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12th International Conference on Transport Survey Methods

# Sampling, nonresponse, and quality in travel surveys

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## Abstract

Response rates have been continuously declining in most countries for many decades. Therefore, the risk of selectivity and of response bias are steadily increasing. During the workshop, we discussed the use of different lists based on sampling frames, as this can greatly improve the efficiency of data collection. However, the impact of the weighting procedure must be considered. The study of nonresponse mechanism is fundamental for representativeness of the sample of respondents. Furthermore, soft refusal is not limited to not reporting any trips at all, but can also be defined as underreporting trips. We found that it is necessary to improve surveys with the help of technologies or usage logs in order to deal with burdensome and underreporting. At the end of the workshop we came up with research priorities and recommendations for the next conference.

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*Keywords:* Sampling Frame; Multiple-Frame Sample ; Convenience Sample; Total Nonresponse; Measurement Errors; Data Quality; Ground Truth

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## 1. Introduction

Response rates have been continuously declining in most countries for many decades and there is a growing interest on “hard-to-reach people”. Therefore, the risk of selectivity and of response bias are steadily increasing. Changes in existing strategies for sampling, recruiting, surveying, and adjustment as well as new strategies for travel behaviour data collection are widely discussed in order to ensure a high quality of survey data. In the meanwhile, multi-frame sampling and mixed-mode techniques are frequently applied. Collecting data by smartphone or other GPS tracking devices is gaining importance, with a shift from conventional methods for household surveys (e.g., face-to-face), to more individual survey instruments (cell phone, internet, etc.). As sampling is crucial for representativeness and participation, many recruitment techniques and approaches such as crowdsourcing, gamification, but not only, are under investigation. The workshop discussed both traditional and new approaches to survey individual travel data.

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Objectivity, validity, and reliability of survey results are paramount criteria of surveying quality as well as the estimation of data accuracy. The participants shared their survey experiences and research results from a methodological perspective.

## 2. Sampling (probability vs. convenience sample, individual vs. household)

Traditional single-frame probability-sampling techniques (e.g., address-based sampling by accessing official population registers) are increasingly supplemented and partially replaced by multi-frame techniques as well as new recruitment approaches such as crowdsourcing, convenience sampling, and gamification.

By now, increasing practical experience as well as the existence of comparative studies, enable discussion of the strategies in detail. Face-to-face or Computer Assisted Telephone Interview (CATI) travel surveys are usually conducted by drawing a probability sample from an exhaustive list (e.g., households drawn from the census for the French National Travel Survey, phone landlines for the O-D surveys in Montreal, etc.). In such cases, the primary sampling unit (PSU) is the household (or dwelling with a landline) from which individuals (household members) could be considered as secondary sampling units (SSU) or even all household members are units to be surveyed. Whether trip data are collected only for selected individuals (minimum one) or all individuals in each household, strongly depends on local survey traditions. Standard methods of weighting (based on inclusion probability and nonresponse adjustment) are typically applied for extrapolating survey results to the whole population. New technologies (e.g., smartphone, GPS) suggest to have a more precise trip recording than what could be obtained by widely-used and well-known trip diaries. However, they are typically individual based rather than household based, which changes the perspective on accessing or recruiting participants, the availability of sample frames, as well as on the application of weighting and extrapolation methods.

A major issue is the integration of survey results obtained through different instruments (see Verreault and Morency). In the Montreal O-D surveys, the results of the traditional landline phone and a mobile phone survey had been integrated, while paying attention to hard-to-reach individuals like students and users of car-sharing services. Moreover, when using a multiple-frame sample technique, it is important to get a minimum number of units for each frame and to add a frame-specific item to the questionnaire to ensure that the researcher is able to know the membership of each frame.

As an illustration, two contributions have shown how to combine the results provided by different survey instruments: Wörle et al. present the combination of different subsamples for analysing the acceptance of an autonomous minibus service. Julio and Monzon show the combination of personal interception interviews at bike-sharing stations with a follow-up online survey for analysing the use of bike-sharing in Madrid; face-to-face short interaction, improves the response and completion rate. Moreover, users are more prone to responding than non-users because they want improvements to the service.

In recent years, the sample frame has received notable attention as the use of landlines, which, as an example, should be eliminated in France around 2025, has declined with a corresponding increase in cell phone availability. Simultaneously, thanks to large amounts of data coming from individuals volunteering their data (crowdsourcing), smartcards, and other passive data collection techniques, the characteristics of survey participants, which are often unknown a priori, have changed. This suggests a need for discussing alternative frames or survey methods to compensate for and take advantage of these new data sources.

Weber et al. showed remarkably similar sample structures between a conventional address-based probability sample and a non-probability sample, for which participants were indirectly recruited through press releases (issued by the city administration and by the local university (e-mail circulars, newsletters, and social media) or directly in private or workplace environments; looking at full-time employed individuals (18–59 years) in detail, no significant differences referring to sample composition and travel behaviour were identified, showing potential use for specific research tasks.

The contribution by Berger et al. also focuses on the recruitment process, participant motivation, and response for a smartphone-based travel survey. Indeed, with smartphones as everyday individual companions, detailed and comprehensive travel data can be collected. In Vienna, for a local travel survey, about 500 participants tracked their

travel behaviour with smartphones and filled in an online household and personal questionnaire for one whole week. In this research project, different strategies of recruitment process for a smartphone-based travel survey are compared. The authors found that a postal pre-announcement of the visit of a recruiter and a second visit to assist participants filling in both online surveys increased the willingness to participate.

### 3. Nonresponse and selectivity (units, drop-out mechanisms)

Unit nonresponse is the complete drop out of chosen sampling elements within a sample frame. Nonresponse can potentially induce systematic bias and undermine probability mechanisms. Nonresponse frequently results in selection errors which are, beside measurement errors, an important source of non-sampling errors. Improving modalities of contacts or allowing proxy-reporting are typical strategies to increase participation rates for some hard-to-reach population groups. These strategies have specific advantages and drawbacks. In the context of travel diary surveys, unit nonresponse can also arise for a number of different reasons including refusal, not-at-home, non-contact, unknown eligibility, unable-to-answer, inability to participate, or language problems. While nonresponse results in a reduced sample size, a more important concern of researchers is the possible impact on nonresponse bias. Indeed, bias is introduced when those that do not respond to the survey behave systematically different, for key travel-related survey outcomes, from those that do respond. However, the sensitivity of survey results, due to different weighting approaches, may be one evaluation criterion for accessing nonresponse effects.

The contribution by Wittwer et al., relies on a follow-up non-response survey, conducted on 3,108 individuals after the “Mobility in Cities – SrV 2018” survey. Standard analysis techniques in the social sciences and multivariate statistics, i.e. response-propensity models, were developed which examined drop-out mechanisms and participation probability. Thus, statistically explainable differences in travel behaviour between respondents and non-respondents, were evident to a limited extent. Education was identified as an explanatory variable; however, there were no indications that this factor could play a role in weighting for improving the representativeness of reporting-day-specific travel patterns. Therefore, the analyses demonstrate the effectiveness of weighting procedures in terms of survey-result sensitivity using different auxiliary variables within a uniform weighting approach. The standard auxiliary variables, age, gender, and household size, already reduced the impact of distorted formal education. In consequence, although differences in formal education existed between respondents and non-respondents, key survey outcomes and particularly reporting-day-specific travel patterns remained stable, when comparing different weighting approaches with and without formal education as variables within weighting. Secondary survey outcomes such as having a driver’s license and occupation status, showed low sensitivity to the weighting procedure.

A particular challenge in smartphone-based travel surveys is dealing with decreasing response rates concerning not only registration, but on top of that downloading and activation of the smartphone app, as well as, uploading and validation of trips. To improve the rate of participation, it is necessary to understand the reasons and problems which lead people to dropping out of the survey; for example, technical issues, problems of understanding and response burden. This leads to clarifying the explicit and implicit motivation to participate in a smartphone-based travel survey; for example, technological affinity, support of research activities, self-monitoring in travel behaviour. While the motivation to participate in conventional surveys has been researched in detail, there is very little knowledge about response factors for smartphone-based surveys. To obtain a representative sample, it is crucial to understand these different motivations of different social groups to participate. This knowledge allows to optimise the quality of the fieldwork for example the recruitment process, and to improve conversation guidelines of the on-site team.

The contribution by Tebar and Hasiak shows through qualitative interviews in France, that about half of potential participants to a one-week smartphone survey with a time-consuming editing of GPS traces, are willing to participate with an incentive of 20 Euros, while the other half could do it for free as “good citizens”; although, transferring this amount as charity or attributing it through a lottery is quite difficult in France for fiscal and legal reasons.

The contribution by Balsero et al. aims to explore the efficiency of the communication actions carried out for improving the response rate of the 2021 University Mobility web Survey conducted in Madrid during COVID-19. Emails were sent to students and administrative staff with a dedicated link to the survey and a price for those who would complete the survey. The response rate was around 12% among students and 40% for administrative staff,

with 80% of questionnaires completed. A reminder message from the head of the University has been quite efficient in raising the response rate.

Armoogum et al. took advantage of a very rich sampling database (tax data with demographic information on individuals and household structure) to test the administration of the Global Mobility survey in Paris region by Computer-Assisted Personal Interviews (CAPI) and Computer-Assisted Telephone Interviewing (CATI), in order to study the effect of both media on the response mechanism. Through statistical techniques (logit models), it appears that:

- Household income, the size of the housing, the age and gender of the reference person, the housing occupancy status and the type of household play a role in the response mechanism for the face-to-face survey;
- Household income, the size of the housing, the age of the reference person, housing occupancy status and the type of household, the response day and the zone of residence play a role in the response mechanism for the web survey;

In the CAPI survey, where all members of the household have to describe their mobility behaviour, there is an important measurement error for large households. In addition, the necessity to have all household members present for the description of their mobility, means that the day for which this mobility is described, is not considered to be taken at random.

Considering the issue of soft refusal, immobility studies give an overview of the quality of a travel survey. The paper by Garcia, Batur, Armoogum, Pendiola compares results on immobility from travel surveys and time use surveys, in France and USA. A logit model has been used to establish 15 profiles according to age class, work status, health and urban localisation. Time-use surveys allow to discover the activities done for a whole day for each profile. The immobility rate difference between the travel survey and the time use survey, is an indicator of soft refusal, if the rate is higher within the travel survey. Interestingly, the immobility rate is much larger in travel surveys; the difference is 10 % for the USA and 16 % for France. The immobility rate and high frequency of work or studies outside activities, suggest that mobile people are busy, more than any of the other profiles. So, the origin of soft refusal would be the intention to shorten the interview by not declaring some trips.

Within the workshop, other interesting discussions specifically addressed how to avoid non-response and to decrease response burden.

- It appears that an invitation letter to respond to the survey is important. Researchers should entice people by giving them the reason why the data is needed and how this knowledge may help them for improving their own mobility in the future.
- New indicators are needed for tackling environmental issues (calculation of GHG emissions).
- Incentives may help in increasing the response rate, especially for smartphone-based surveys. They are widely applied in some countries, although the risk of selectivity increases, and the completion quality of questionnaires is more likely to decline.
- Gamification may help to make the survey more fun and this also could be an approach to encourage participation and avoid non-response.
- Decreasing the length of the questionnaire (response burden), is a most promising way to rise the response rate.
- More efforts have to be made to keep in touch with the respondents, for example by sending them the main results of the survey.

There is a need for identification of hard-to-reach population and maybe the use of multi-frame survey could help in the representativity of the survey.

#### 4. Quality (validity, ground truth)

The measurement error on a specific variable depends on the precision of survey instruments and is the difference between the obtained sample value and the unknown true value in the population. There are several sources of measurement error such as: interviewer effects (in-person vs. self-reported questionnaire); memory errors; imprecision and proxy responses. The permission of proxy respondents means a decrease in the risk of nonresponse

errors, whereas the risk of measurement errors increases. In travel surveys, measurement errors are frequently caused by underreporting trips, but also by consciously or unconsciously wrong reporting. The solution is either by reducing the response burden or by correcting the under or wrong reported trips.

The contribution by Sammer et al. particularly focuses on under-reporting of trips by the interviewees: either to reduce the recording effort of the survey consciously, or because these short trips or intermediate stops are simply forgotten. After the 2013 Austrian National Travel Survey, two GPS surveys have been conducted with an emphasis on under-reported trips in order to calibrate a new weighting procedure. The implementation of this procedure indicates an increase in the number of daily trips per person from 3.3 up to 4.4. That result corresponds to an increase of about 40% on the mean value of all modes. The increase primarily affects short trips of cycling, walking, and car driving. The daily trip length increased to a lesser extent of about 5% and the daily trip duration rose by about 12% on average. These changes in travel behavioural patterns have a significant influence on modal split results. Finally, Pike and Handy show that, even though a homogeneous reweighting of data could be achieved, the evolution of PT and active modes in California cannot be determined using only the 2012 state-wide CHTS and the 2017 NHTS, because their modal share are too small.

One way to avoid unreported trips, might be combining a smartphone-based survey with a traditional questionnaire. All questions on socio-demographics may be asked with CAPI/CATI/CAWI, and the trip diary may be collected with an App. It's a way to skip burdensome and repetitive questions and furthermore collect a more realistic trip distance.

## 5. Conclusion and research priorities

In this workshop on “Sampling, Nonresponse, and Quality in Travel Surveys”, three different issues (Sampling, Nonresponse and Selectivity, Quality) were specifically addressed, and solutions or best practices were discussed and proposed to improve data collection methods, reduce sampling biases and selection effects, as well as increase survey quality. During our discussion, we identified research priorities:

- **Multi-frame surveys**  
The use of different lists as basis of sampling frames can greatly improve the efficiency of data collection when sampling a small part of the full population. This method helps to reduce data collection costs while still sampling from the entire target population. However, the impact of the weighting procedure must be considered.
- **Nonresponse mechanism**  
The risk of response bias is steadily increasing. The study of nonresponse mechanism is fundamental for representativeness of the respondent sample. Furthermore, soft refusal is not limited to not reporting any trips at all, but can also be defined as underreporting trips. There is very little knowledge about response factors by different social groups for smartphone-based surveys.
- **Data fusion**  
It is necessary to improve surveys with the help of technologies or usage logs in order to deal with burdensome and underreporting. Merging data from small surveys on a continuous basis will eliminate some of the burden of having to respond to a long questionnaire and prevent underreporting. For instance, a core survey together with satellite surveys (e.g. combination with a vehicle-based survey for the calculation of GHG emissions).
- **New indicators**  
Surveys using new technologies will be individual based rather than household based, which means that for example: for car availability, for each car it may be worth asking who is the main driver and who are the secondary drivers, which could be calculated from previous household surveys for the measurement of evolutions.

In addition, the following questions should be considered: how to communicate with interviewees & policy makers about data needs? How to ease participation in travel surveys?

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