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International Handbook of Survey Methodology



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Preface

In August, 2003, two of us (De Leeuw and Dillman) met in Berlin at the International Statistical Institute meetings to teach a short course on survey design. The audience consisted of surveyors from most continents of the world. Our first impressions were how different the data collection and analysis problems were that people faced, for example doing face-to-face interviews in rural villages of Uganda and web surveys of the general population in The Netherlands and Denmark. Our second, and more lasting impression, was how much all of the participants had in common. Regardless of country, all of the surveyors in the room had to deal with sample designs, writing questions, turning those questions into meaningful questionnaires, locating sample units, processing data, and analyzing the results.

Procedures we originally thought to be of interest only to those from certain countries, such as visual design for mail and web questionnaires, turned out to be of equal interest to those from developing countries who were concerned with more effective visual layouts for interviewer questionnaires and instructions. The idea for this *International Handbook of Survey Methodology* originated from this experience of two fascinating days with this diverse audience with many common needs and interests.

Our experience there was bolstered further by observations of the difficulties being faced in mounting surveys across national borders, and increased concern that they have to be done. For example, expansion of the European Union from 6 countries in 1957 to 15 countries in 1995 (with 9 candidate-members in 2006), has increased interest in collecting cross-national statistical information, including information from sample surveys. We have also observed with much interest emergent efforts to regularly conduct polls and surveys across continents. These surveys aim to facilitate comparisons of responses across countries widely separated in space, as well as technological development, and economic well-being. All this survey effort has resulted in greater concern about how survey methods unique to one country compare to those used in other countries, and how well questionnaire formats and items translate across cultures. It is also difficult to maintain using the same survey mode in all countries.

Within many countries we have noticed the trend towards mixed-mode surveys that is now occurring. Concerns about coverage and nonresponse in telephone surveys, rising costs for conducting face-to-face interviews, and the emergence of web survey capabilities that only some households have, are all encouraging surveyors to mix modes

We are entering a new era in survey design, in which surveyors throughout the world must think about the fundamentals of survey data collection and methods of turning answers to questions into meaningful results. Increasingly it is a mixed-mode world. Whereas at one time it was possible to learn a single survey mode, e.g., face-to-face interviewing or telephone interviewing, and apply it to all survey situations, doing that is no longer possible. It is now imperative for students and practitioners of surveying to

learn the procedures associated with multiple modes of collecting sample survey information and apply the method or combination of methods that fit their specific situation.

This handbook provides expert guidance from acknowledged survey methodologists and statisticians around the world, who bring their experiences to bear on issues faced in their own and other countries. It serves as an excellent text for courses and seminars on survey methodology at the masters and graduate level. It is a key reference for survey researchers and practitioners around the world. The book is also very useful for everyone who regularly collects or uses survey data, such as researchers in psychology, sociology, economics, education, epidemiology, and health studies and professionals in market and public opinion research.

The book consists of five parts: foundations, design, implementation, data analysis, and quality issues. The book begins by focusing on the foundations of all sample surveys, ranging from sources of survey error to ethical issues of design and implementation. It is followed by a design section, which gives building blocks for good survey design, from coverage and sampling to writing and testing questions for multiple survey modes. The third section focuses on five modes of data collection, from the oldest, face-to-face interviews, to the newest, interactive voice response, ending with the special challenges involved in mixing these modes within one survey. The fourth section turns to analyzing survey data, dealing with simple as well as complex surveys, and procedures for nonresponse adjustment through imputation and other means. The fifth and final section focuses on special issues of maintaining quality and of documenting the survey process for future reference. The first chapter of the book, *The cornerstones of survey research*, ends with a more detailed description of the structure and contents of this book. There is a companion website <http://www.xs4all.nl/~edithl/surveyhandbook>.

As we move further into the 21st century, surveys will become inherently more international in scope and in practice. It is our hope that this book will prove helpful for those who are learning the craft of surveying, which like other life skills, will increasingly be applied beyond one's country of origin.

We thank our colleagues across the world for many lively and stimulating discussions about survey methodology. We also thank our students who inspired us and especially the master class in survey methodology 2006 who enthusiastically and critically discussed the drafts. The final book has profited from close reading and copy-editing by Mallory McBride, Sophie van der Zee, Evert-Jan van Doorn, and Amaranta de Haan. We thank Allison O'Neill for her creative cover design. We also thank Emily Wilkinson and Debra Riegert of Lawrence Erlbaum Associates for their patience and careful prodding in getting this book done.

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Chapter 1

The Cornerstones of Survey Research

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1.1 INTRODUCTION

The idea of conducting a survey is deceptively simple. It involves identifying a specific group or category of people and collecting information from some of them in order to gain insight into what the entire group does or thinks; however, undertaking a survey inevitably raises questions that may be difficult to answer. How many people need to be surveyed in order to be able to describe fairly accurately the entire group? How should the people be selected? What questions should be asked and how should they be posed to respondents? In addition, what data collection methods should one consider using, and are some of those methods of collecting data better than others? And, once one has collected the information, how should it be analyzed and reported? Deciding to do a survey means committing oneself to work through a myriad of issues each of which is critical to the ultimate success of the survey.

Yet, each day, throughout the world, thousands of surveys are being undertaken. Some surveys involve years of planning, require arduous efforts to select and interview respondents in their home and take many months to complete and many more months to report results. Other surveys are conducted with seemingly lightning speed as web survey requests are transmitted simultaneously to people regardless of their location, and completed surveys start being returned a few minutes later; data collection is stopped in a few days and results are reported minutes afterwards. Whereas some surveys use only one mode of data collection such as the telephone, others may involve multiple modes, for example, starting with mail, switching to telephone, and finishing up with face-to-face interviews. In addition, some surveys are quite simple and inexpensive to do, such as a mail survey of members of a small professional association. Others are incredibly complex, such as a survey of the general public across all countries of the European Union in which the same questions need to be answered in multiple languages by people of all educational levels.

In the mid-twentieth century there was a remarkable similarity of survey procedures and methods. Most surveys of significance were done by face-to-face interviews in most countries in the world. Self-administered paper surveys, usually done by mail, were the only alternative. Yet, by the 1980s the telephone had replaced face-to-face interviews as the dominate survey mode in the United States, and in the next decade telephone surveys became the major data collection method in many countries. Yet other methods were emerging and in the 1990s two additional modes of surveying—the Internet and responding by telephone to prerecorded interview questions, known as Interactive Voice Response or IVR, emerged in some countries. Nevertheless, in some countries the face-to-face interview remained the reliable and predominantly used survey mode.

Never in the history of surveying have there been so many alternatives for collecting survey data, nor has there been so much heterogeneity in the use of survey methods across countries. Heterogeneity also exists within countries as surveyors attempt to match survey modes to the difficulties associated with finding and obtaining response to particular survey populations.

Yet, all surveys face a common challenge, which is how to produce precise estimates by surveying only a relatively small proportion of the larger population, within the limits of the social, economic and technological environments associated with countries and survey populations in countries. This chapter is about solving these common problems that we described as the cornerstones of surveying. When understood and responded to, the cornerstone challenges will assure precision in the pursuit of one's survey objectives.

1.2 WHAT IS A SURVEY?

A quick review of the literature will reveal many different definitions of what constitutes a survey. Some handbooks on survey methodology immediately describe the major components of surveys and of survey error instead of giving a definition (e.g., Fowler, Gallagher, Stringfellow, Zalavsky Thompson & Cleary, 2002, p. 4; Groves, 1989, p. 1), others provide definitions, ranging from concise definitions (e.g., Czaja & Blair, 2005, p. 3; Groves, Fowler, Couper, Lepkowski, Singer & Tourangeau, 2004, p. 2; Statistics Canada, 2003, p. 1) to elaborate descriptions of criteria (Biemer & Lyberg, 2003, Table 1.1). What have these definitions in common? The survey research methods section of the American Statistical Association provides on its website an introduction (Scheuren, 2004) that explains survey methodology for survey users, covering the major steps in the survey process and explaining the methodological issues. According to Scheuren (2004, p. 9) the word survey is used most often to describe a method of gathering information from a sample of individuals. Besides sample and gathering information, other recurring terms in definitions and descriptions are systematic or organized and quantitative. So, a survey can be seen as a research strategy in which quantitative information is systematically collected from a relatively large sample taken from a population.

Most books stress that survey methodology is a science and that there are scientific criteria for survey quality. As a result, criteria for survey quality

have been widely discussed. One very general definition of quality is fitness for use. This definition was coined by Juran and Gryna in their 1980s book on quality planning and analysis, and has been widely quoted since. How this general definition is further specified depends on the product that is being evaluated and the user. For example, quality can be focusing on construction, on making sturdy and safe furniture, and on testing it. Like Ikea, the Swedish furniture chain, that advertised in its catalogs with production quality and gave examples on how a couch was tested on sturdiness. In survey statistics the main focus has been on accuracy, on reducing the mean squared error or MSE. This is based on the Hansen and Hurwitz model (Hansen, Hurwitz, & Madow, 1953; Hansen, Hurwitz, & Bershad, 1961) that differentiates between random error and systematic bias, and offers a concept of total error (see also Kish, 1965), which is still the basis of current survey error models. The statistical quality indicator is thus the MSE: the sum of all squared variable errors and all squared systematic errors. A more modern approach is total quality, which combines both ideas as Biemer and Lyberg (2003) do in their handbook on survey quality. They apply the concept of fitness for use to the survey process, which leads to the following quality requirements for survey data: accuracy as defined by the mean squared error, timeliness as defined by availability at the time it is needed, and accessibility, that is the data should be accessible to those for whom the survey was conducted.

There are many stages in designing a survey and each influences survey quality. Deming (1944) already gave an early warning of the complexity of the task facing the survey designer, when he listed no less than thirteen factors that affect the ultimate usefulness of a survey. Among those are the relatively well understood effects of sampling variability, but also more difficult to measure effects. Deming incorporates effects of the interviewer, method of data collection, nonresponse, questionnaire imperfections, processing errors and errors of interpretation. Other authors (e.g., Kish, 1965, see also Groves, 1989) basically classify threats to survey quality in two main categories, for instance differentiating between errors of nonobservation (e.g., nonresponse) and observation (e.g., in data collection and processing). Biemer and Lyberg (2003) group errors in sampling error and nonsampling error. Sampling error is due to selecting a sample instead of studying the whole population. Nonsampling errors are due to mistakes and/or system deficiencies, and include all errors that can be made during data collection and data processing, such as coverage, nonresponse, measurement, and coding error (see also Lyberg & Biemer, Chapter 22).

In the ensuing chapters of this handbook we provide concrete tools to incorporate quality when designing a survey. The purpose of this chapter is to sensitize the reader to the importance of designing for quality and to introduce the methodological and statistical principles that play a key role in designing sound quality surveys.

A useful metaphor is the design and construction of a house. When building a house, one carefully prepares the ground and places the cornerstones. This is the foundation on which the whole structure must rest. If this foundation is not designed with care, the house will collapse or sink in the unsafe, swampy underground as many Dutch builders have experienced in the past. In the same way, when designing and constructing a survey, one should also lay a well thought-out foundation. In surveys, one starts with preparing the underground

by specifying the concepts to be measured. Then these clearly specified concepts have to be translated, or in technical terms, operationalized into measurable variables. Survey methodologists describe this process in terms of avoiding or reducing specification errors. Social scientists use the term construct validity: the extend to which a measurement method accurately represents the intended construct. This first step is conceptual rather than statistical; the concepts of concern must be defined and specified. On this foundation we place the four cornerstones of survey research: coverage, sampling, response, and measurement (Salant & Dillman, 1994; see also Groves, 1989).

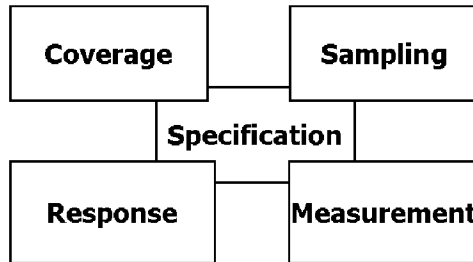


Figure 1.1 The cornerstones of survey research

Figure 1.1 provides a graphical picture of the cornerstone metaphor. Only when these cornerstones are solid, high quality data are collected, which can be used in further processing and analysis. In this chapter we introduce the reader to key issues in survey research.

1.3 BREAKING THE GROUND: SPECIFICATION OF THE RESEARCH AND THE SURVEY QUESTIONS

The first step in the survey process is to determine the research objectives. The researchers have to agree on a well-defined set of research objectives. These are then translated into a set of key research questions. For each research question one or more survey questions are then formulated, depending on the goal of the study. For example, in a general study of the population one or two general questions about well-being are enough to give a global indication of well-being. On the other hand, in a specific study of the influence of social networks on feelings of well-being among the elderly a far more detailed picture of well-being is needed and a series of questions has to be asked, each question measuring a specific aspect of well-being. These different approaches are illustrated in the text boxes noted later.

Example General Well-being Question (Hox, 1986)

Taking all things together, how satisfied or dissatisfied are you with life in general?

- ☐ VERY DISSATISFIED
- ☐ DISSATISFIED
- ☐ NEITHER DISSATISFIED, NOR SATISFIED
- ☐ SATISFIED
- ☐ VERY SATISFIED

Examples General + Specific Well-being Questions (Hox, 1986)

Taking all things together, how satisfied or dissatisfied are you with *life in general*?

- ☐ VERY DISSATISFIED
- ☐ DISSATISFIED
- ☐ NEITHER DISSATISFIED, NOR SATISFIED
- ☐ SATISFIED
- ☐ VERY SATISFIED

Taking all things together, how satisfied or dissatisfied are you with *the home in which you live*?

- ☐ VERY DISSATISFIED
- ☐ DISSATISFIED
- ☐ NEITHER DISSATISFIED, NOR SATISFIED
- ☐ SATISFIED
- ☐ VERY SATISFIED

Taking all things together, how satisfied or dissatisfied are you with *your health*?

Taking all things together, how satisfied or dissatisfied are you with *your social contacts*?

Survey methodologists have given much attention to the problems of formulating the actual questions that go into the survey questionnaire (cf. Fowler & Cosenza, Chapter 8). Problems of question wording, questionnaire flow, question context, and choice of response categories have been the focus of much attention. Much less attention has been directed at clarifying the problems that occur *before* the first survey question is committed to paper: the process that leads from the theoretical construct to the prototype survey item (cf. Hox, 1997). Schwarz (1997) notes that large-scale survey programs often involve a large and heterogeneous group of researchers, where the set of questions finally agreed upon is the result of complex negotiations. As a result, the concepts finally adopted for research are often vaguely defined.

When thinking about the process that leads from theoretical constructs to survey questions, it is useful to distinguish between conceptualization and operationalization. Before questions can be formulated, researchers must decide which concepts they wish to measure. They must define they intend to measure by naming the concept, describing its properties and its scope, and defining important subdomains of its meaning. The subsequent process of operationalization involves choosing empirical indicators for each concept or each subdomain. Theoretical concepts are often referred to as 'constructs' to emphasize that they are theoretical

concepts that have been invented or adopted for a specific scientific purpose (Kerlinger, 1986). Fowler and Cosenza's (Chapter 8) discussion of the distinction between constructs and survey questions follows these line of reasoning.

To bridge the gap between theory and measurement, two distinct research strategies are advocated: a theory driven or top down strategy, which starts with constructs and works toward observable variables and a data driven or bottom up strategy, which starts with observations and works towards theoretical constructs (cf. Hox & De Jong-Gierveld, 1990). For examples of such strategies we refer to Hox (1997).

When a final survey question as posed to a respondent fails to ask about what is essential for the research question, we have a specification error. In other words, the construct implied in the survey question differs from the intended construct that should be measured. This is also referred to as a measurement that has low construct validity. As a result, the wrong parameter is estimated and the research objective is not met. A clear example of a specification error is given by Biemer and Lyberg (2003, p. 39). The intended concept to be measured was "...the value of a parcel of land if it were sold on a fair market today." A potential operationalization in a survey question would be "For what price would you sell this parcel of land?" Closer inspection of this question reveals that this question asks what the parcel of land is subjectively worth to the farmer. Perhaps it is worth so much to the farmer that she/he would never sell it at all.

There are several ways in which one can investigate whether specification errors occur. First of all, the questionnaire outline and the concept questionnaire should always be thoroughly discussed by the researchers, and with the client or information users, and explicit checks should be made whether the questions in the questionnaire reflect the study objectives. In the next step, the concept questionnaire should be pretested with a small group of real respondents, using so called cognitive lab methods. These are qualitative techniques to investigate whether and when errors occur in the question-answer process. The first step in the question answer process is understanding the question. Therefore, the first thing that is investigated in a pretest is if the respondents understand the question and the words used in the question as intended by the researcher. Usually questions are adapted and/or reformulated, based on the results of questionnaire pretests. For a good description of pretesting, methods, see Campanelli Chapter 10. Whenever a question is reformulated, there is the danger of changing its original (intended) meaning, and thus introducing a new specification error. Therefore, both the results of the pretests and the final adapted questionnaire should again be thoroughly discussed with the client.

1.4 PLACING THE CORNERSTONES: COVERAGE, SAMPLING, NONRESPONSE, AND MEASUREMENT

As noted earlier, specification of the research question and the drafting of prototype survey questions are conceptual rather than statistical; it concerns the

construct validity of the measurement. In other words, does the question measure what it is supposed to measure, does it measure the intended theoretical construct (Cronbach & Meehl, 1955). In contrast, the sources of data collection error summarized in our four cornerstones can be assessed statistically by examining the effect they have on the precision of the estimates. Three of the four cornerstones refer explicitly to the fact that surveys typically collect data from a sample, a fraction of the population of interest. *Coverage error* occurs when some members of the population have a zero probability of being selected in the survey sample. For example, the sample list (frame) may fail to cover all elements of the population to which one wants to generalize results. *Sampling error* occurs because only a subset of all elements (people) in the population is actually surveyed. Sampling error is statistically well understood provided that probability samples are used: in general the amount of sampling error is a direct function of the number of units included in the final sample. For a clear discussion of coverage and sampling, see Lohr (Chapter 6). *Nonresponse error* occurs when some of the sampled units do not respond and when these units differ from those who do and in a way relevant to the study. For an introduction into nonresponse and nonresponse error, see Lynn (Chapter 3). The last cornerstone is *measurement error*, which occurs when a respondent's answer to a question is inaccurate, departs from the "true" value (see also Hox, Chapter 20).

A perfect survey would minimize all four sources of errors. Coverage error is avoided when every member of the population has a known and nonzero chance of being selected into the survey. Sampling error is reduced simply by sampling enough randomly selected units to achieve the precision that is needed. Nonresponse error is avoided if everyone responds or if the respondents are just like the nonrespondents in terms of the things we are trying to measure. Measurement error can be prevented by asking clear questions; questions that respondents are capable and willing to answer correctly. In the survey design stage the methodological goal is to prevent or at least reduce potential errors; in the analysis stage the statistical goal is to adjust the analysis for errors in such a way that correct (i.e., unbiased and precise) results are produced. The methodological survey literature suggests a variety of methods for reducing the sources of survey error; however, one should keep in mind that there is more than one source of error and that one has to compromise and choose when attempting to reduce total survey error. And, do this all within a workable budget too; or as Lyberg and Biemer put it in Chapter 22: "the challenge in survey design is to achieve an optimal balance between survey errors and costs." In the remainder we discuss the four cornerstones in more detail and relate these to specific chapters in this book.

1.4.1 Coverage and Coverage Error

When doing a survey one has an intended population in mind: the target population. To draw a sample from the target population, a sample frame is needed. This can be a list of target population members, for instance, a list of all members of a certain organization, or the register of all inhabitants of a certain

city. But it may also be a virtual list, or an algorithm, such as in area probability sampling or in Random Digit Dialing (RDD) sampling (cf. Lohr, Chapter 6 on coverage and sampling, and Steeh, Chapter 12 on RDD). In area probability sampling, the population is divided into clusters based on geographical proximity, and then specific areas are selected. In RDD, random telephone numbers are generated using an algorithm that conforms to properties of valid telephone numbers in the country that is being investigated. Frame coverage errors occur when there is a mismatch between the sampling frame and the target population. In other words when there is no one-to-one correspondence between the units in the frame and the units in the target population.

The most common form of coverage error is undercoverage, that is, not all units of the target population are included in the sampling frame. A clear example of undercoverage is persons with an unlisted phone number when the sampling frame is the telephone book. Another form of coverage error is overcoverage; here a unit from the target population appears more than once in the sampling frame. Duplications like this can occur when a sampling frame results from the combination of several lists. For example, on one list a woman is listed under her maiden name, and on a second list under her married name. If these lists are combined, the same person is listed under two different entries. Another example is surveys that use mobile (cell) telephones; these overcover persons who own more than one phone. A third type of coverage error is caused by erroneous inclusions in the frame. For example, a business number is included on a list with household phone numbers.

As a final example, consider the case of web surveys. A common way to attract respondents to a web survey is placing a link to the survey on a popular web site. Basically, this means that the researcher has no control over who responds to the questionnaire. Coverage error for web surveys is related to two different causes (cf. Ramos, Sevedi, & Sweet, 1998). First, it is the respondent who has to make contact with the data collection program. In a web survey, this requires access to a computer and the Internet, plus some degree of computer skill. Individuals who lack these are not covered. In addition, interviewing software is in general not hardware or software independent. Screens look differently in different resolutions, or when different browsers are used to access the survey website, and some combinations of hardware and software may make the survey website inaccessible to some users, resulting in coverage error. For an overview of different types of web surveys and their potential for errors, see Lozar Manfreda and Vehovar (Chapter 14).

The availability of comprehensive lists or algorithms that cover the population differs widely depending on the target population, but also on the country. For instance, in countries like Denmark and The Netherlands the national statistical agency has access to the population registry (see also Bethlehem Chapter 26). This makes it possible for the national statistical agency to draw a probability sample not only of the general population, but also to draw specific subsamples. Some countries have good lists of mobile phone users, whereas others do not. In some areas, the telephone system has a well-defined structure of used and unused number banks, which makes it possible to generate random telephone numbers with good coverage properties. In most areas, the telephone system does not have such a structure or several competing

telephone systems are in use, which makes generating random telephone numbers more difficult (cf. Steeh, Chapter 12).

Web surveys are a special challenge to survey methodologists, because the coverage problem is large and difficult to solve. There are no lists of the population that can be used to draw samples with known properties. Email addresses have no common structure that can be used to generate random addresses similar to the way random telephone numbers are generated in RDD. Finally, the often-used volunteer samples are convenience samples, for which coverage cannot be determined (cf. Lozar Manfreda & Vehovar, Chapter 14).

1.4.2 Sampling and Sampling Error

Sampling error occurs because only a sample of the population is investigated instead of the whole population. Sampling and sampling error is treated by Lohr (Chapter 6). Based on the values for the variables in the *probability* sample, the value for the population is estimated using statistical theory. When simple random sampling is used, standard statistical techniques can be used; however, when more complicated sampling schemes are used, such as cluster sampling or stratification, the standard statistical techniques do not provide accurate *p*-values and confidence intervals and more complicated statistical techniques should be used. Methods for analyzing complex survey designs are discussed by Stapleton in Chapter 18.

Sampling error can be controlled by drawing samples that are large enough to produce the precision wanted. Table 1.1 gives an indication of the number of respondents needed for estimated percentages with a specified precision (e.g., Devore & Peck, 2005, pp. 377–378).

Table 1.1 Precision: Number of respondents needed for percentage estimates within 95 percent Confidence Interval (C.I.).

Number of respondents	Width of 95% C.I.
96	± 10%
384	± 5%
1537	± 2.5%
9604	± 1%

Base percentage 50%, 95% Confidence Interval based on normal approximation

The main point of Table 1.1 is that a large precision requires very large samples. The rule of thumb is that to decrease the sampling errors by half we need a completed sample that is four times as large.

The most important issue about sampling is that if our sample is *not* a probability sample, statistical inference is not appropriate. The difference between probability and nonprobability sampling is that nonprobability sampling does *not* use a *random* selection procedure. This does not necessarily mean that nonprobability samples are unrepresentative of the population; however, it does mean that nonprobability samples cannot depend upon statistical probability theory. With a probabilistic sample, we know the probability that we represent the population well and therefore we can estimate confidence intervals and significance tests. With a nonprobability sample, we

may or may not represent the population well, but it is not appropriate to apply statistical inference to generalize to a general population. At best, we can use statistical inference to assess the precision with which we can generalize to a population consisting of whoever responded. Whether this is representative for any general population is beyond statistical inference.

1.4.3 Response and Nonresponse Error

Nonresponse is the inability to obtain data for all sampled units on all questions. There are two types of nonresponse in surveys: *unit nonresponse* and *item nonresponse*. Unit nonresponse is the failure to obtain any information from an eligible sample unit. Unit nonresponse can be the result of noncontact or refusal. Lynn (Chapter 3) provides an extensive overview on nonresponse and nonresponse error; for a discussion of nonresponse error in cross-cultural studies, see Couper and de Leeuw (2003); for statistical adjustment and weighting see Biemer and Christ (Chapter 16). Item-nonresponse or item missing data refers to the failure to obtain information for one or more questions in a survey, given that the other questions are completed. For an introduction see de Leeuw, Hox, and Huisman (2003), for statistical approaches to deal with missing data see Chapter 18 by Rässler, Rubin, and Schenker.

Nonresponse error is a function of the response rate and the differences between respondents and nonrespondents. If nonresponse is the result of a pure chance process, in other words if nonresponse is completely at random, then there is no real problem. Of course, the realized sample is smaller, resulting in larger confidence intervals around estimators. But the conclusions will not be biased due to nonresponse. Only when respondents and nonrespondents do differ from each other on the variables of interest in the study, will there be a serious nonresponse problem. The nonresponse is then *selective* nonresponse and certain groups may be underrepresented. In the worst case, there is a substantial association between the nonresponse and an important variable of the study causing biased results. A classic example comes from mobility studies: people who travel a lot are more difficult to contact for an interview on mobility than people who travel rarely. Thus, selective nonresponse caused by specific noncontacts leads to an underestimate of mobility. For more examples, see Lynn (Chapter 3).

Two main approaches are used to cope with nonresponse: *reducing* and *adjusting*. Nonresponse reduction applies strategies that, in general, reduce the number of noncontacts and refusals. Causes of noncontact depend on the specific survey design. For instance, in face-to-face surveys, noncontact can be the result of the inability of the interviewer to reach the respondent within the allotted number of contact attempts. Increasing the number of contact attempts not only increases the number of contacted and thus the response rate, but also the costs. Varying the days and times at which contact is attempted also increases the response rate, without affecting the cost as much. In mail and Internet surveys, noncontacts can be the result of undeliverable mailings due to errors in the address list. Tools to reduce refusals also depend on the data collection mode used. For instance, interview surveys may use specially trained interviewers to convert refusals, while mail and Internet surveys have to rely on

incentives or special contacts to counteract explicit refusals. For more detail, see Lynn (Chapter 3).

Nonresponse adjustment refers to statistical adjustments that are applied after the data are collected. If the difference between the respondents and the nonrespondents is known, for instance because we can compare certain characteristics of the respondents to known population values, statistical weighting can be used to make the sample resemble the population with respect to these characteristics. The problem with statistical adjustment is that usually only simple respondent attributes such as age, sex, and education can be used to weigh the sample. This improves the representativeness of the sample with respect to the variables of central substantive interest only if these variables are related to the attributes used in the weighting scheme. Biemer and Christ discuss weighting for survey data in detail in Chapter 17.

Finally, nonresponse figures should be clearly reported in surveys. This often takes the form of a response rate figure. When reporting response rates it is important to state how the response rate was calculated. For details of response rate calculation and a description of sources of nonresponse, see the brochure on standard definitions of the American Association for Public Opinion Research (AAPOR). A regularly updated version and an online response rate calculator can be found on the AAPOR website (www.aapor.org).

1.4.4 Measurement and Measurement Error

Measurement error is also called error of observation. Measurement errors are associated with the data collection process itself. There are three main sources of measurement error: the questionnaire, the respondent, and the method of data collection. When interviewers are used for data collection, the interviewer is a fourth source of error.

A well-designed and well-tested questionnaire is the basis for reducing measurement error. The questions in the questionnaire must be clear, and all respondents must be able to understand the terms used in the same way. With closed questions, the response categories should be well defined, and exhaustive. When a question is not clear, or when the response categories are not clearly defined, respondents will make errors while answering the question or they do not know what to answer. When the data are collected through interviews, interviewers will then try to help out, but in doing this they can make errors too and introduce additional interviewer error (Fowler, 1995). Therefore, improving the *questionnaire* is a good start to improve the total survey quality. For a good introduction into designing and writing effective questions, see Fowler and Cosenza (Chapter 8). It should be emphasized that even carefully designed questionnaires may contain errors and that a questionnaire should always be evaluated and pretested before it may be used in a survey. In Chapter 10 Campanelli provides the reader with information about the different methods for testing survey questions and gives practical guidelines on the implementation of each of the methods.

Respondents can be a source of error in their own right when they provide incorrect information. This may be unintentional, for instance when a respondent does not understand the question or when a respondent has difficulty

remembering an event. But a respondent can also give incorrect information on purpose, for instance when sensitive questions are asked (see also Lensvelt-Mulders, Chapter 24). Measurement errors that originate from the respondent are beyond the control of the researcher. A researcher can only try to minimize respondent errors by making the respondent's task as easy and as pleasant as possible. In other words, by writing clear questions that respondents are willing to answer. In Chapter 2, Schwarz, Knäuper, Oyserman, and Stich describe how respondents come up with an answer and review the cognitive and communicative processes underlying survey responses.

The *method of data collection* can be a third source of measurement error. In Chapter 7 of this book, de Leeuw describes the advantages and disadvantages of major data collection techniques. One of the key differences between survey modes is the way in which certain questions can be asked. For instance, in a telephone interview respondents have to rely on auditive cues only: they only hear the question and the response categories. This may cause problems when a long list of potential answers has to be presented. Dillman, in Chapter 9 on the logic and psychology of questionnaire design, describes mode differences in questionnaire design and proposes a unified or uni mode design to overcome differences between modes. This is of major importance when mixed-mode designs are used, either within one survey, or in longitudinal studies (e.g., panel surveys see also Chapter 25 by Sikkels & Hoogendoorn), or between surveys as can be the case in cross-national and comparative studies in which one mode (e.g., telephone) is used in one country and another mode (e.g., face-to-face interviews) is used in another. For important issues in comparative survey research, see Harkness (Chapter 4); for more detail on the challenges of mixed mode surveys, see De Leeuw, Dillman, and Hox (Chapter 16).

A second major difference between modes is the presence versus the absence of an interviewer. There may be very good reasons to choose a method without interviewers and leave the locus of control with the respondents, such as ensuring more privacy and more time to reflect for respondents. Self-administered questionnaires in general are described by De Leeuw and Hox in Chapter 13; technological innovations are described by Lozar Manfreda and Vehovar in Chapter 14 on Internet Surveys and by Miller Steiger and Conroy in Chapter 15 on Interactive Voice Response. On the other hand, using interviewers also has many positive points, especially when very complex questionnaires are used or when special tasks have to be performed. As Loosveldt states in Chapter 11: "...the task of the interviewer is more comprehensive and complex than merely asking questions and recording the respondent's answer. Interviewers implement the contact procedure, persuade the respondents to participate, clarify the respondent's role during the interview and collect information about the respondent."

However, when an interviewer is present, the interviewer can be a source of error too. Interviewers may misinterpret a question, may make errors in administering a questionnaire, or in registering the answers. When posing the question, interviewers may unintentionally change its meaning. By giving additional information or explaining a misunderstood word, they may inappropriately influence a respondent. Even the way interviewers look and dress may influence a respondent in a face-to-face interview. Selecting and

training interviewers carefully helps reducing interviewer related errors. For more details, see Chapter 23 on interviewer training by Lessler, Eyerman, and Wang. Interviewers can make genuine mistakes, but they also may intentionally cheat. Interviewers have been known to falsify data, or skip questions to shorten tedious interviews. Monitoring interviewers helps to reduce this. Having a quality controller listening in on telephone interviewers is a widely used method. In face-to-face interviews, recordings can be made and selected tapes can be checked afterwards. Special verification contacts or re-interviews may be used to evaluate interviewer performance in large-scale face-to-face surveys (cf. Lyberg & Biemer, Chapter 22; Japac, 2005, p. 24).

1.5 FROM DATA COLLECTION TO ANALYSIS: HOW THE FOUNDATION AFFECTS THE STRUCTURE

There are several ways in which the design of a survey and the precise data collection procedure affects the subsequent data analysis stage. These also involve the four cornerstones. The most direct influence is the actual *sampling* procedure that is used. As mentioned earlier, standard statistical procedures assume that the data are a simple random sample from the population. In most surveys, other sampling schemes are used because these are more efficient or less expensive, for instance cluster sampling or stratification. When these sampling schemes are used, the analysis must employ special statistical methods (see also Stapleton, Chapter 18). Similarly, when weighting (cf. Biemer & Christ, Chapter 17) is used to compensate for different inclusion probabilities, either by design or because of nonresponse problems, special statistical methods must be used. Standard statistical packages may or may not include these methods. For instance, the package SPSS (version 15 and higher) can analyze complex survey data with weights and complicated sampling schemes, but it includes only selected statistical analyses for such data. The other procedures in SPSS can include weighting, but do not correct the standard errors for the effects of weighting, which produces incorrect statistical tests.

A less obvious way in which the survey design affects the data analysis lies in the adjustment for the combination of coverage error and nonresponse. These may result in data that are not representative for the population, and the most often-used adjustment method is weighting on respondent characteristics for which the population values are known. For more detail, see Biemer and Christ (Chapter 17). Two issues are important here. First, statistical adjustment aims at producing unbiased estimates of population parameters when selection probabilities are not equal; however, no amount of statistical cleverness restores information that we have failed to collect. So, prevention by reducing the problem in the data collection phase is important. Second, the quality of the adjustment depends strongly on the amount and quality of background information that we have available to construct the weights. Collecting this information requires careful planning in the design phase. Auxiliary variables must be included for which the population values are known, for instance for a sample from the general population via the national statistical agency, or for samples from a special population via an existing registry. Because the use of

registries is regulated by privacy concerns, in the latter case it may be necessary to obtain prior permission. For more on privacy and ethics in survey research, see Singer (Chapter 5). Finally, to be able to use the information, it is crucial that the data collection procedure uses the same wording and response categories that were used to collect the known population data (cf. Dillman, Chapter 9). Preferably, the same method of data collection should be used, to prevent confounding of selection and measurement errors.

A special case of nonresponse is the failure to obtain information on some of the questions, which leads to incomplete data for some of the respondents. Just as is the case with unit-nonresponse discussed earlier, prevention and the collection of auxiliary information is important with item missing data too (see also de Leeuw, Hox, & Huisman, 2003). The next step is statistical adjustment. In Chapter 19, Rässler, Rubin, and Schenker discuss concepts regarding mechanisms that create missing data, as well as four commonly used approaches to deal with (item) missing data.

Measurement errors, that is discrepancies between the measurement and the true value, influence the analysis in more subtle ways. Again, prevention is the best medicine. Measurement errors originate from the question wording and the questionnaire, from the survey method and the interviewer, from the respondents and from complex interactions between these. Many decisions in the survey design phase have the potential to affect measurement error (cf. Biemer & Lyberg, Chapter 22). Prevention rests on the application of known best practices in survey design; this assumes that these are well documented (cf. Mohler, Pennel, & Hubbard, Chapter 21). Another important step in reducing measurement error as far as possible is thorough pretesting of the survey instrument before it is actually used (cf. Campanelli, Chapter 10). In the analysis phase, some adjustments for the effect of measurement errors can be made; Hox discusses this in Chapter 20. Adjustments for measurement errors can be made when multi-item scales are used, or if auxiliary information is available about the amount of measurement error in specific variables. Again, to be able to adjust in the analysis phase, the design of the survey must make sure that the necessary information is available.

1.6 CAN WE AFFORD IT? BALANCING DESIGN FEATURES AND SURVEY QUALITY

Earlier we discussed the foundation of survey research: breaking the ground (specification) and placing the four cornerstones (coverage, sampling, nonresponse, and measurement). The same fundamental quality criteria are discussed in quality handbooks. For instance, in Eurostat's 2000 publication on the assessment of quality in statistics, the first quality criterion is the relevance of the statistical concept. A statistical product is relevant if it meets user's needs. This implies that user's needs must be established at the start. The concept of relevance is closely related to the specification problem and the construct validity of measurement. Did we correctly translate the substantive research question into a survey question? If not, we have made a specification error, and the statistical product does not meet the needs of the users. Almost all handbooks on survey

statistics mention *accuracy* of the estimate as quality criterion. Accuracy depends on all four cornerstones and is discussed at length earlier in this chapter. But, there are additional criteria for quality as well. Biemer and Lyberg (2003) stress the importance of timeliness defined as available at the time it is needed, and accessibility, that is the data should be accessible to those for whom the survey was conducted. Eurostat (2000) distinguishes seven distinct dimensions of statistical quality, adding a.o. comparability, meaning that it should be possible to make reliable comparisons across time and across space. Comparability is extremely important in cross-cultural and cross-national studies (see also Harkness, Chapter 4). For a discussion of quality and procedures for quality assurance and quality control, see Lyberg and Biemer (Chapter 22).

Both Biemer and Lyberg's (2003) quality concepts and Eurostat's (2000) dimensions go beyond the foundation and cornerstones described earlier in this chapter, and are relevant for the quality of the entire survey process and the data it produces. Their criteria were developed mainly for use in large scale survey organizations and governmental statistical offices, but survey quality and quality assurance is an issue that also applies to smaller scale surveys, where the survey researcher is also the survey user. It does not matter if it is a small scale survey or a large survey, whether the survey is using paper and pencil or high technology, quality can and should be built into all surveys. For procedures for quality assessment, see Lyberg and Biemer (Chapter 22).

To come back to the metaphor of building a house: there are many different ways to build a good, quality house. But, there is also a large variety in types of houses, ranging from a simple summer cottage to a luxurious villa, from a houseboat to a monumental 17th century house at a canal, from a working farm to a dream palace. What is a good house depends on the needs of the resident, what is a good survey depends on the survey user (cf. Dippo, 1997). The research objectives determine the population under study and the types of questions that should be asked. Privacy regulations and ethics may restrict the design; other practical restriction may be caused by available time and funds. Countries and survey organizations may differ in available resources, such as skilled labor, administrative capacities, experience with certain procedures or methods, computer hardware and software. It is clear that survey methodologists must balance survey costs and available resources against survey errors, and that any actual survey will be the result of methodological compromises. Surveys are a complex enterprise and many aspects must be considered when the goal is to maximize data quality with the available resources and within a reasonable budget of time and costs.

Finally, surveys are carried out in a specific cultural context, which may also affect the way these aspects influence the survey quality. Survey methodologists need to take this into account when designing a survey. For instance, when a telephone (or Internet) survey is contemplated for an international study, it is important to understand how telephones and Internet are viewed in the different cultures included in the survey. Is it a personal device, such as mobile telephones? Is it a household device, as landline telephones mostly are? Or is it a community device, with one (mobile) telephone or Internet connection shared by an entire village? Survey design means that costs and quality must be optimized, and in a global world this

means that they must be optimized within the bounds of cultural and technological resources and differences.

1.7 CONTENTS OF THIS BOOK

The goal of this book is to introduce the readers to the central issues that are important for survey quality, to discuss the decisions that must be made in designing and carrying out a survey, and to present the current methodological and statistical knowledge about the consequences of these decisions for the survey data quality.

The first section of the book, *Foundations*, is a broad introduction in survey methodology. In addition to this introduction, it contains chapters on the psychology of asking questions, the problem of nonresponse, issues and challenges in international surveys, and ethical issues in surveys.

The second section, *Design*, presents a number of issues that are vital in designing a quality survey. It includes chapters on coverage and sampling, choosing the method of data collection, writing effective questions, constructing the questionnaire, and testing survey questions.

The third major section, *Implementation*, discusses the details of a number of procedures to carry out a survey. There are chapters on face-to-face interviews, telephone interviews, self-administered questionnaires, Internet surveys and Interactive Voice Response surveys. Finally, there is a chapter on the challenges that result when different data collection modes are mixed within a survey.

The fourth section, *Data analysis*, discusses a number of statistical subjects that are especially important in analyzing survey data. These include chapters on constructing adjustment weights, analyzing data from complex surveys, coping with incomplete data (item nonresponse), and accommodating measurement errors. The final section, *Special issues*, contains a number of special interest topics for quality surveys. It includes chapters on survey documentation, quality assurance and quality control, interviewer training, collecting data on sensitive topics, and panel surveys including access panels. The final chapter introduces collecting survey-type data without asking questions of respondents, by combining and integrating existing information.

GLOSSARY OF KEY CONCEPTS

Construct validity. The extent to which a measurement instrument measures the intended construct and produces an observation distinct from that produced by a measure of a different construct.

Coverage error. Coverage errors occur when the operational definition of the population includes an omission, duplication, or wrongful inclusion of an element in the population. Omissions lead to undercoverage, and duplications and wrongful inclusions lead to overcoverage.

Measurement error. The extent to which there are discrepancies between a measurement and the true value, that the measurement instrument is designed to

measure. Measurement error refers to both variance and bias, where variance is random variation of a measurement and bias is systematic error. There are a number of potential sources; for example, measurement error can arise from the respondent, questionnaire, mode of data collection, interviewer, and interactions between these.

Nonresponse error. Nonresponse is the failure to collect information from sampled respondents. There are two types of nonresponse: unit nonresponse and item nonresponse. Unit nonresponse occurs when the survey fails to obtain any data from a unit in the selected sample. Item nonresponse (incomplete data) occurs when the unit participates but data on particular items are missing. Nonresponse leads to nonresponse error if the respondents differ from the nonrespondents on the variables of interest.

Sampling error. Error in estimation due to taking a sample instead of measuring every unit in the sampling frame. If probability sampling is used then the amount of sampling error can be estimated from the sample.

Specification error. Specification error occurs when the concept measured by a survey question and the concept that should be measured with that question differ. When this occurs, there is low construct validity.

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