

WORKSHOP ON MULTI-METHOD AND MULTI-INSTRUMENT SURVEYS

Resource Paper

Surveys Using Multiple Approaches

Konstadinos G. Goulias

*Department of Civil and Environmental Engineering and the Pennsylvania
Transportation Institute, Pennsylvania State University*

ABSTRACT

In transportation research and practice, we make use of multiple survey approaches, using many methods and instruments to explore an issue from different perspectives and/or to reach different population segments. The combination of these different approaches and data, however, generates some unresolved problems that are presented in this paper. First, the four basic types of survey data, i.e., general surveys, travel and/or activity diaries, off-sample background surveys, and in-depth surveys, are briefly described. This is followed by summaries on survey issues including nonresponse, survey design methodologies, data collection methods, technology options, and data combination/fusion. The paper concludes with four themes: selectivity and sample representation, (pre) testing and experimentation, harmonizing surveys and survey items, and information fusion. A brief description of the multiple-approach survey types addressed by the workshop and the survey stages for which the workshop developed guidelines is also provided.

INTRODUCTION

Transportation surveys involve the use of many different methods and associated instruments to collect data. For example, in a typical inventory creation for urban transportation planning models, we would find cordon surveys, traffic counts, census data, and household travel survey data, all combined together in sometimes statistical, and other times haphazard, ways (for examples, see 1, 2, 3, 4, and 5, among others). Even when the objective is simply to “update” models within the traditional forecasting process, a variety of surveys are again needed, and their data combined (6, 7, and 8). In addition, a variety of existing databases are used either to validate/verify transportation models, e.g., traffic counts to verify traffic assignment outputs; or simply to provide inputs to models used in forecasting, e.g., sociodemographic population characteristics allocated to traffic analysis zones and then input into aggregate travel-demand equations (9, 10). All these databases, at one time or another, emerge from data collection activities that are most likely to have followed a different survey methodology.

On the one hand, combination of different survey data is the only feasible way to procure the information needed for transportation system description and policy analysis, and it may be the most efficient way to study various aspects of human behavior (11). However, data and model credibility is clearly based on how we best achieve the combination of different methods and instruments. Some evidence begins to emerge of the risks associated with small changes to the survey method that have resulted in substantial

and significant inferential differences across different methods, e.g., the stated preference example in (12). In addition, comprehensive data analysis of response patterns in multistage questionnaires shows systematically different survey participation at each stage of a survey that uses different methods to recruit and retain respondents, with a resultant sample not representing its target population (13). All this, at best, undermines survey data credibility, creates the need for data adjustment problems (which cannot always be avoided, even using sophisticated statistical techniques), and ultimately lends support to the critics of more in-depth data collection and use in decision making.

Guidelines for best practice are increasingly needed in three settings defined for this workshop. The first setting is on different methods of approaching population segments, based on their contact requirements, yielding better survey performance. The second setting is the use of different survey methods to obtain complementary information that allows us to observe a given problem from different perspectives. A third setting, of more pragmatic nature, is the combination of different existing data sources containing complementary information to answer one or more policy questions.

Based on a survey of the literature in the past five years and state-of-the-art review reports in transportation and other related fields, it becomes apparent that the use of data emerging from different data collection methods and data collection instruments is made without having first verified if it is appropriate to combine the databases. This results in a haphazard mix and match of methods to suit project needs, constraints, and sponsor requirements, which may lead to severe study biases. Naturally, the task of statistically and procedurally analyzing all the data used in a regional and/or national transportation forecasting model exercise is a daunting task that by far exceeds the resources of the striking majority of projects. Unfortunately, however, very little attention has been paid to the need and appropriateness of using different methods and instruments, even within the same “data collection project.” In addition, comparative studies have focused on very narrow areas (e.g., questionnaire horizontal-versus-vertical layout), which to some extent were needed to create controlled experiments. This research gap is clear not only in the transportation literature but also in the more general survey methods literature. Dealing with well-controlled and detailed multi-method and multi-instrument survey comparisons may be an extremely expensive task. As a result, we may be forced to use indirect evidence and related comparisons made in survey research. Those comparisons that focus on specific aspects (e.g., face-to-face interviews versus telephone interviews) of survey design offer some initial information and guidance for this workshop.

In this paper, an attempt is made to provide a concise summary, at the cost of losing detail, of the literature on and experience with combining methods, instruments, and related databases. In addition, since the charge of this workshop is to develop suggestions for better standards for multi-method and multi-instrument surveys (renamed, in the course of the workshop, the multiple approach), challenges that are specific to multi-method and multi-instrument survey practice are identified, and associated workshop themes provided. The ultimate workshop outcomes are “practice standards” that should not be “straightjackets” that inhibit innovation and creativity, but rather, formulated in terms of lessons learned by and provided to the survey research and practice community.

The remainder of the paper is organized as follows. First, the four basic survey types are described. Summaries of survey issues that include nonresponse, methodologies

of survey design, data collection methods, technology, and data fusion are provided next. The paper concludes with a section on workshop themes.

BASIC SURVEY TYPES

In transportation, data collection is performed mainly for two reasons: population monitoring, and creation of models that are used to understand the past and present, and predict the future. The types of data needed by transportation analysts span the entire spectrum of data about human life. Indeed, recent developments in transportation diary data collection move us closer to time use diaries, which are also beginning to be accepted for quality-of-life studies (*11*). Transportation surveys, however, may take a variety of forms, depending on the detail required by the data. This, in turn, depends on the types of policy questions that need an answer (see *14*, which provides a wide variety of details on this, in a handbook format).

Here we will consider four types of surveys:

1. Surveys that collect sociodemographic and other background data about persons and their households in the survey sample;
2. Diaries that provide detailed information about what a person and/or a vehicle in the survey sample does for a given length of time;
3. Off-sample background information that may emerge from documents and/or preexisting databases;
4. In-depth surveys that are either group surveys, e.g., of a focus group, or in-depth interviews and interactive engagement of respondents.

Each of these survey methods may prove superior to others in collecting some types of information, at a given cost per item of information, per observed unit. For example, many studies have collected sociodemographic person and household data using a more structured type of questionnaire by telephone (see *15*, *16*, and *17*, among many others). This is sometimes a general background questionnaire, and it may include information about the person interviewed, the household in which the person lives (household is much broader than family), the neighborhood and city where the person resides, and the workplace, if the person is employed. Some surveys collapse this personal information into a household survey that is provided by a household spokesperson. In the past, a survey of this type also included summary “typical” day travel information. This type of questionnaire has been studied extensively in a variety of research contexts well beyond transportation research, and substantial evidence exists that can help us create guidelines for best practice (see *11*, *14*). It is also possible in a survey of this type to attach an attitudinal component that attempts to collect information about respondent values, attitudes, and general preference data (*18*), though in (*14*), the claim is that the capabilities of this type of data collection are limited.

The recognition that respondents would not account for their trip-making correctly (see one of the latest examples, in *19*), e.g., they may omit reporting small unimportant trips and locations close to home and work, provided the rationale to create the travel diary, e.g., a booklet to use for recording everything that happens in a day of the respondent’s life. This is the second type of survey here, and it may take a rich variety of form (*20*). Three popular terms, in order of increasing information content of the diary, are:

1. *strictly travel diaries*, where we record only trips;
2. *activity diaries*, where we record mostly out-of-home activities;
3. *time-use diaries*, where we record almost everything we do in a day, except for very sensitive activities (see also 21).

Background information such as land uses, service characteristics, area sociodemographics, and other macroeconomic indicators that have not been considered central to transportation, is provided by a variety of other methods that, in the same way as their data, have been considered “exogenous” to the transportation analysts’ domain. This is partly due to our need to limit our data collection objectives in light of limited budgets. However, very often these data are not in the format or detail transportation models need. As a result, there are increasing efforts to produce more and better sociodemographic and other “exogenous” data within transportation studies (22, 23). Methods to do this correctly, however, are still under development.

The fourth type of survey in the review here is a derivative of the conjoint analysis and contingent valuation methods in economics (24). In transportation research, this is usually named the stated preference (25), and over time it has evolved into a set of in-depth surveys aiming at different types of measurements (26). Typical information that can be collected using these tools is the possible action by travelers when something new happens in their usual environment. This is the only tool that we have to study transportation options that would cost too much to experiment with in the real world. The outcome of these surveys may be willingness to pay, value of time, and so forth.

Within the in-depth surveys, we may also classify a family of surveys coming under the term “situational approach,” which has received insufficient attention. This survey is better combined with diaries that are complemented with more detailed respondent “debriefings” that attempt to identify the reasons a person made specific choices (the situational dimensions), which are then expressed in terms of objective and subjective constraints with respect to one or more aspects of each trip, e.g., mode (27, 28). These surveys allow us to unveil not only physical and nonphysical constraints travelers face when they choose a mode of travel, but also subjective evaluations and tastes. This is of paramount importance in the context of dynamic models of travel behavior (29). This additional information is obtained at some cost to the respondent, but potentially provides more accurate information about trip rates and the underlying preference structure, e.g., the activity-travel causality, constraints, and so forth.

SUMMARY OF SURVEY ISSUES

Performance of a data collection activity can be cast in terms of survey “performance” that includes data quality for creating a population barometer and/or general models of behavior. Survey performance includes data validity, accuracy, survey reliability, and costs. Each of these dimensions can be defined in terms of many additional dimensions (see 11 for examples). In this paper, we will review some issues with respect to nonresponse, methodologies in survey design, data collection methods (instruments), technology, and data fusion/combination.

Nonresponse

Unit nonresponse, i.e., when members of the sample refuse to take part in the survey, is detrimental to the survey quality only when nonrespondents are systematically different, in their known and unknown characteristics, from their counterpart respondents and/or create such a decrease in sample size that statistics have low power. Within nonresponse, we can include item nonresponse, also named response incompleteness, i.e., leaving blank answers in a questionnaire (e.g., the age or income questions). The factors contributing to nonresponse include

1. respondent burden (30, 31),
2. respondent interest and appeals (30, 32, 33),
3. interviewer capability and training to elicit answers and provide respondents with guidance (34, 35),
4. instrument used (36, 37),
5. assurances of confidentiality for sensitive questions (38),
6. amount and form of payments (11, 17),
7. precontract, reminders and general layout (11, 14),
8. a variety of other supporting tasks in the survey design (39).

In this conference, there are at least two workshops that will be exploring this in more depth (Workshops 2 and 3).

Most important, however, for our workshop is that nonresponse is systematically different across different survey methods and across different survey instruments. This entails that combining either method and/or instruments is more likely to yield a sample that is self-selected in a way that depends on the method and/or the instrument. There is at least one major unresolved issue on this. It is unclear from field research what are the traits of the self-selected respondents to each survey method, because it depends on many other factors. Comparisons, then, are impossible without a well-controlled, and presumably expensive, experiment.

Methodologies in Survey Design

In the methods category, one can include three distinct groups of issues: survey design, temporal considerations, and sampling. Travel survey design has now moved beyond the traditional trip diary format and includes more detailed data on out-of-home activities, in-home activities that may be a substitute for out-of-home activities, or even information on “secondary” activities, i.e., information on the multiple ways that people use their time, e.g., grading exams during your commute trip home, which is also called polychronic time use. The methods can affect nonresponse, item nonresponse, and reporting error. For example, in time-use surveys, we are able to collect information on very short and previously considered unimportant trips and activities, e.g., walk from the parking lot to your office, and we may be able to have more accurate estimates of the time spent in activities and travel (21). However, due to respondent fatigue, we may lose large blocks of information as the survey proceeds. For example, some diary surveys are limited to one-day diaries that cannot capture longitudinal, day-to-day variation in behavior correctly.

Temporal considerations have been dominated by longitudinal survey designs (e.g., panel surveys that are the repeated data collection, every six months or a year, on the same or rotating individuals over time) and multi-day diary designs (e.g., instead of one “representative” day, we include one or more additional days to capture trip-making

variability). Lately, more attention has been paid to some additional time considerations such as day-to-day variation in trip-making, weekday-versus-weekend travel, and more general long-term trends (see 40).

Many of the issues related to temporal considerations will be examined in another workshop within this conference. However, for multi-method surveys, the opportunity and risk of using different methods at different times should also be explored. Most experiments have dealt with different methods and/or instruments within the same time frame. Over time, however, we have seen our instruments change, and from a practical viewpoint, this creates a major problem (41). Since longitudinal surveys allow us to account for respondent heterogeneity in a better way than their counterparts, cross sections and repeated cross sections, and they require a smaller sample size, they may also allow one to incorporate parallel surveys in different time points, while at the same time accounting for survey type, time, and respondent-specific effects. However, all this should be considered in the context of panel-specific problems such as attrition (see, for an example, 13).

Sampling issues have always been a potential problem in travel surveys. This is particularly important when “rare” trip modes need to be represented at a minimum sample size, or when rare population segments or segments with systematic nonresponse patterns need to be oversampled. In an extensive survey on diaries, (11) suggest those “mixed mode” questionnaires could be used for high-mobility households that are hard to reach, precisely because of their mobility. In addition, different sample components based on sociodemographics, space, time, and values/culture may be more appropriately reached using different techniques.

Data Collection Modes (Instruments) and Other Material

In this category, we can identify data collection modes, data items-questionnaire content, and respondent materials. The methods used to collect transportation-specific and transportation-related data can be classified in a variety of ways. With respect to the medium (survey mode) used to exchange information between analysts and respondents, the following is one of the standard classification schemes. When the respondents complete forms on their own (self-completed), we can have three types that depend on the technology used to complete or aid in completing the questionnaires:

1. Self-administered questionnaires (SAQs), using paper and pencil,
2. Computer-assisted, self-administered interviewing (CASI),
3. Audio computer-assisted, self-administered interviewing (ACASI).

When an interviewer plays a significant role in questionnaire administration, i.e., beyond the mere delivery of the instrument, we have

1. Paper and pencil interviewer-administered (PAPI), which is a face-to-face interview;
2. Computer-assisted personal interview (CAPI), which is also a face-to-face interview;
3. Computer-assisted telephone interview (CATI), which is an “ear-to-ear” interview.

The effects on survey accuracy of each of these methods have been studied in detail in the past and have been widely documented in the literature. For example, reporting errors and reporting incompleteness are lower when sensitive questions are asked in SAQ, CASI, and ACASI formats than when an interviewer is present or on the phone (37). On the other hand, however, SAQs, even for the U.S. Census, which is mandated to respondents by law, suffer from severe nonresponse problems. Telephone interviews fail to reach very mobile groups, groups who do not have a phone or who do not list their phone numbers, and persons who use answering machines to shield themselves from salespeople. Computers, used in all their elaborate forms (e.g., recruitment by E-mail, web-based questionnaire submission, and computer- or TV-based multimedia to substitute the intrusion of personal contact), may yield samples that are severely and systematically self-selected, not only with respect to sociodemographic characteristics, but also in terms of values, attitudes, lifestyle, and life philosophies. The threat, then, for multi-instrument surveys is the lack of knowledge in sample composition. The major advantage of using different instruments emerges from the same sources as the threat. Different persons whom we are unable to reach using a set of instruments can be reached using a different set of instruments. The questionnaire content and respondent material issues are dealt with in the following section on the survey stages.

Data Collection Stages

The stages within a data collection exercise have been enumerated as pretest and pilot test, on-line data monitoring, and post-survey validation. Textbook suggestions for pretesting are undoubtedly very clear. Within this stage, different methods are compared and mutually contrasted, verifying what the project budget can afford (42). In addition, during this stage, alternate questionnaire designs are tested. It is at this stage practitioners decide to use multiple modes and instruments, and for this reason, pretesting may be the most important stage for multi-method and multi-instrument designs. In practice, however, very little time is dedicated and very little lead-time is allowed due to project administration (e.g., the lead-time between project start and survey execution may not be sufficient).

The three steps within the pretesting stage are *focus groups* to identify general issues to be considered in the survey, *laboratory cognitive testing* of alternate questionnaires, and *small-scale field study* of all materials to be used in the survey, with possible inclusion of a second cognitive analysis. In addition, from survey research, we learn that automatic procedures to identify problematic questionnaire designs exist, allowing us to design questionnaires that produce comparable data, and this type of pretesting may not cost more than 3% of the total survey cost, yielding a much higher benefit (43).

Data quality is also influenced by the method of administration, the incentive to the respondent, and the joint factors between the two. In addition, this influence is of a different degree when we examine a travel diary than when we examine a hypothetical-scenario survey. The title “respondent materials” was used in the Transportation Research Board’s “Conference on Household Travel Surveys: New Concepts and Research Needs” to encompass a variety of activities with many unresolved issues, which will also be discussed in this conference. These are survey complexity, common-sense use of questionnaires (e.g., activity reporting may be easier to the respondent than trip reporting), layout and visual design, incentives, and respondent-aiding material/instructions. The

survey research literature also reports differential effects of these materials by questionnaire type, as follows:

1. appeal may cause higher response completeness in PAPI (36),
2. some types of payments are associated with higher response rates and retention in panel surveys (17, 44),
3. precontacts and reminder letters increase response rates overall (11, 14),
4. the effect on reporting error is higher in CATI and PAPI, and it is also present in SAQ (45, 46),
5. context affects reporting error in PAPI, CATI, and SAQ (46),
6. the direction of referent comparison is influential in binary comparisons that are important for stated preference surveys (47).

In addition, the effect of wording has been confirmed in (48, 49), and its effect depends on other factors such as the gender of the interviewer. Indeed, females were found to provide more reliable data when skip-sequencing questionnaires are used (50). The effect of question format was found higher in SAQ (45), while the choice of completion in CAPI is affected by respondent literacy, vision, and motivation, and no cultural effect was found on response rates across diverse cultures when total design method is used (51).

Technology

Technology tools are increasingly developed to meet a variety of survey needs. For example, in the recent past, the use of computers with telephone interviews was considered an advanced technology. Today, the use of Geographic Information Systems (GIS—an electronic map to which is attached a sophisticated relational database) is another “new” technology that is becoming part of the practitioner’s toolbox (52). Other technology tools include touch-screen capabilities to collect data at intercept surveys (53), and video imaging for cordon surveys (8). In addition, the use of Geographic Positioning Systems (GPS) has also been offered as a potential solution to respondent labor intensity (54), with an experiment completed in the U.S. (55). All these tools can help the multi-method, multi-instrument surveys in a number of different ways. However, most central to our workshop is the use of the new hardware and software generation. At least in the U.S., one can purchase portable, multimedia fast-processing machines and software to create complete interactive video-audio interfaces combined with maps, pictures, and movies. Indeed, this has been acknowledged by some researchers (11, among others). A few potential benefits of heavier technology use can be

1. Use of technology may decrease labor costs and processing time, thus leaving some breathing room in the budget for experimentation.
2. Use of computer software technology allows substitution of key inhibitors, e.g., the interviewer, when sensitive questions are asked, and at the same time provide detailed and clear instructions on how to complete the survey, e.g., by multimedia survey design.
3. Surveys can be designed as a pleasant (fun) game. This may improve nonresponse for interactive in-depth surveys that can be administered wherever the respondent desires.

4. Some technology may decrease response latency, i.e., the time it takes to answer a question (48), which in turn may decrease the time it takes to complete the entire survey session. This may increase willingness to participate.

Very little is known, however, about survey participation and technology of the type described above. In addition, a cost-benefit and cost-effectiveness analysis may show that, under some circumstances, e.g., personnel training costs and technology development, more traditional approaches are preferable.

Data Fusion/Combination

The combination of data from different sources has a long history in transportation studies. Most textbooks on transportation planning models contain examples on how one can “derive” trip patterns in a region by merging data from households (the trip production stage in trip generation) with data from business attractiveness patterns (the trip attraction stage in trip generation), which then are combined together and weighted according to a weight of “faith” in one or the other stage (56). In a similar way, one can devise a variety of ways to combine data sources and surveys. For example:

1. Create an institutional structure that aims at harmonizing key surveys and survey items to ensure comparability. One such attempt is currently done by EUROSTAT, CEMT, and UNO to harmonize national and international transportation statistics (57) and suggestions for expansion of this scheme have been provided to DGVII of the European Commission (58). In addition, analysts (e.g., 59) have identified the following as key actions to move toward integration: (a) modify questionnaires so that reference variables, i.e., anchor items, can be inserted to link different databases; and (b) create uniform classifications to allow comparisons, e.g., use the same definition of activity-travel behavior variables.

2. Create a “technology-transfer” structure to move into practice sophisticated statistical methods. Statistical-econometric techniques to combine databases (also called data fusion) have been used in a variety of settings (60, 61). In addition, disaggregation of externally provided input data (sociodemographic microsimulation and/or allocation methods) has been used in research settings (22, 62), and some of these techniques have been used in practice (9, 10). These methods offer a promising direction for integrating databases, but they have not received the necessary scrutiny to become widespread recommended practice.

3. Qualitative survey research methods are considered to be “open survey methods.”

These are, by definition, in-depth respondent surveys, and they include three types of surveys: (a) an informal conversational interview that relies on spontaneous generation of questions; (b) a general interview guide approach outlining a set of topics to be explored with each respondent, much like in a focus group setting in which the order and the wording of the questions are not predetermined; and (c) a standardized open-ended interview that involves a predetermined sequence and wording of the same set of questions to be asked of each respondent, to minimize the possibility of bias. Unlike quantitative research methods, the loose structure of the survey allows respondents to express the phenomenon under study in their own ways. This allows us to gain more insights about

transportation from the respondent's viewpoint. This type of interview setting has been used in transportation surveys to formulate the issues in a study through the focus group approach, and then decide what questions to include in questionnaires, leading to a quantitative analysis. Popular methods in other fields, such as the "case study" approach used in educational research (63), have not been used productively in transportation practice.

A related point concerns the use of "triangulation," which is the combination of research methods, qualitative and quantitative, in the same study to examine the same phenomenon, e.g., trip making by a household's members, and the relationship of trip-making within the household. Advocates of this way of doing research will state that (64) triangulation (a) increases the researchers' confidence in their results; (b) creates the setting to invent new methods; (c) helps uncover "deviant" behaviors and deviations from theoretical models; (d) allows synthesizing of theories; (e) functions as a test for competing theories; and (f) provides analysts with increased closeness to the problem at hand. The role of qualitative research methods in such a context is to function as the "glue" of all constituent quantitative and qualitative information component parts. However, this way of combining information suffers from mainly two problems: (a) it may become very expensive; and (b) replication of the results and procedure(s) may be impossible.

In terms of combining information from different data sources, in a quantitative context, we can identify two distinct data analysis stages. The first stage is the exploratory analysis that aims at quantifying possible biases emerging from different components of a survey. This has been done in more detail in panel surveys (see 65, on the Dutch National Mobility Panel, and 13, on the Puget Sound Transportation Panel). In this stage, researchers can assess the relative magnitude of biases emerging from the different survey components and take some remedial action, e.g., create sample weights or models that quantify the biases. In a similar fashion, the second stage, of behavioral modeling, can combine data from different sources to "enrich" the models in terms of their capability in depicting and predicting human behavior. One example is the recent popularity of combining observed-behavioral with hypothetical-scenario data (66 and other papers in the same issue). In essence, the data fusion in this case requires data on choices made by individuals in the real world and in a set of hypothetical scenarios that contain the same choice attributes, for which we change their levels. Then, the data are pooled together, and scaling is used to combine the different data sets accounting for differing variances within the data emerging from each source (observed-behavior versus hypothetical-scenario responses).

During these stages, we find the same attempt to distinguish among components of variation and account for them in model estimation. These components are due to observed heterogeneity in responses that can be explained by respondent characteristics and/or trip making circumstances, differences in responses that are due to survey method(s) and instrument(s) used, differences in responses that are due to the time period of the survey (time of day, day of week, season, year, and so forth), and unobserved time-varying and time-invariant factors. To separate, identify, and provide quantitative estimates for each of these "components of variation" for a given sample, one needs to design a survey as a "repeated measures experiment." Unlike current practice, which uses survey pretesting to examine alternate questionnaire design formats and accompanying material, the suggested pretesting here aims at assessing the magnitude of components of

variance and survey biases, which is a much more valuable argument to survey-sponsoring agencies. By neglecting this issue in a survey, we are inflating behavioral variation by confounding it with variation that emerges from survey design sources.

CHALLENGES AND WORKSHOP THEMES FOR GOOD PRACTICE

The lessons learned from the survey research literature presented above are not very clear for multi-method/multi-instrument surveys. This is in agreement with state-of-the-art reviews on mixed-mode survey designs, such as in (67, p. 546). In this section, an attempt is made to first define four broader workshop themes, their associated challenges to good practice, and preliminary guidelines for best practice. This, in turn, is followed by a brief summary of two multiple-approach survey types considered by this workshop, and the four fundamental areas for which workshop participants developed guidelines for good practice.

Selectivity and Sample Representation

Different survey methods are considered better for a given type of data, e.g., documentary searches for historic sociodemographic information, census data for current general information data, and sample surveys for more in-depth current data. Similarly, different instruments are used to collect different data items, e.g., sociodemographic information is best collected by telephone interviews because of cost; however, income and other sensitive information are collected better by self-administered methods. In addition, detailed diaries are better used to unveil complete trip patterns and do not rely on respondents' memory. On the other hand, however, complex tasks that require considerable work by the respondent should be facilitated by personal assistance that may exceed current, but not future, computer-aided applications capabilities.

Systematic unit and item nonresponse may be observed when we vary survey methods and survey instruments. When this systematic pattern can be explained and modeled using quantitative methods, its detrimental effect is mitigated. The real threat comes from no action to diagnose it early in survey execution, so that it becomes an unobserved yet systematic pattern. In addition, sample component characteristics by survey method and survey instrument type should be clearly documented in detail so that other practitioners can understand the strengths and limitations of each application. A related issue regards different instruments that are more likely to be used by systematically different respondents. This systematic pattern should be considered by design and taken into account in data analysis, and procedures to make the sample represent the target population should be undertaken. It is only under these conditions that a multi-method and multi-instrument survey design can be considered a suitable way to reach hard-to-get sampling units. However, the use within the same project of mixed modes to collect the same or similar information may inevitably create parallel surveys, the data of which may be neither comparable nor combinable, except for some notable examples discussed in this paper, and they should be used separately for model creation.

Testing and Experimentation

Pretesting of surveys is very often done in short time frames and without polling current practice and methodological developments. This may lead to a lost opportunity in creating well-organized and well-designed surveys. Lack of extensive experimentation does not

allow knowledge to be gained about what may happen during the formal survey, during which it may be too late to recover from mistakes. Multi-instrument surveys require substantially more time dedicated to the design and testing of respondent-aiding material. The material provided to respondents needs to be tailored to the instrument itself, and this in turn increases the survey costs, budget, and, potentially, lead time needed. In addition, longitudinal surveys are able to control for many more factors than cross-sectional surveys (see the paper by Pendyala and Pas and the multi-day and multi-period workshop summary in this volume). This makes them a unique candidate to explore parallel survey designs, use as pretests of later surveys, and create, in this way, a well-controlled multi-method and multi-instrument survey. It is also imperative to allow for longer time frames for pretesting and piloting surveys, and we should allocate much longer times and larger budgets for pretesting multi-method and multi-instrument surveys.

Harmonizing Surveys and Survey Items

Harmonizing surveys and allowances for anchor data items are needed that allow one to compare different databases emerging from different survey methods and instruments, e.g., the definition of a trip. Harmonization of survey questionnaires and item anchoring have been suggested as tools for data integration. Related to this is also the emergence of new technologies that may help us design better methods to record information about respondents and to administer surveys more efficiently.

Information Fusion

Statistical data fusion/combination techniques have been suggested as potential methods to integrate databases. One such example is the “mixed estimation” of choice models using revealed and stated preference data. Some practitioners are using these methods, reporting positive and negative experience. In addition, qualitative research methods allow us to unveil what is important to the transportation system user, providing more in-depth information than other quantitative approaches. For example, focus groups have helped us design better surveys, unveiling, early during a study, issues to be considered. There may be other uses of qualitative research that have not been explored in transportation studies. The use of different methods to study the same phenomenon (triangulation) may provide strength to the research results when all methods lead to the same or similar conclusions. However, large differences in results from different methods have been observed and considered as a threat. The workshop should identify specific “case studies” that can be used by practitioners as benchmark studies to design their own surveys accordingly.

Early on during the workshop, for reasons of tractability, multiple approaches were divided into two types, based on two specific objectives. The first type emerges from the necessity to reach different segments using dissimilar techniques. The second type emerges from the need to use different techniques to unveil different aspects of the same problem that we examine from different perspectives. The workshop participants explored guidelines that are specific to the multiple-approach surveys on sampling, survey design, survey administration, data compilation, and survey documentation. In addition, the advantages and potential risks of using surveys with multiple approaches were also identified (see the workshop report in this volume).

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Workshop Summary

José Viegas

CESUR - Instituto Superior Técnico

INTRODUCTION

The use of multiple instruments and methods in conducting transport surveys is quite common, but this is recognised to happen with varying scopes and for different reasons. The group thus felt an advantage to unify the designation, expressing multiplicity of "approaches", as well as to clarify the circumstances under which this multiplicity is found.

Situations on which multiple approaches to a survey are needed have been grouped in two types:

- Type A - We basically want one set of data, but we use multiple approaches because they allow better capture of the characteristics of certain segments or an alternative reading of certain aspects; In this type we have general purpose surveys (which are conducted as a basis of information, and are generally repeated at regular intervals) and special purpose surveys (which are conducted in the framework of a particular study);
- Type B - We are studying a very complex problem, which requires observation from different perspectives, yielding different types of data;

Whereas in situations of type A, the initial choice would probably be a single approach survey, and we are pushed to using multiple approaches for reasons of better representation of (some aspects of) the reality, in situations of type B, the initial choice would probably be a multi-approach survey, although we may be pulled away from those multiple approaches by reasons of budget or time available;

The introduction of this typology allows a more focused discussion of the remaining points and problems occurring in the preparation and administration of the surveys as it happens that they can be rather different from one type of situation to the other.

ADVANTAGES AND RISKS OF USING MULTIPLE APPROACHES

Whatever the situation, opting for a multi-approach survey always means the development of more complex operations, and must thus be the result of careful considerations, involving the advantages and difficulties that such an option entails.

Along the discussion of the advantages and risks of such an option, we have frequently come across technical problems that were to be targeted by other workshops (i.e. non-response, respondent burden, etc.). The option taken was to avoid in-depth discussion of such points, limiting the work of this group to the question of whether multiple approaches made such problems worse or relieved them.

The following tables (Table 1 and 2) summarize the main advantages and risks of multi-approach surveys:

TABLE 1 Advantages and Risks of Using the Type A Survey Approach

Type A	
Advantages	Consistency checking of key variables Custom design for different segments Use of multiple sources of information may help reduce respondent burden Helps understand nonresponse Targeted observation reduces variable costs Stronger learning factor for future surveys
Risks	Higher complexity, requiring higher technical and organizational skills Data compilation is essentially more difficult Requires better ex-ante knowledge about population and its variations Instrument Specific variations (bias) Good documentation is critical Probably higher fixed costs

TABLE 2 Advantages and Risks of Using the Type B Survey Approach

Type B	
Advantages	Allows multiple perception of a single problem. (If the problem is rather complex, may be the only solution) Allows testing of more comprehensive theories
Risks	Requires sensible aggregation of multiple perceptions (for explanation and communication) Greater organizational complexity Good documentation is critical

Multiple approaches are also often used to provide consistency checking, even if the intended results could be obtained through a single approach. This is especially important when dealing with large-scale surveys, for which the high cost must be counterbalanced by a strong guarantee of consistent results.

When large-scale surveys are carried out frequently (every one or two years), a single approach may be sufficient, because longitudinal comparisons provide a good tool for consistency checking. If, on the other hand, these large scale surveys are repeated at large periods (every 5 or 10 years), longitudinal comparisons are much more subject to failure and a cross-section consistency checking (with other readings of some key variables) is recommended.

GUIDELINES FOR GOOD PRACTICE

Being aware of the added difficulties of a multiple approach survey, and still deciding to carry it on, it is important to know what are the main points to be observed and the main pitfalls to avoid.

The remainder of the discussion of the group was centred on the production of Guidelines regarding good practice of these surveys, treating in succession five different areas of the process of data collection and treatment: sampling, survey design, survey administration, data compilation, documentation. To ensure clarity of the recommendations, they are presented here as bulleted lists, each item accompanied by a short text that should make the justification for each recommendation clear to the reader.

In doing this, the focus of our discussion (and of these notes) has been on the aspects that are especially important when dealing with multiple approaches, although of course the key elements of good practice in each of the chosen approaches must still be considered.

On Sampling

- Be aware of implications of sampling strategies, as they may bias representation of different population segments;
 - When multiple approaches are being used just because of non-response, explore first the possibilities of higher response, in particular by improving the information to the potential respondents of their advantage in co-operating, and by promising adequate forms of feed-back to them of the most relevant results of your survey work;
 - Determine simple sampling strategy for each population segment, on the basis of appropriateness, cost effectiveness, and precision of representation. This must be well documented for correct compilation;
 - When covering different aspects of a problem with sub-samples (type B situation), control for bias in the constitution of sub-samples with respect to the main sample, which may be especially critical in the case of self-selection. For this purpose, it may be necessary to include some variables in the questionnaire for this purpose alone;

On Survey Design

- Type A surveys may be of two kinds: same data and population, with different instruments; similar data, different populations, same or different instruments;
 - In either case, content and design formats of various approaches must be compatible. In particular, survey definitions and questions must have the same understanding for all respondents;
 - Whenever possible, survey design must be done in close co-ordination with the requirements of modellers and practitioners who will be making use of the data to be gathered;
 - Prepare for combination of data from various sources from the outset;
 - Include core variables in design of all approaches, and whenever possible use control groups of one approach in segments covered by other approaches in order to estimate instrument induced variations;

- Use same basic pre-contact material for all groups to ensure consistency. Some additional material may be needed for specific groups, namely for motivation;
- Pre-testing of every approach is very important both for administration and data compilation;
 - When using different languages, check forward and backward translation of all the terms and concepts used;
 - Develop explanatory material (with positive glossary - what each term means - and negative glossary - what each term does not mean);
 - When seeking different perspectives of problem (type B situation) check for language consistency across disciplines;

On Survey Administration

- Training messages for interviewers must be consistent across all instruments;
- Quality procedures must be consistent across all instruments;
- Set-up a process for collecting and analysing data on non-responses and refusals across instruments, in order to better manage repeated pressure for response (on same instrument), re-addressing (change of instrument) or weighting of remaining non responses;
 - When approaching social groups with specific cultures or lifestyles, try to use interviewers with good knowledge of those groups (or even part of them);

On Data Compilation

- Tag all records with information about population segment, instrument and interviewer;
 - All compilation must be done in conformity with previous stages. In particular, weighting and expansion must be done in line with sampling strategy, first within sample segments and then across segments;
 - Identify variables which can be compared across segments;
 - Non-response must be analysed separately for each segment;
 - Scale variances of population segments because random affects cannot be assumed the same before pooling data;
 - When joining data from different sources, key element is to understand the bias associated to each source and try to correct for it, before actually merging the data;
 - The information reported in the literature about instrument specific deviations (bias) should be compiled and included in an annex to these Guidelines. Since these deviations may tend to vary over time, large scale surveys should have as one of their goals the regular updating of this information, so that small scale surveys can always proceed with acceptable safety in using it;

On Documentation

- Main goals of documentation are possibility of replication, further analysis of the data by others, and deeper understanding of process;

- Extra care must be exerted in documenting all stages of the process: strategy underlying the choice of multiple approaches, and for each of them sampling procedures and sample sizes, cross-checks made and their results, etc.
- When using undocumented data from other sources, include assumptions made about it in documentation;
- When documenting and archiving questionnaires that have been administered electronically, a version based on paper (flow chart for instance) should be available for better understanding of the structure and contents of those questionnaires;

CONCLUDING REMARKS

The discussion has shown that there seems to be a lack of published material specifically related to the questions arising when dealing with multi-approach surveys. Most papers and reports cover questions of technical detail, but a small collection of well presented case studies, showing the difficulties, the options available and finally chosen, and the general ex-post appraisal of the endeavour would be of great value.