to increase sample size and response rate. In this case it is generally necessary to re-estimate weighted and expansion factors. But again if we have methods which can apply for a single database like margin calibration methods for



example, we need to develop new methods in order to optimize calibration taking into account sample size of each original database in each population segment.

Lastly we identified the advantages to combine data from different sources, for example public transport usage from travel survey with public transport operator smart card data analysis (as done in Montréal for example) or traffic count or more generally all big data which became progressively available. But the target population is not always the same, the definition of indicators might be different, the data processing too and obviously data collection methods are different. We need to develop our knowledge of all these databases to better understand the potential they present and to develop method to combine them with travel survey data in order to enrich our data.

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Of course all errors are our sole responsibility.

## Appendix A. Papers presented during the workshop

- Combining evidence on driver behaviour from simulator experiments and stated preference surveys. Authors: Stephane Hess, Michiel Bliemer, Darryl Hibberd and Hamish Jamson.
- How to combine survey media (web, telephone, face-to-face): Lyon and Rhône-Alps case study. Authors: Caroline Bayart and Patrick Bonnel.
- Measuring and predicting behavior change in response to new cycle tracks. Authors: Jennifer Dill, Kelly Clifton, Christopher Monsere and Nathan McNeil.
- Maintaining best practice: an investigation into the suitability of Computer Assisted Personal Interviewing (CAPI) for the Sydney Household Travel Survey. Authors: Nicholas Seary, Yun Zhang and Roniga Hang

## Appendix B. Posters associated with the workshop

- Test of two panel surveys to measure local mobility in France. Authors: Maria Tebar, Jean-Loup Madre and Jimmy Armoogum.
- Comparison of travel behaviour in 11 European countries by use of post-harmonized European national travel surveys. Authors: Linda Christensen, Jean-Paul Hubert, Tuuli Järvi, Martin Kagerbauer, Natalia Sobrino and Christine Weiß.
- Face-to-face versus Online – differences in the use of scales in transport surveys. Authors: Simon Fifer and Lee Rushton
- A Stated-Preference Intercept Survey of Long-Distance Mode Choice for Estimating High-Speed Rail Demand. Authors: Joshua Auld, Behzad Karimi, Zahra Pourabdollahi, Abolfazl Mohammadian and Kazuya Kawamura.

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