New Issue

An Introduction to Sample Surveys

A User's Guide

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PREFACE

The Australian Bureau of Statistics (ABS) provides a high quality user-oriented and dynamic statistical service for all sectors of the community. The statistical information it makes available has an important role to play in the decision-making processes that are undertaken by governments, private businesses and individuals.

Sample surveys are used extensively by the ABS as part of its role in collecting information for these decision-making processes.

This publication is intended to be a basic and practical guide to the use of sample surveys for the purpose of conducting all types of research or information gathering. The chapters are structured in a logical sequence—from the aims and objectives of the survey through to the presentation of the results. The publication is by no means an exhaustive study of the theory and practice of sample surveys, both of which are further covered in numerous journals and books.

Prudent users of statistics will realise that to run a good survey an essential ingredient is a healthy dose of common sense along with the application of sound statistical principles. Poorly run surveys can be costly in terms of the quality of data and operating costs. Data from a survey must be suitable for meaningful analysis and informative presentation. It is hoped that this publication will help people understand more about sample surveys and how to make better use of them.

An Introduction to Sample Surveys draws on a high level of statistical expertise and many years of practical experience by ABS staff. The fact that this issue marks the fourth printing of this user guide (previously released as catalogue no. 1202.2) is indicative of the value of its contents.

The ABS also provides a statistical consultancy and training service as part of its range of products and services. This service can provide advice on conducting surveys, questionnaire design, analysis of results, or any other aspect of conducting a sample survey. For assistance or advice in conducting a sample survey or any other aspect of statistical services, you can contact the ABS Statistical Consultancy Service—contact details are provided on the last page.

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ABBREVIATIONS AND SYMBOLS

ABS	Australian Bureau of Statistics
CAI	Computer-assisted interviewing
CATI	Computer-assisted telephone interviewing
ICR	Intelligent character recognition
OCR	Optical character recognition
OMR	Optical mark recognition
PES	Post-enumeration survey

CHAPTER 1 AIMS AND OBJECTIVES

INTRODUCTION

A major aspect of any research is the gathering of information. Whether it will be used as the basis for decision-making, the allocation of funds, to analyse the outcome of policies or programs or to determine the direction of future operations, there are a number of factors which need to be considered before deciding to commission or undertake a survey. This chapter is intended to assist researchers and managers identify some of these factors, analyse their requirements and select the most appropriate method of collecting the necessary information.

REASONS FOR THE STUDY

Before undertaking any research or study it is essential to define the purposes of the study and to translate these into specific information requirements.

What is the population being studied?

The first consideration is to define the target population. The target population must be an identifiable group which is relevant to the study. Examples of target populations are persons aged 65 and over, retail businesses in a specific urban area, and motor vehicles produced in a given year.

What do you want to know about this population?

Having defined the population or group under study the next step is to decide what information needs to be collected. For example, a study may be aimed at describing a target population in terms of specific characteristics such as age, sex, income or employment group, or may be far more subjective in nature, collecting information on background, community attitudes, opinions etc.

If the requirement is for quantitative data the researcher needs to determine whether simple frequency counts are required (e.g. basic counts of responses in each cell or box on a questionnaire) or whether there is a need for detailed cross-classified tabulations (such as age by sex by country of birth). If it is expected that this type of cross-tabulation will be required it is important to specify, or define, as soon as possible the detailed tables that will need to be derived and this will determine both the content of the survey and the size of sample required.

Is the information required on an ongoing basis?

If a sample survey is used as the means of collecting the required information, there may be different requirements in terms of survey design and management if the data are to be collected on an ongoing basis compared to the requirements if the data are to be collected only once. Such decisions need to be made early to ensure that the eventual data collection process developed is the most effective.

IS A SURVEY APPROPRIATE?

Although a sample survey may provide the data required for a study it is not always the most practical or efficient method to adopt. A number of alternative sources and methodologies, together with their relative advantages and disadvantages, are discussed below.

Existing data sources

Having defined the target population and data requirements the next step is to find out whether the information needed is already available from another source. Possible data sources include:

- *Research of subject documentation.* Some topics may be satisfactorily approached through systematic examination of existing documents, for example, academic journals, books, newspapers, information papers, government files etc.
- *Administrative by-product.* A second major source of existing data is administrative by-product information, i.e. statistics kept by government departments and agencies as part of their ongoing operations. Examples of these agencies include the Registrar of Births, Deaths, and Marriages; the Department of Foreign Affairs and Trade; and the road traffic authorities.
- *Previous surveys.* These include surveys conducted in previous years, interstate or overseas, the results of which are usually available in tabulated form. In many cases additional data can be obtained through special tables generated from the survey's unit record file or by other means by contacting the agency responsible for conducting the survey.

The major advantages of existing data sources are that information can be obtained comparatively quickly and at relatively low cost. However, in many cases the data available may be only an approximation of what is required, and may not be current (i.e. many existing statistical collections have been run on a one-off or infrequent basis). The lack of a single source from which to obtain a range of related data may also lead to problems of comparability between data items.

Non-survey methodologies

Set out below are three alternatives to running a sample survey that may provide sufficient information to satisfy the researcher's requirements:

- *Focus groups.* This technique will be discussed in chapter 4. The process involves bringing together a number of people who have similar identifiable characteristics to discuss the issues involved. The group is usually between 6 and 12 people.
- *Controlled experiment.* Used in the medical and scientific fields and usually involves selecting two groups of subjects as similar to each other as possible; one group is designated the experimental group, the other the control group. The experimental group is subjected to some form of change (experiment) while factors affecting the control group are kept constant. Data are collected from each group both before and after the experiment and any changes may then be measured.
- *Case study.* In preparing a case study the researcher seeks to collect and analyse as much data about the chosen subject as possible from a relatively small number of cases.

A detailed discussion of controlled experiment and case study is outside the scope of this user's guide.

Non-survey methodologies *continued*

The main advantage of these methodologies is that they allow the researcher to collect quite detailed information for a comparatively modest cost. The major disadvantage, however, is the small number of participants studied, which may result in the data not being representative of the target population.

Full enumeration (census)

Where resources permit, a complete enumeration of the population under study can overcome many of the disadvantages associated with sample surveys and yield reliable information, but at maximum cost. In a census the objective is to collect data in relation to every member of the population under study. The advantages include:

- data will be truly representative of the whole population;
- data are generally available at highly disaggregated levels, e.g. for small geographic areas or sub-sets of the population; thus detailed cross-tabulations are possible, e.g. age by sex by country of birth; and
- benchmark data may be obtained for future studies, e.g. a census of retail establishments may yield data on stocks, turnover or employment. This can then be used to determine a suitable sampling frame (or list of the members of a population or group) for future surveys, e.g. a survey of retail floorspace or of part-time/full-time employment.

The main disadvantages of a census are:

- resource costs are large, both in staff and monetary terms;
- the number of questions asked has to be kept as small as possible, so as to minimise both the reporting burden on data providers and costs;
- it may be difficult to approach all members of the population within a reasonable time; and
- processing time is slow, so the results may become available too late to be useful.

A full enumeration of the target population may be a very large project with associated logistical problems. This can lead to errors in the resultant data output that could be avoided in a smaller survey. Thus, a small survey conducted effectively may result in higher quality results than a full scale census where available resources can be stretched too far.

Sample surveys

In a sample survey, only a part of the total population is approached for information on the topic under study. These data are then 'expanded' or 'weighted' to represent the target population as a whole.

Advantages of sample surveys include:

- resource costs are generally significantly lower than for a census;
- more, or more detailed, questions can be asked; and
- results can be available far more quickly.

Sample surveys *continued*

The major disadvantages of sample surveys are:

- data may not be representative of the total population, particularly where the number of respondents is small; and
- finely classified data (e.g. small area data) are generally not available.

SUMMARY

The first task to be undertaken in planning any research project is to define clearly the aims and objectives of the study. Knowing the target population, what information is required and how it is going to be used are essential if the researcher is to make an informed evaluation of the alternative methods available for collecting data.

The remainder of the publication assumes that a survey is the most appropriate method for gathering the required information and discusses a range of issues associated with the collection and analysis of survey data.

CHAPTER 2 DATA COLLECTION METHODS

INTRODUCTION

There are a number of methods available for collecting data and the choice between these depends on a number of factors. It should be stressed at the outset that the success of the survey will depend to a large extent on the suitability and appropriateness of the collection method chosen.

FACTORS INFLUENCING CHOICE OF METHOD

Nature of the questions

The nature of the questions, and in particular the depth and complexity of the topics to be covered, will in many cases dictate the collection method to be employed. Similarly the quality of responses sought may determine the choice of an appropriate collection method, e.g. it is difficult to obtain detailed answers to complex questions by telephone or mail survey, whereas personal face-to-face interviews will generally yield a greater depth of response.

Response rates

The quality and reliability of survey data can be affected by the degree of response to a survey. Although it is rare to achieve a 100% response rate for any survey, choice of collection method can influence the response rate obtained. For example, telephone interviews usually achieve a far better response rate than mail questionnaires.

Resources

Where staff and/or financial resources are limited the researcher may be constrained to use, for example, mail-out techniques for the collection phase of the survey because of the lower cost. Often this will conflict with the quality requirements of the survey. In these circumstances the researcher must try to achieve an acceptable compromise, or seek resources or cost savings elsewhere.

Time

As with resources the time constraints on the survey may dictate the choice of methodology. Telephone surveys (particularly using computer-assisted telephone interviewing) are much quicker than mail-out surveys or personal interviews. However, savings in time often necessitate sacrifices in the complexity or sensitivity of the questions asked, and the depth of responses received.

Sampling frame

The type and quality of the sampling frame (the list of 'members' from which the sample is to be selected) may influence the choice of collection method, e.g. to conduct a mail survey it is necessary to have a list of the names and addresses of all elements in the sampling frame. If this is unavailable there may be no option but to use personal interviews and an area based frame for the survey.

OPTIONS AVAILABLE

The commonly used collection methods can be divided into two basic types: personal interview and self-enumeration. These in turn can be further divided, and some methods utilise a combination of the elements. In choosing a collection method for a survey, the advantages and disadvantages of each type of method should be assessed in the light of the influencing factors discussed above.

Personal interviewing

There are two types of personal interviewing: face-to-face and telephone.

Face-to-face

As the name suggests this method involves having an interviewer visit each 'member' selected from the sampling frame for the survey. This form of data collection is highly effective in terms of establishing rapport, boosting response rates and data quality, and collecting sensitive or complex data. However, the disadvantages of personal interviews are the costs (in staff, time, and money required to obtain, train, and manage an interviewer workforce), the possibility of bias being introduced by interviewers, the cost of supervision, and the cost of 'call backs' when respondents are unavailable.

Telephone

Telephone interviewing has a number of advantages over face-to-face interviewing; costs are usually lower because fewer staff are required, interview times are generally shorter and there are no travel costs; supervision may be centralised; and 'call backs' and follow-up are quick and inexpensive.

The disadvantages of telephone surveys include the difficulty of establishing rapport with respondents which can lead to lowered response rates. Other disadvantages include the ease with which the respondent can terminate the interview, thus leading to problems of partial response; the need for questionnaires to be brief and simple to avoid boredom or fatigue on the part of the respondent; and the obvious limitation that only persons with telephones can be surveyed. The exclusion of people without telephones may introduce a slight bias into the survey, e.g. if the researcher is investigating topics such as income distribution, socioeconomic groupings or employment status. There is also the issue of respondents screening calls using answering machines which may reduce response rates and bias results. Another drawback of telephone surveys is the need for a frame of applicable telephone numbers. For example, not all private numbers are listed. This can be overcome by the use of random digit dialling (RDD) however this can be inefficient and can result in a large number of non contact and out of scope calls.

Self-enumeration

Self-enumeration surveys are those in which it is left to the respondents to complete the survey questionnaires. Although these are primarily postal, or mail-out surveys, they can also include hand-delivered questionnaires.

Postal surveys

In many situations postal surveys can provide an effective and efficient method of data collection, particularly where information is to be collected regularly or over a long period and is generally available from respondents' records. Postal surveys are a relatively inexpensive method of collecting data, and it is possible to distribute large numbers of questionnaires in a very short time. Other advantages of postal surveys include the ability to cover a wide geographic area; the opportunity to reach people who are otherwise difficult to contact, such as people away from home or out on business; and the convenience that it affords respondents to complete the questionnaires in their own time.

The major disadvantage of postal surveys is that they usually have lower response rates, leading to potential problems with data quality and reliability. Other disadvantages include the need for questionnaires to be kept simple and straightforward to avoid confusion or errors; the difficulties faced by respondents with only limited ability to read or write in English; and the time taken to answer correspondence or resolve queries by mail.

For surveys including businesses, a particular problem with a post-based approach is the need to ensure the questionnaire is received by the appropriate person within the business. Failure to ensure that the right contact within the business receives the questionnaire can result in both low response rates and poor quality information.

Hand-delivered questionnaires

An alternative form of the self-enumerated survey is where questionnaires are delivered to, and/or collected from, the respondents personally by an 'interviewer' or collector. This method usually results in improved response rates (compared with a postal survey) and is particularly suitable where information needs to be collected from several members of a household, some of whom may be unavailable when an interviewer calls.

Disadvantages of this methodology include the cost, the need for the questionnaire still to be relatively straightforward and the difficulty of achieving a sufficient level or quality of response.

Computer-assisted interviewing

Computer-assisted interviewing (CAI) is a technique applying modern computer technology to telephone and, sometimes, personal interviewing. It involves the use of a computer to collect, store, manipulate and transmit data relating to interviews conducted between the interviewer and respondents. Computer-assisted personal interviewing is one type of CAI and involves the conduct of face-to-face (household or business) interviews between the interviewer and respondent. Computer assisted telephone interview is another type of CAI and involves the conduct of interviews via the telephone.

Computer-assisted interviewing *continued*

Advantages of computer-assisted interviewing

Timeliness. CAI speeds up the whole survey process by integrating data collection, data entry and data editing and by allowing data to pass directly from data collection to analysis, therefore enabling users to receive analysed data more quickly.

Improved data quality. With CAI, sequencing of the questionnaire is automatic, thus avoiding any such errors. Furthermore, errors can be automatically identified during interview, and inconsistencies in the respondent's answers can be more readily queried, thereby allowing corrections to be made to answers during the interview stage.

Flexibility. CAI questionnaires can be altered and added to relatively quickly, allowing faster response to users' needs. CAI also has the potential to hold more than one survey within the one workload, and automatically generate the appropriate survey to be conducted at the household or business, without specific instructions being required of the interviewer.

A particular strength of CAI is the capacity to handle complex surveys and, for repeated surveys, to offset high development costs through repeated application of the survey.

Disadvantages of computer-assisted interviewing

These are the high start-up and maintenance costs for equipment, software, site preparation etc., and the need for interviewers with computer or typing skills involving consequent training overheads.

The CAI instrument needs to be completely specified and coded before survey enumeration commences. This includes instructions that would be common sense to an interviewer working with a printed questionnaire. For example, interuptions to interviews must be planned for and the capacity to move back through the questionnaire to revisit a question must be provided.

SUMMARY

The choice of a method of data collection may depend on any or all of the factors discussed above. The researcher needs to have a clear idea of the aims and objectives of the survey, the data to be obtained and the degree of accuracy required. It is also necessary to estimate available resources in advance, in terms of staff, time, and money. Only then is it possible to evaluate realistically the alternative methods and determine which is the most appropriate for a particular researcher's requirements.

CHAPTER 3 QUESTIONNAIRE DESIGN

INTRODUCTION

An integral part of any sample survey is the questionnaire through which information is to be gathered. The design of the questionnaire can influence the response rate achieved by the survey, the quality of responses gained, and the reliability of conclusions drawn from the survey results.

GENERAL CONSIDERATIONS

The central aim of a questionnaire is to collect accurate and relevant data. In order to achieve this, the questionnaire should:

- enable respondents to complete it accurately within a reasonable time;
- be properly administered by the interviewers;
- use language that is readily understood by respondents;
- appear uncluttered on the form/screen; and
- be easily processed by both people and machines.

Since the first four considerations may conflict with the fifth, it is important to utilise a well-designed form to reduce this conflict.

To facilitate respondents' completion of the form, a researcher first needs to ascertain whether the information sought is readily available from the respondents. Next, the questions should be so designed as to prevent confusion arising in the mind of the respondent. This can be achieved in a number of ways by:

- maintaining a logical order in the sequencing of questions (see diagram on next page);
- minimising and simplifying instructions and explanatory notes;
- providing clear instructions or explanations *before* rather than after directing respondents to 'jump' to a new question;
- making any sequencing instructions very obvious;
- providing for all possible response variations, including not applicable, zero, and non-response;
- avoiding 'leading' questions which assume a certain response to a question not explicitly asked (e.g. 'Which cinemas do you attend?' assumes the respondent goes to cinemas);
- making questions simple—complicated or double-barrelled questions increase the likelihood of errors and non-response as well as making responses difficult to intrepret; and

GENERAL CONSIDERATIONS
continued

- trying to reduce memory bias. Respondents tend to remember what should have been done rather than what was done, and they tend to include in a reference period events that occurred outside the reference period. Where possible, framing questions that relate to respondents' own record keeping can enhance accurate reporting. Minimising the recall period also helps to reduce memory bias. For example, recalling events that happened 'last month' is easier than for 'the same month one year ago'.

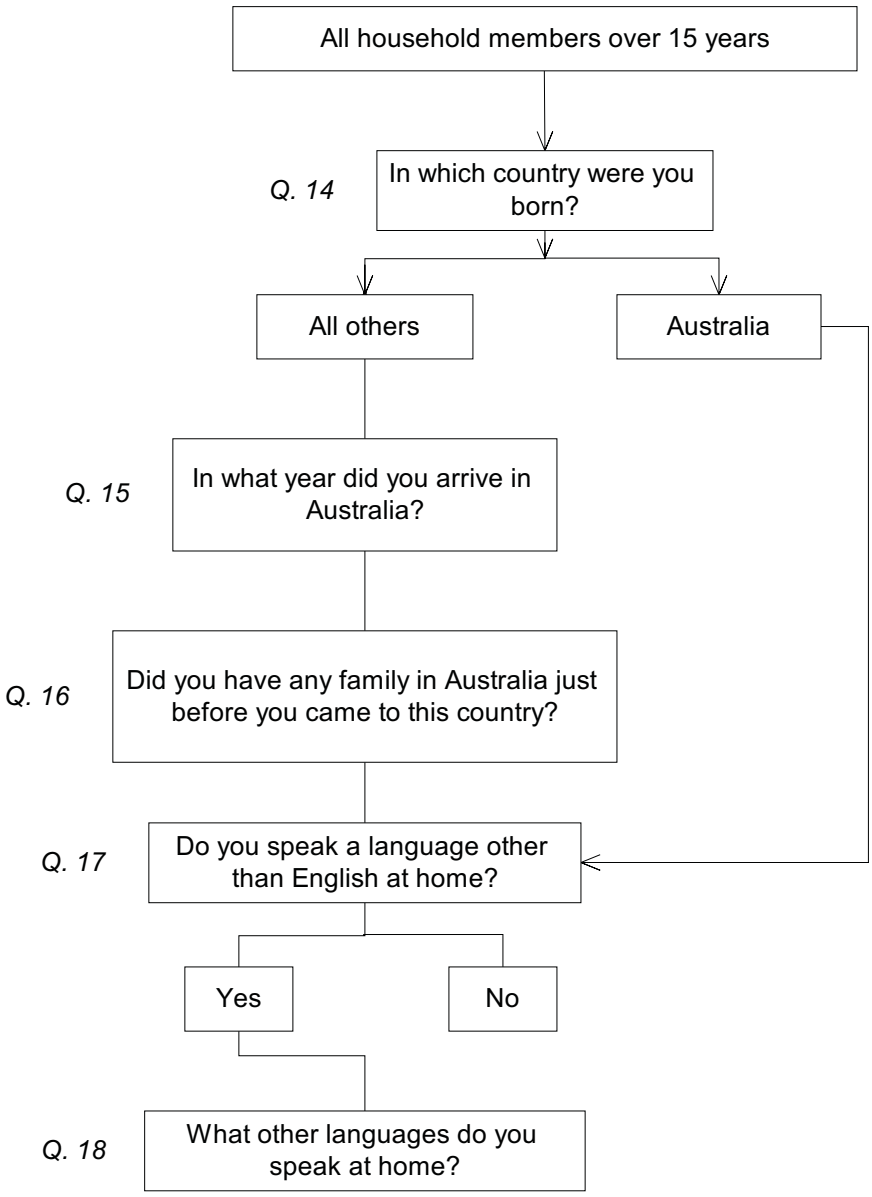
It is also important to consider how the answers on the form will be processed to produce statistics. To facilitate accurate processing of the survey data, space should be provided on the form for coding answers. If the data are to be entered into a computer system directly from the questionnaire, the codes for each type of answer should be displayed clearly on the form. See chapter 9 for a discussion of Optical Mark Recognition and Intelligent Character Recognition.

Testing of questionnaires should be conducted during the questionnaire development stage. It is essential that questionnaire testing be implemented for all new surveys and for already existing surveys on which substantial modifications have been made, in order to determine whether the objectives are likely to be met by the proposed questionnaire. See chapter 6 for detailed information.

QUESTION TYPES

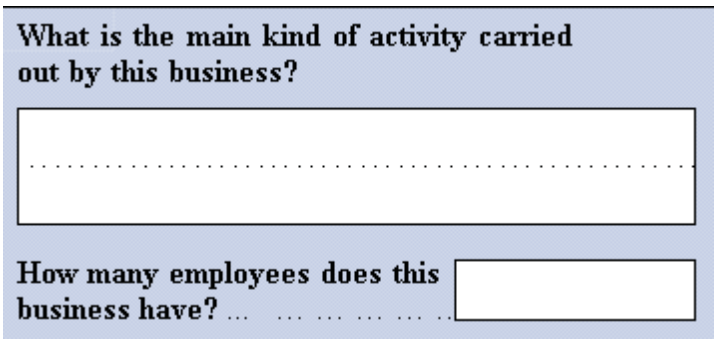
Questions may generally be classified as one of two types—open or closed—according to the degree of freedom allowed in answering the question. In choosing question types, consideration should be given to factors such as the kind of information which is sought, ease of processing, and the availability of time, money, and personnel.

BIRTHPLACES/LANGUAGES: Q. I4–18

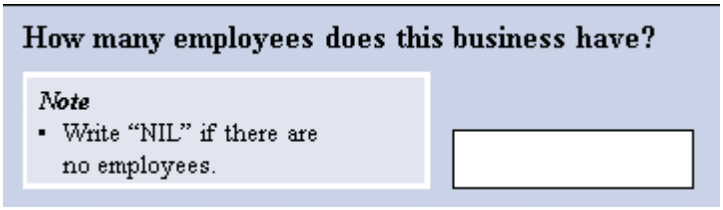


Open questions

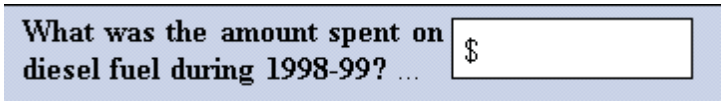
Open questions allow respondents to answer the questions in their own words. The answer box or area should allow sufficient space for a high percentage of the likely answers, for example:



It is often a good idea to provide some directions or examples on how to answer an open question and to make it clear how the respondent should answer if a 'not applicable', 'zero', or 'non-response' applies.



The questions need to be understood by all respondents in the same way. Even an apparently simple question can be understood in different ways, for example, a question 'How much diesel fuel did this business use in the year 1998–99?' may be answered in several ways such as in 'litres', 'gallons' or as a 'dollar value'. A more precise way of asking for this information, where quantity could be derived from value, is shown below:



The advantages of open questions are that they allow many possible answers and they can collect exact values from a wide range of possible responses. The open questions are often used in initial pilot testing to determine the range of possible answers and the availability of the data being sought.

The disadvantages are that they are more demanding than closed questions both to answer and to process. In particular, processing problems arise from the need to create a coding frame to interpret a variety of responses, and from the difficulty of reading poor handwriting.

Closed questions

Closed questions can be of several types, reflecting the style of response permitted. They are generally cheaper, easier to answer, and easier to process than open questions. Closed questions are appropriate when the researcher can anticipate most of the responses and when exact values are not needed. The disadvantage of closed questions is that they require significantly more effort than open questions in the development and testing stages.

Limited choice questions are those which require a respondent to choose one of two mutually exclusive answers (e.g. Yes/No).

Did you buy a car in the period of 1 July 1998 to 30 June 1999?

No ☐
Yes ☐

Multiple choice questions require a respondent to choose one of a number of responses provided.

How many litres of diesel fuel did this business use in year 1998?

Tick one only

Less than 100 litres ... ☐
100 to 500 litres ... ☐
Over 500 litres ... ☐

Checklist questions allow a respondent to choose more than one of the responses provided.

Have you ever heard of or are you aware of:

Tick all the boxes applied

Neighbourhood houses ...	☐	01
Drop-in centres ...	☐	02
Senior citizens clubs ...	☐	03
None of the above ...	☐	04

Partially closed questions provide a set of responses where the last alternative is 'Other, Please specify'. Partially closed questions are useful when it is difficult or impractical to list all possible choices.

What is the legal status of this business?

Tick one only

Sole proprietor ... ☐ 01

Partnership ... ☐ 02

Incorporated company ... ☐ 03

Other (Please specify) ... ☐ 04

Attitudinal questions generally seek to locate a respondent's opinion on a rating scale with a limited number of points (usually five). For example, respondents may be asked the level of satisfaction with a given statement.

What is your level of satisfaction with your skills in using Lotus 123?

Very high	High	Fair	Low	Very low
☐	☐	☐	☐	☐

Alternatively respondents may be asked to rate, for example, the cleanliness of their bus line according to the following scale:

\– ——————————— +

0

In other cases, respondents may be asked to rate, for example, their train service on waiting time by recording their responses on the following rating scale:

good ——————————— bad

Special care should be taken when designing attitudinal questions because:

- they are interpreted subjectively and this interpretation can differ between respondents;
- respondents may have difficulty interpreting the scale correctly;
- if there are a large number of similar questions, respondents are likely to answer in a hurried or careless fashion; and
- expressions of attitude can differ markedly from actual behaviour.

Choosing between question types

The choice between question types depends upon a number of factors including:

- the researcher's data requirements;
- the level of accuracy needed;
- the sort of information which is potentially available from respondents;
- the processing system to be used to code and analyse the survey results;
- the experience of respondents (i.e. whether the survey is to be conducted regularly or once only);
- the position of questions on the form; and
- the sensitivity of the question—(closed questions generally elicit more positive responses to sensitive topics than open questions).

Once the questions have been chosen they should be tested to determine whether the best choice has been made. See chapter 6 for survey testing details.

SEQUENCING

The sequence of questions should be designed so as to:

- encourage respondents to complete the questionnaire and to maintain their interest in it;
- facilitate respondents' recall;
- direct respondents to the information source;
- be relevant to respondents' own record keeping, if any;
- appear sensible to respondents; and
- focus on the issue under consideration.

Logical structure

The questions on a form should follow a sequence that is logical to the respondents. Regardless of the method used to administer the questionnaire, the sequence should flow smoothly from one question to the next. A smooth progression through the questions is particularly important if the questionnaire is answered in unfavourable conditions (e.g. in a dim room, or outdoors in wind or rain).

It is a good idea to start the questionnaire with simple, straightforward questions which both promote interest in the survey and establish respondents' confidence in their ability to answer the remaining questions. In particular, the opening questions should establish (if necessary) that the respondent is a member of the survey target population.

Logical structure *continued*

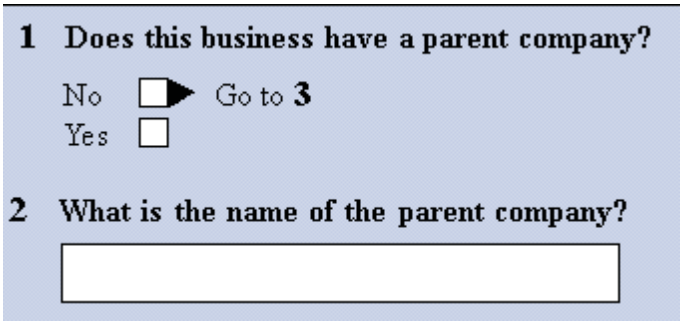
The remaining questions should be logically structured so that the interviewer or respondent does not need to alternate between pages of the questionnaire. Questions on related topics should be grouped together and all questions on a particular topic should be asked before proceeding to another topic. Care should be taken to use a logic or grouping that reflects the understanding of the respondents targeted for the survey.

Sensitive questions

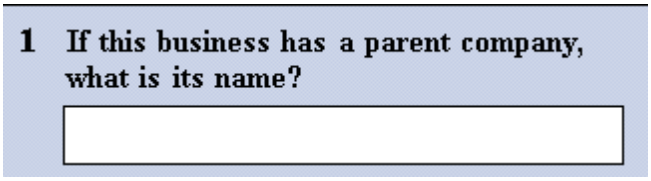
Questions which may be sensitive to respondents should generally not be placed at the beginning of a questionnaire. Rather, they should be placed in a section of the form where they are most meaningful in the context of relevant questions. In this way the format of the questionnaire can act as a buffer to help the respondent feel more comfortable with sensitive questions. For example, the item 'owner's drawings' from an unincorporated business might be sensitive, but putting it in the context of an income statement (comprising net sales, cost of sales, gross margin, other expenses, operating income, owners' drawings, and net income) may make it less sensitive. Also, placing sensitive questions last minimises the impact of a possible refusal.

Filtering

Filtering can be used to ensure that respondents answer only those parts of the questionnaire that are relevant. This is achieved by the use of filter questions which direct respondents to skip questions that do not apply to them. Filter questions also help respondents to understand the sequence of questions and they are simpler to follow than conditional questions. An example of a filter question is:



This filter question is preferable to the following conditional question:



With conditional questions it is not clear whether a blank answer represents a non-response or a 'not applicable' response.

In general, filter questions should place the 'No' response before the 'Yes' response because it is usually the 'No' response which directs respondents to a subsequent question. Respondents then do not have to read the 'Yes' response.

Filtering *continued*

Filter questions are useful in situations where respondents are being asked for attitudinal information. They are used to ensure that the respondent actually has an attitude or a view about a particular topic or subject before asking for that view. For example, a respondent may be asked 'Do you have views about <topic>' before being asked those views in order to ensure that people who have no real interest in a topic do not influence the outcome of that part of a survey.

LANGUAGE

Careful wording of questions is essential to ensure that respondents understand questions correctly and do not misinterpret them. When framing the wording of questions a number of techniques can be used to facilitate correct and quick understanding:

- Use short sentences which convey a single item of information rather than long sentences.
- Arrange clauses in chronological order within each sentence. For example, the sentence 'Read the instructions then fill in the form' is more quickly understood than 'Before you fill in the form, read the instructions'.
- Ask positive questions rather than negative ones. For example, 'Are you: married, single, etc? Tick one.' is easier to understand and can be answered more quickly than 'Place an X in the box next to those items which do not apply'.
- Use sentences in the active voice rather than the passive voice. Active voice is when the subject performs the action, e.g. 'The operator is to complete this form.' Passive voice is when the subject is acted upon, e.g. 'This return is to be completed by the operator'.
- Avoid making nouns out of verbs. For example, 'The Managing Director must certify this document' is clearer and more direct than 'Certification of this document must be done by the Managing Director'. (In this example, making a noun out of a verb also requires passive voice to be used.)
- Use a conversational style rather than omitting helpful phrases for the sake of brevity. An example of conversational style is 'Please comment on any unusual events which affected your agricultural activity this year. Some examples are drought, flood, fires, and hailstorms'. This example is clearer than 'Comment here on unusual circumstances (drought, flood, fires, hailstorms, etc.)'.
- Use words of one or two syllables rather than longer words unless the longer words are very familiar to most people.
- Provide some context for words whose meaning can change in different circumstances. It is important to describe briefly the purpose of the survey and how the statistics will be used.
- Avoid using technical and statistical terms or, if they must be used, explain them in plain English.

LANGUAGE *continued*

- Use simple punctuation such as commas, full stops, and question marks. If a semi-colon or a succession of commas is needed, the sentence should be broken into at least two shorter sentences.

In general, the wording of questions should be as direct as possible and should avoid being ambiguous, too general, or using vague words such as 'occasionally', 'often', etc. The meaning a researcher attaches to a word may not be the meaning respondents attach to it. Things which appear clear to people in the know are often not so clear to the general population. The best way to find out is to test the questions with a group of respondents. If necessary, the questions can then be re-worded and re-tested until the respondents' understanding of the questions matches the researcher's understanding.

PHYSICAL DESIGN

The questionnaire should be physically set out so as to minimise the time needed to interview, respond, and process the results. Specifically, consideration should be given to the form's construction, graphics, and layout. More detailed guidelines are documented in *The Form Designer's Quick Reference Guide* by Robert Barnett (second edition 1994.) Numerous technical papers and books on questionnaire design are also available from libraries.

Construction

The number of pages should be as many as are needed for a clear layout. A small, short form may be cramped, difficult to read and complete and may compromise the results of the survey. It is also important for the paper to be sufficiently opaque so that writing and printing on one side of the paper do not show through to the other side. If a booklet is used, the staples should be on the spine. (Printers refer to this as saddle-stitching.)

Graphics

The speed and accuracy of responses can be enhanced by using the following graphics guidelines which cover the areas of typography, colour, and ruled lines:

Typography

- Line length should be no more than can be read in two or three eye fixations (about 115 mm)—an advantage for poor readers.
- Upper case text is difficult to read, and should be avoided where possible.
- Avoid ornate and decorative typefaces. Serif type fonts (e.g. Times) are easier to read for questions than sans serif types (e.g. Helvetica).
- The top line of questions should overhang the bottom line to prevent poor readers from skipping to the end of the bottom line without reading the whole question.
- Left align text where possible.
- Leading is another point to consider and refers to the amount of space between lines on the form.

Colour

- The background colour of the form should contrast sufficiently with the text to facilitate reading and office processing. For example, black text should be used with white or orange backgrounds.

Ruled lines

- These are used for dividing columns, sections, and questions, and for defining screen boundaries, answer box boundaries, and guidelines for writing in answer boxes.
- Use the minimum number of lines consistent with what is necessary.
- Lines should be as thin as possible to do the job.
- If using Yes/No tick boxes, be consistent in whether 'Yes' or 'No' appears first. It is generally preferable for 'Yes' to appear first although when using filter questions, the 'No' response will usually appear first.
- The aim should be to unclutter the page by removing all unnecessary ink.

Layout

Two basic principles should be followed when designing the layout of a form. Firstly, the graphics standards (discussed in this chapter) should be applied consistently throughout the form. Secondly, the sequence of material presented in the form should match the sequence that respondents are expected to follow when filling out the form. Any notes to questions should appear with the relevant questions so that respondents do not have to alternate between different parts of the form. Enabling respondents to progress through the form one step at a time reduces the likelihood of errors.

Page margins should be 5 mm for the top, bottom and two side margins. The layout within these boundaries can be either full-page (single-column) format or split-page (double-column) format. These two formats should not be mixed on the one page. If instructions or explanations are to be incorporated with the questions, full-page format is preferable as there is sufficient room to allow for this. If a large number of short questions and answers are being used, split-page format offers a better use of space. Split-page format also has the advantages of being easier to read (owing to shorter lines) and of providing a clearer, linear progression for respondents to follow. Split-page format should not be used where a matrix is included covering the full width of the page.

SUMMARY

Questionnaire design begins by determining the data which are to be produced by the survey to meet desired aims and objectives and devising a list of questions to obtain these data. Careful consideration should be given to a number of factors including the types of questions to be used, the logical sequence and wording of questions, and the physical design of the form. It is important to test each of these aspects of questionnaire design with a group of respondents before finalising the questionnaire. If necessary, the form can then be modified and re-tested until respondents can complete it accurately and quickly with a minimum of errors. See chapter 6 for details of survey testing.

CHAPTER 4 SAMPLE DESIGN

INTRODUCTION

Sample design covers the areas of sampling frame, sample size, and sampling methodology. Aspects to be considered within these areas include:

- accuracy required
- cost
- timing
- strata

This chapter describes some alternative sample designs and how to choose the most appropriate one for a particular researcher's requirements. It should be noted that the descriptions given are outlines and additional assistance from a statistician is recommended. In particular, efficient sample design can introduce complexities that are best dealt with by an expert survey methodologist.

SAMPLING FRAME

A sampling frame is a list of all members (e.g. persons, households, businesses, schools) of the target population for the survey. For example, a sampling frame may be the electoral roll, the membership list of a club, or a register of schools. Alternatively, the frame may cover one stage of a multistage sample. For instance, the frame may be a list of schools from which students will be surveyed. In some cases, researchers may need to construct their own frames.

For most sampling methodologies it is important to have a complete list from which to select a sample otherwise the sample may not accurately represent the target population. In practice, however, it can be difficult to compile a complete and reliable list of all population members. Any known deficiencies in the coverage of the sampling frame should be stated when the survey results are documented. Flaws in the sampling frame can include omissions, duplications, and incorrect entries. Omissions are very common and can be particularly serious as the omitted members may have a common characteristic. If there are too many flaws in the frame then the survey results should be used to generalise only about those types of population members which are included in the sampling frame.

Each member of the sampling frame should have a known non-zero probability of being selected in the sample. If a suitable sampling frame does not exist and cannot readily be constructed by the researcher then an alternative method of collecting data should be considered (see chapter 2).

SAMPLE SIZE

Choosing sample size for a survey involves considering factors such as:

- the resources (of time, money, and personnel) available to conduct the survey; and
- the level of accuracy required for the results.

These are distinct but related quantities:

- the amount of detail needed in the results;
- the proportion of the population with the attributes being measured;
- whether members of the target population differ greatly from one another on those attributes (i.e. the variability of the attributes being measured);
- the expected levels of non-response; and
- the sample design used.

Resources and accuracy

Estimates that are based on information from a sample of units in a population are subject to sampling variability. That is, they may differ from the figures that would have been obtained had the entire population been surveyed. A large sample is more likely than a small sample to produce results that closely resemble those that would be obtained if a census was conducted. This difference between survey results, or estimates, and census results can be measured by the standard error.

When planning a sample survey, a researcher may wish to minimise the size of the standard error in order to maximise the accuracy of the survey results. In this event, the sample size can be as large as resources permit. Alternatively, the researcher may wish to specify in advance the size of the standard error to be achieved in order to minimise the costs of the survey. In this case, the sample size is chosen to produce the specified size of standard error.

The standard error is used to construct a confidence interval which is expected to include the 'true value'. A 68% confidence interval is equivalent to the survey estimate plus or minus one standard error of the estimate. A 95% confidence interval is equivalent to the survey estimate plus or minus two times the standard error of the estimate. A 99% confidence interval is the survey estimate plus or minus three times the standard error. In practice, this means that in 99 out of 100 samples the confidence interval is expected to contain the ‘true value’ for the target population.

For example, if a survey finds that 60% of respondents are in favour of a proposal and the standard error of the estimate was 4%, we can be 95% confident that the ‘true value’ lies between 52% and 68%. If the researcher wants to be 95% confident that the ‘true value’ lies between 56% and 64%, a standard error of 2% is required. A reduction in the standard error reduces the range of the confidence interval, but requires a corresponding increase in the sample size.

Determining sample sizes for a simple random sample

To demonstrate how accuracy requirements are used in determining sample size, the following example is provided.

This example assumes a simple random sample is to be selected from an infinite population. If more complex sampling techniques, such as clustering or stratification are used, alternative formula and calculations are required. The proportion p being estimated by the survey needs to be roughly known in advance from supplementary information. However, the formula used in the example will give reasonable results for most large population sizes encountered.

A researcher wishes to measure the proportion of dwellings with electrical safety switches installed. The government safety authority believes that the proportion is approximately 40% and needs to know how many dwellings should be sampled to obtain an estimate with a 95% confidence limit.

The researcher could interpret the requirement of the safety authority as:

p = 0.4
CI level = 95%
CI range = 0.35–0.45

where
p stands for proportion
CI stands for confidence interval

The standard error required to achieve this can be calculated in the following manner:

SE = p–CI range (lower value) / 2
= 0.4–0.35 / 2
= 0.025

If a survey is designed to measure simple proportions, without any requirement for complex classifications of estimates (eg. cross classifications), the following formula can be used to determine the size of the sample:

$$n = pq / SE^2$$

where
n = sample size
p = sample proportion
q = 1–p
SE = required standard error of the sample proportion

The sample size required for this example is calculated as follows:

n = 0.4 x 0.6 / 0.025 x 0.025
= 384

If this survey was then completed with a sample size of n = 384 and it was found that the sample proportion p was 0.3 (not 0.4 as believed), then the standard error of this sample proportion of 0.3 would be 0.023, i.e. 2.3% (using the above formula). The 95% confidence interval for the sample proportion (i.e. 0.3) would be from 0.254 to 0.346.

The following table provides some examples of sample sizes required for certain standard error sizes and sample proportions.

The table assumes that the samples are being randomly drawn from an infinite population.

SAMPLE SIZES

	Standard error of sample proportion (%)									
Sample proportion	*0.5*	*1.0*	*1.5*	*2.0*	*2.5*	*3.0*	*3.5*	*4.0*	*4.5*	*5.0*
%	*no.*	*no.*	*no.*	*no.*	*no.*	*no.*	*no.*	*no.*	*no.*	*no.*
10	3 600	900	400	225	144	100	73	56	44	36
20	6 400	1 600	711	400	256	178	131	100	79	64
30	8 400	2 100	933	525	336	233	171	131	104	84
40	9 600	2 400	1 067	600	384	267	196	150	119	96
50	10 000	2 500	1 111	625	400	278	204	156	123	100
60	9 600	2 400	1 067	600	384	267	196	150	119	96
70	8 400	2 100	933	525	336	233	171	131	104	84
80	6 400	1 600	711	400	256	178	130	100	79	64
90	3 600	900	400	225	144	100	73	56	44	36

Use of relative standard error in the determination of sample size

Relative standard error is defined as:

$$\frac{\text{standard error of the proportion}}{\text{proportion}}$$

Relative standard error is usually preferred in the determination of sample size because of its greater objectivity of application across different values of the sample proportion p.

Cross-classification

If the survey seeks to produce detailed results that include cross-classifications, it is important that the sample size of each sub-group be large enough to produce reliable estimates (i.e. with low standard error) for the sub-group. A useful approach is to draw up a blank table showing all the characteristics to be cross-classified. The more cells there are in the table, the larger will be the sample size needed to produce reliable estimates. This larger sample size, in turn, will require more resources to conduct the survey.

The number of cells in a table is determined by both the number of characteristics to be cross-classified and the number of categories for each characteristic. For example, a table cross-classifying 10 age categories by 2 sex categories by 10 birthplace categories will have 200 cells, a table cross-classifying 5 age categories by 2 sex categories by 2 birthplace categories will have 20 cells, and a table cross-classifying 10 age categories by 2 sex categories will have 20 cells.

Non-response

Sample size should be increased to compensate for expected levels of non-response. However, the characteristics of non-respondents may differ markedly from those of respondents. The survey results could therefore be misleading even if a sufficient number of responses are obtained to produce low standard errors. The higher the non-response rate, the more accentuated this effect will be because the sample represents less of the target population. Selecting larger sample sizes to achieve target response levels may not be an appropriate means of compensating for high non response as those responding may still be unrepresentative of the target population. The first aim should be to minimise non response.

SAMPLING METHODOLOGY

A number of alternative methodologies can to be used to select a sample for a survey. The choice between these methodologies depends on considerations such as the nature of the target population, the nature of any supplementary information that can be obtained, the levels of accuracy desired, the availability of sampling frames, personnel, processing facilities, funds, and the time available to complete the survey. Each of these factors can influence the accuracy of the survey estimates for a given sample size. The reverse is also true-for a given level of accuracy these factors can affect the sample size required.

Simple random sampling

With simple random sampling, each member of the sampling frame has an equal chance of selection and each possible sample of a given size has an equal chance of being selected. Every member of the sampling frame is numbered sequentially and a random selection process is applied to the numbers. The random selection process may involve, for example, using a table of random numbers or randomly selecting numbered balls.

The advantage of simple random sampling is that it is simple and easy to apply when small samples are involved. The disadvantages are that it requires a complete list of members of the target population and it is very cumbersome to use for large samples.

Systematic sampling

Systematic sampling uses a fixed interval to select members from a sampling frame. For example, every twentieth member may be chosen from the frame. The size of the interval *I* is calculated by dividing the size of the target population *N* by the size of the sample required *n*, as follows:

$$I = \frac{N}{n}$$

The members of the frame must first be numbered sequentially. A random number is then chosen between one and the size of the sampling interval *I*. The member corresponding to that number is selected in the sample together with every following *I*th member on the list. (Note: If *I* is not a whole number, then round it to the nearest whole number.)

For example, a systematic sample of 300 students from a registration list of 6,000 would require a sampling interval of 6,000/300=20. The starting point would be chosen by selecting a random number between 1 and 20 from a table of random numbers. If this number was, say, 16, the sixteenth student on the list would be selected in addition to every following twentieth student. The sample of students would be those corresponding to the registration numbers 16; 36; 56; 76;.....; 5,936; 5,956; 5,976; and 5,996.

The advantage of systematic sampling is that it is simpler and easier to select one random number and then every *I*th (e.g. twentieth) member on the list than to select as many random numbers as the size of the sample (e.g. 300). It also gives a good spread right across the population if the list is ordered in a useful way. For example, school students can be ordered by year of study and a systematic sample will yield a good spread of selections across the years of study as well as increase the accuracy (reduce the standard error) of the survey estimates. The disadvantage is that additional variability can be introduced if the list is ordered in a non useful way. In general the list will be at worst random, but extreme cases can arise if poor ordering exists. For example, a frame which lists men and women on alternate lines would produce a sample of all men or all women if the selection interval were an even number. For this reason it is always a good idea to check the ordering of your population to see if systematic sampling is appropriate.

Although a complete list of the target population is required for systematic sampling, the list does not necessarily have to be in written form. Proxy lists can be used such as individual case records in a file.

Stratified sampling

If supplementary information is available concerning the composition of the target population, it may be more efficient to use this information to divide the population into groups, or strata. Either simple random sampling or systematic sampling techniques are then applied to the strata rather than to the population as a whole. The strata should be as different from each other as possible while members within each group should be as like each other as possible. Some examples of strata commonly used by the Australian Bureau of Statistics are States, industry size, age and sex.

Stratified sampling *continued*

When planning a stratified sample, a number of practical considerations should be kept in mind:

- The strata should be designed so that they collectively include all members of the target population.
- Each member must appear in only one stratum.
- The definitions or boundaries of the strata should be precise and unambiguous.

The five main benefits of stratified sampling are:

- The representation of different groups within the sample can reflect the proportions that occur in the target population (e.g. 60% men, 40% women).
- Minority groups can be 'oversampled'. Greater probabilities of selection can be applied to minority groups than to the majority group. This is useful if the survey is focusing more on the minority groups than on the majority group. However, oversampling introduces complexity into the estimation stage of the survey because it must be taken into account in the weights used at estimation. For example, if three times as many of men are selected as women, the weight allocated to men should be one third of that allocated to women when calculating population estimates.
- The results are more accurate. Sampling error is reduced because of the grouping of similar units.
- Different selection or interviewing procedures can be applied to the various strata. This is useful if the strata differ greatly in geography, topography, customs, language, the availability of maps, materials or funds, the convenience of administration or their cost parameter.
- Separate information can be obtained about the various strata. Stratification permits separate analyses on each group and allows different characteristics to be analysed for different groups. Stratification also enables control of an adequate sample in each group. However, analysis across strata is possible even if stratification occurs, thus it is not necessary to have each group that is to be analysed in a separate situation.

Stratification is most useful when the stratifying variables are simple to work with, easy to observe, and closely related to the topic of the survey. However, elaborate stratification should be avoided as difficulties with analysing the results can increase as the number of stratifying variables increases. For example, the sample sizes of the strata need to be large enough to support analysis where desired, so that as the number of stratifying variables increases, the sample size can also increase.

If a stratifying variable is difficult to observe at the sampling stage (e.g. PC ownership, in a household survey) it should be applied at the analysis stage instead. This procedure is known as post-stratification. However, in order to apply post-stratification, it is necessary to know the distribution of the post-strata in the target population.

Cluster sampling

Cluster sampling involves selecting members of the target population in groups, or clusters, rather than individually. Each member within a selected cluster is included in the sample. Examples of clusters are factories, schools, and geographic areas such as electoral subdivisions.

The advantages of cluster sampling are that costs are reduced, field work is simplified, and administration is more convenient than with non-clustered designs. Cluster sampling is particularly suitable for surveys aimed at regional, State, national, or even international coverage. Instead of the sample being scattered over the entire coverage area, the sample is localised in relatively few 'centres' (i.e. the clusters). If the survey involves face-to-face interviews, cluster sampling facilitates the recruitment and teaching of locally based interviewers and reduces travel time and costs. Cluster sampling also facilitates the administration of field work and the supervision of interviewing. The lighter workload and simplified administrative procedures often result in lower costs for expenses such as salaries, office supplies, postage, and telephone calls.

The main disadvantage of cluster sampling is higher sampling error (and therefore less accurate results) than for a simple random sample with the same sample size. This is because members within a cluster tend to be similar while differences between clusters can be large. The extent of the increased sampling error depends on how representative the clustered sample members are of the target population. In practice, cluster samples often need to be larger than simple random samples in order to compensate for the higher associated sampling error. In some cases, the lower costs of cluster sampling permits the sample to be expanded to the point where sampling error is actually lower than for simple random sampling with the same cost constraint.

Two-stage and multistage sampling

Two-stage and multistage sampling involves selecting a sample in at least two stages. At the first stage, large groups or clusters of members of the target population are selected. These clusters are designed to contain more members than are required for the final sample. At the second stage, members are sampled from the selected clusters to derive the final sample. If more than two stages are used, the process of sampling within clusters continues until the final sample is achieved. An example of multistage sampling is where firstly electoral subdivisions (clusters) are sampled from a city or State, secondly blocks of houses are selected from within the selected electoral subdivisions and thirdly houses are selected from within the selected blocks of houses.

Two-stage and multistage sampling *continued*

As with stratified sampling, a number of practical considerations should be kept in mind when planning a multistage sample:

- The clusters should be designed so that they collectively include all members of the target population.
- Each member must appear in only one cluster.
- The definitions or boundaries of the clusters should be precise and unambiguous. In the case of geographic clusters, natural and man-made boundaries such as rivers and roads are often used to delimit the cluster boundaries.

The advantages of multistage sampling are convenience and economy. As with cluster sampling, multistage sampling makes administration easier and reduces interviewing costs. Multistage sampling does not require a complete list of members in the target population and this greatly reduces the cost of preparing the sample. The list of members is required only for those clusters used in the final stage. At other stages, only the clusters need to be listed.

The main disadvantage of multistage sampling is the same as for cluster sampling, i.e. higher sampling error. To compensate for this, larger sample sizes are needed. A design issue which needs to be addressed in working with multistage sampling is the number of units selected in each stage. If more first stage units are selected, costs will generally increase while sampling errors decrease. If relatively more second stage units are selected, the reverse applies. The optimal sampling scheme will take account of the cost and variance structures of the population and is quite complex. Raising the number of clusters selected in the first stage is likely to have greater cost consequences than raising the sampling fraction for later stages.

SUMMARY

The concerns of cost versus accuracy have a major bearing on the choice of both sampling methodology and sample size. The most suitable sampling methodology for a particular survey depends on the nature of the target population, the availability of a sampling frame, the nature of any supplementary information about the target population, the requirements of the survey, the availability of resources and the time available to complete the survey. Choice of sample size often reflects a compromise between the size needed for reliable results and the size for which resources are available. However, if there are insufficient resources to satisfy the survey's objectives in the time available, the survey may need to be modified or even cancelled. Alternatively, non-survey methods could be considered such as those outlined in chapter 1.

The descriptions given in this chapter are merely outlines and the mechanical use of these outlines will rarely produce the best results. Additional assistance from a trained statistician should always be sought for more complex designs. The Australian Bureau of Statistics may be able to provide this assistance through its Statistical Consultancy Service—see contact details on the last page.

CHAPTER 5 SOURCES OF ERROR

INTRODUCTION

Two types of error can occur in sample surveys: sampling error and non-sampling error. Sampling error arises through selecting a sample of only part of the target population. Non-sampling error can occur at any stage of a survey and can also occur with censuses (i.e. when every member of the target population is included). Sampling error can be measured mathematically whereas measuring non-sampling error can be difficult. It is important for a researcher to be aware of the causes of these errors, in particular non-sampling error, so that they can be either minimised or eliminated from the survey.

SAMPLING ERROR

Sampling error reflects the difference between an estimate derived from a survey and the 'true value' that would be obtained if the whole target population were included. If sampling principles are applied carefully, sampling error can be kept to a minimum.

Factors affecting sampling error

The size of the sampling error indicates how different the survey results are likely to be from the results which would be obtained from a complete enumeration of the target population. The following factors influence the size of the sampling error:

- *Sample size*. In general, larger samples give rise to smaller sampling error. However, in order to halve the size of the sampling error it is necessary to increase the sample size fourfold, which greatly increases the cost of the survey.
- *Sample design*. Stratified sampling generally reduces the size of the sampling error by reducing the variability of the population to that within each stratum whereas cluster sampling tends to increase the error.
- *Sample/population ratio*. The larger the sample is as a proportion of the target population, the smaller will be the sampling error. However, non sampling errors may increase as sample size increases.
- *Population variability*. When members of a target population differ widely based on the characteristic being measured, sampling error is greater than when the members are similar. Sample size should be increased in order to make the sample more representative of the target population and to reduce the size of the sampling error. Cluster sampling increases the size of the sampling error when the characteristic being measured is clustered in particular areas which cannot be identified in the sample design stage. Stratified sampling can reduce sampling error by reducing population variability within each stratum.

Measurement of sampling error

One measure of sampling error is called standard error or standard deviation. Any estimate derived from a survey has a standard error associated with it (called the standard error of the estimate). The standard error is used to determine a range of values, or an interval, that is expected to contain the 'true value' that is being measured by the survey estimate. Assuming that the target population is distributed

Measurement of sampling error *continued*

normally (i.e. it follows a bell-shaped curve) on the characteristic being measured, the interval is usually calculated as being one, two, or three standard errors above and below the survey estimate. There is a 95% chance that the confidence interval lying within two standard errors on either side of the estimate contains the 'true value'. This interval is called the 95% confidence interval and is the most commonly used confidence interval. Other confidence intervals are the 68% confidence interval (where the confidence interval lying within one standard error on either side of the estimate has a 68% chance of containing the 'true value') and the 99% confidence interval (where the confidence interval lying within three standard errors on either side of the survey estimate has a 99% chance of containing the 'true value').

For example, suppose a survey estimate is 50 with a standard error of 10. The confidence interval 40 to 60 has a 68% chance of containing the 'true value', the interval 30 to 70 has a 95% chance of containing the 'true value' and the interval 20 to 80 has a 99% chance of containing the 'true value'.

NON-SAMPLING ERROR

In principle, every operation of a survey is a potential source of non-sampling error. Some examples of causes of non-sampling error are non-response, badly designed questionnaire, respondent bias and processing errors. The sections that follow discuss the different causes of non-sampling errors.

Causes of non-sampling error

Non-sampling errors can be grouped into two main causes: systematic and random.

Systematic error (called bias) makes survey results unrepresentative of the target population by distorting the survey estimates in one direction. For example, if the target population is the population of Australia but the sampling frame is just males, then the survey results will not be representative of the target population due to systematic bias in the sampling frame.

Random error can distort the results on any given occasion but tends to balance out on average.

Some of the types of non-sampling error are outlined below.

Failure to identify the target population

This can arise from the use of an inadequate sampling frame, imprecise definition of concepts, and poor coverage rules. Problems can also arise if the target population and survey population do not match very well.

Non-response bias

Non-respondents may differ from respondents in relation to the attributes/variables being measured. Non-response can be total (none of the questions answered) or partial (some questions may be unanswered owing to memory problems, inability to answer, etc.). To improve response rates, care should be taken in training interviewers, assuring the respondent of confidentiality, motivating him/her to cooperate, and

Causes of non-sampling error *continued*

calling back if the respondent has been previously unavailable. 'Call backs' are successful in reducing non-response but can be expensive.

Non-response is a particular problem for surveys of businesses. Care needs to be taken to ensure the right contact is reached in the business, the data required are available and an adequate follow up strategy is in place. Good survey testing (Chapter 6) practices are vital for all surveys, especially those of businesses.

Questionnaire

The content and wording of the questionnaire may be misleading and the layout of the questionnaire may make it difficult to accurately record responses. Questions should not be misleading or ambiguous, and should be directly relevant to the objectives of the survey.

Interviewer bias

The way the respondent answers questions can be influenced by the interviewer's manner, choice of clothes, sex, accent and prompting when a respondent does not understand a question. A bias may also be introduced if interviewers receive poor training as this may have an affect on the way they prompt for, or record, the answers.

Respondent bias

Refusals and inability to answer questions, memory biases and inaccurate information will lead to a bias in the estimates. An increasing level of respondent burden due to the number of surveys being conducted has resulted in considerable difficulty in encouraging potential respondents to participate in a survey. When designing a survey it should be remembered that uppermost in the respondent's mind will be protecting their own personal privacy, integrity and interests. Also, the way the respondent interprets the questionnaire and the wording of the answer the respondent gives can cause inaccuracies to enter the survey data. The non availability of data can also prove to be a significant hurdle for a survey. Careful questionnaire design, effective training of interviewers and adequate survey testing can overcome these problems to some extent.

Processing errors

There are four stages in the processing of the data where errors may occur: data grooming, data capture, editing and estimation. Data grooming involves preliminary checking before entering the data onto the processing system in the capture stage. Inadequate checking and quality management at this stage can introduce data loss (where data are not entered into the system) and data duplication (where the same data are entered into the system more than once). Inappropriate edit checks and inaccurate weights in the estimation procedure can also introduce errors to the data. To minimise these errors, processing staff should be given adequate training and realistic workloads.

Causes of non-sampling error *continued*

Misinterpretation of results

This can occur if the researcher is not aware of certain factors that influence the characteristics under investigation. A researcher or any other user not involved in the collection stage of the data gathering may be unaware of trends built into the data due to the nature of the collection (e.g. for a survey collecting income as a data item among all persons earning an income, the estimate would be different from the estimate produced by a survey conducted among persons found at home during daytime hours). Researchers should carefully investigate the methodology used in any given survey.

Time period bias

This occurs when a survey is conducted during an unrepresentative time period. For example, a survey designed to collect data about the weekly entertainment expenditure of families in Sydney should not be conducted in the period of the Royal Easter Show as the results may be affected by the show itself. If it is required to collect information on people's recreational patterns, these can be affected noticeably by both the time of week and the time of year and such factors would need to be kept in mind when designing a suitable questionnaire.

Minimising non-sampling error

Non-sampling error can be difficult to measure accurately, but it can be minimised by:

- careful selection of the time the survey is conducted;
- using an up-to-date and accurate sampling frame;
- planning for 'call backs' to unavailable respondents;
- careful questionnaire design and adequate testing;
- careful design of the processing system, including edit checks;
- providing thorough training for interviewers and processing staff; and
- being aware of all the factors affecting the topic under consideration.

Non-response

Non-response results when data are not collected from respondents. The proportion of these non-respondents in the sample is called the non-response rate. Non-response can be either partial or total. It is important to make all reasonable efforts to maximise the response rate as non-respondents may have differing characteristics to respondents. This causes bias in the results.

Non-response *continued*

Partial non-response

When a respondent replies to the survey answering some but not all questions then it is called partial non-response. Partial non-response can arise due to memory problems, inadequate information or an inability to answer a particular question. The respondent may also refuse to answer questions if they:

- find questions particularly sensitive; or
- have been asked too many questions (the questionnaire is too long).

Total non-response

Total non-response can arise if a respondent cannot be contacted (the frame contains inaccurate or out-of-date contact information or the respondent is not at home), is unable to respond (may be due to language difficulties or illness) or refuses to answer any questions.

Minimising non-response

Response rates can be improved through good survey design via short, simple questions, good forms design techniques and by effectively explaining survey purposes and uses. Assurances of confidentiality are very important as many respondents are unwilling to respond due to privacy concerns. For business surveys, it is essential to ensure that the survey is directed to the person within the organisation who can provide the data sought. Call backs for those not available and follow-ups can increase response rates for those who, initially, were unable to reply.

Following are some hints on how to minimise refusals in a personal or telephone contact:

- use positive language;
- get the right contact, particularly for business surveys;
- state how and what you plan to do to help with the questionnaire;
- stress the importance of the survey and the authority under which the survey is being conducted;
- explain the importance of their response as being representative of other units;
- emphasise the benefits from the survey results;
- give assurance of the confidentiality of the responses; and
- find out the reasons for their reluctance to participate and try to talk through them.

Other measures that can improve respondent cooperation and maximise response include:

- public awareness activities including discussions with key organisations and interest groups, news releases, media interview and articles—this is aimed at informing the community about the survey, identifying issues of concern and addressing them; and

Non-response *continued*

- where possible, use a primary approach letter, which gives respondents advance notice and explains the purposes of the survey and how the survey will be conducted.

In case of a mail survey most of the points above can be stated in an introductory letter or through a publicity campaign. Other non-response minimisation techniques which could be used in a mail survey are:

- including a postage-paid mail-back envelope with the survey form; and
- reminder letters.

Allowing for non-response

Where non response is at an unsatisfactory level after all reasonable attempts to follow-up are undertaken, bias can be reduced by imputation for item non-response (non-response to a particular question) or imputation for unit non-response (complete non-response for a unit).

The main aim of imputation is to produce consistent data without going back to the respondent for the correct values thus reducing both respondent burden and costs associated with the survey. Broadly speaking the imputation methods fall into three groups:

- the imputed value is derived from other information supplied by the unit;
- values by other units can be used to derive a value for the non-respondent (e.g. average); and
- an exact value of another unit (called donor) is used as a value for the non-respondent (called recipient).

When deciding on the method of imputation it is desirable to know what effect imputation will have on the final estimates. If a large amount of imputation is performed the results can be misleading particularly if the imputation used distorts the distribution of data.

If at the planning stage it is believed that there is likely to be a high non-response rate, then the sample size could be increased to allow for this. However, the problem may not be overcome by just increasing the sample size, particularly if the non-responding units have different characteristics to the responding units. Imputation also fails to totally eliminate non-response bias from the results.

Establishing the extent of non-response bias

If a low response rate is obtained, estimates are likely to be biased and therefore misleading. Determining the exact bias in estimates is difficult. An indication can however be obtained by:

- comparing the characteristics of respondents to non-respondents (e.g. for a survey of attitudes to motor bike racing which is known to be age-related, a comparison of the age distribution of respondents to non-respondents would provide an indication of non-response bias); and

Establishing the extent of non-response bias *continued*

- comparing results with alternative sources and/or previous estimates;
- performing a post-enumeration survey on a subsample of the original sample with intensive follow-up of non-respondents.

Example: Effect of non-response

Consider a postal survey of 3,421 fruit growers that is run to estimate the average number of fruit trees on a farm. Allowing an initial period for response, a low response rate may still exist. After two reminders, suppose there there was still only a 37% response rate with the following results.

	Cumulative response	*Combined average*
Initial response	300	456
After 1 reminder	843	408
After 2 reminders	1277	385

From other information[1], suppose it was known the overall average number of fruit trees was 329. If survey results had been published without any follow-up, then the estimate for the average number of trees (456) would have been too high as farms with a greater number of trees appeared to have responded more promptly. With follow-up, more smaller farms may have sent back survey forms and the estimate (385) became closer to the true value (329).

Benchmarking

Adjusting the weights so they sum to population is referred to as benchmarking. Benchmarking is often used in the ABS to ensure that population surveys are consistent with results from the Population Census. In particular, the ABS benchmarks sex and age break downs. Benchmarking will reduce the effect of non-response bias from estimates, although it will not remove all of the effect.

In some cases, the achieved sample may not accurately represent the population. This could occur due to the random selection of the sample or due to differing response rates for separate population groups. We can use information from other sources to create a more accurate description of the population. Consider a sample of school children in which 30% of the respondents are male and 70% of the respondents are female. Through the schools attendance role we have identified that there are actually 50% males and 50% females in the school. Estimates that we produce from our sample of children would not accurately reflect the entire school. To create more accurate estimates we adjust the

1 In general such 'other information' would of course not be available, otherwise there would be no need to conduct the survey; the above example illustrates though, the need for follow-up to reduce the effect of non-response bias.

Non-response *continued*

weights of the respondents used to derive the estimates, so that they add up to the population total. In this example, the males weight would be increased while the females weight would be reduced.

SUMMARY

Sampling error can be minimised through careful choice of sample design and sample size, within the constraints of available resources. Sampling error can be measured and used to determine how close a sample estimate is to its corresponding 'true value' in the target population. Non-sampling error can be difficult to measure accurately but can be minimised by:

- careful selection of the time the survey is conducted;
- using an up-to-date, accurate sample framework;
- planning for 'call backs' to unavailable respondents;
- careful questionnaire design;
- providing thorough training for interviewers and processing staff; and
- being aware of all the factors affecting the topic under investigation.

If there are remaining doubts about the material covered in this chapter additional assistance should be sought from a trained statistician. The Australian Bureau of Statistics provides this assistance through its Statistical Consultancy Service—see contact details on the last page.

CHAPTER 6 SURVEY TESTING

INTRODUCTION

Testing survey procedures is an important part of developing any survey. Testing is used to:

- assess the suitability of the chosen sampling methodology;
- estimate sampling error and variability in the target population;
- estimate likely response rates;
- identify weaknesses in sample framework, questionnaire design, and the method of data collection;
- assess field work procedures, and processing procedures; and
- estimate costs.

TYPES OF TESTING

Five main types of testing are used to evaluate survey procedures: skirmishing, focus groups, observational studies, pilot testing, and dress rehearsals. Each type is used at a different stage of the survey's development and aims to test different aspects of the survey.

Skirmish or pretesting

A skirmish or pretesting refers to an informal test of a questionnaire with small groups of respondents. The questionnaire used is usually loosely structured, with many open questions, thereby allowing the researcher to examine different ways to word questions. The questionnaire is tested by asking people questions and then getting some feedback from these people on the questionnaire.

A skirmish provides feedback on issues such as:

- the level of knowledge needed to answer the questions; and
- likely responses, and how answers are formulated.

A skirmish is used to detect flaws, awkward question wording, and can also test alternative designs.

Skirmishes are often carried out at the initial developmental stage of the questionnaire or when there is insufficient time or resources available to conduct a focus group or a full pilot test.

Focus groups

A focus group (sometimes also called a discussion group) is an informal discussion of a topic with a small group of people from the survey population, often recruited to meet defined characteristics. It provides insight into the attitudes, opinions, concerns, and knowledge, or experiences of the participants. It is also particularly useful for learning about the scope of a domain, the definitions of items of interest and the comprehension of key words. Focus groups also assist in learning about subgroups and cultures.

Focus groups *continued*

Focus groups can provide a wealth of detailed qualitative information because of the in-depth probing method used. Focus groups can help us to better understand how well respondents understand our concepts, definitions, question wording, and other issues about the topic. They are used to understand the range of attitudes or understanding, rather than gaining quantitative information.

Focus groups are a relatively cheap and easy way to obtain information in a short period of time. Participants can 'feed' off each other, with one comment causing someone to think of another point.

Their purpose is to explore rather than to definitively describe or explain. Therefore focus groups are most often used in the very early stages of the survey development cycle. They are used mostly for new surveys, but can be used for testing changes to an existing survey before the questions are written.

However, group dynamics can interfere with the discussion, e.g. extroverts can take over. This can also bias the results towards the dominant participants. Participants also tend to give 'public' opinions and therefore focus groups are not as suitable for discussion of sensitive issues.

Results from a focus group may be complicated by factors such as:

- people who are willing to take part in a focus group may not be representative of the target population;
- the 'open-ended' nature of responses and hence the large volume of information makes analysis cumbersome.

Focus group research should be regarded as preliminary, with results not generalised to the whole population without further quantitative research.

Observational studies

Observational studies involve getting respondents to complete the draft questionnaire in the presence of an observer. Whilst completing the form, respondents explain their understanding of the questions and the methods required in providing the information. Respondents should be made aware that it is the form that is being tested and not the respondent. It is also important that the respondent is not given assistance in completing the form during an observational study.

Much can be gained from such studies including identifying problem questions through observations, questions asked by the respondents, or the time taken to complete particular questions. Data availability and the most appropriate person to supply the information can also be obtained through observational studies. In the development of business surveys, observational studies are also important for identifying the records that are referenced when providing the data sought, so that advice can be provided to survey respondents about the types of records which would assist in obtaining the data sought for the survey.

Observational studies and/or focus groups can be used to test respondent's interpretation of complex concepts. Particular groups of respondents for which the researcher knows the correct response to a

Observational studies *continued*

topic or series of questions can indicate whether participants are able to respond appropriately to the questions asked.

'Control groups', can be formed that have a particular characteristic or interest that is under investigation. By asking these participants to complete a draft questionnaire or partake in a focus group the research can test whether they are able to respond to the questions being asked. For example, in testing questions on disability, whether a control group, in this case disabled, respond appropriately to the disability questions can be tested.

Pilot testing

Pilot testing involves formally testing a questionnaire or a survey with a small sample of respondents in the same way that the final survey will be conducted. Pilot testing is used to:

- identify any problems with aspects of questionnaire design such as the questionnaire's format, length, wording of questions, and so on;
- compare alternative versions of a questionnaire;
- assess the adequacy of instructions to interviewers; and
- ascertain interview times.

Dress rehearsals

A dress rehearsal is the final test of a survey where the chosen sampling methodology is used to select a small sample from the target population. Dress rehearsals are used to:

- evaluate survey plans;
- estimate survey costs per sampled unit (important for staffing and funding decisions);
- estimate interview, travel, and interviewer editing time per sampled unit;
- estimate variability within the population (i.e. population variances) and hence sampling error; and
- evaluate the processing system design.

If appropriate information is available from previous surveys, it may be possible to estimate population variances and costs from this information rather than from the results of a dress rehearsal. However, if such supplementary information is not available, a dress rehearsal can be used to estimate costs and variances.

Dress rehearsals are normally used only for large-scale surveys.

CONDUCTING SURVEY TESTS

Composition of test samples

The samples chosen for pilot tests and dress rehearsals should be as representative of the target population as possible. This maximises the validity of the test results and ensures that consequent modifications to the survey are appropriate.

Comparison of techniques

Pilot tests can be used as a basis for choosing between alternative procedures for part of a survey. One approach to such testing could be to allocate two equal-size samples to interviewers and each interviewer uses both of the alternative procedures. The two techniques can then be compared without the interfering bias of differing interviewer performance.

Frequency and size of tests

The number of times survey testing should be conducted and the sample sizes used are determined by the complexity of the survey and the availability of funds. For example, a simple, small survey may need only 50 respondents for a pilot test, whereas a larger, more complex survey may need 200 or more respondents.

ANALYSIS OF TEST RESULTS

Implications for questionnaire and survey design

The results of survey testing can bring to light a number of problems with questionnaire and survey design. Some of these problems may be identifiable during a skirmish; others may be identifiable only when the questionnaire is administered to a sample of the target population. Examples of the types of problems that could be highlighted with questionnaire design are:

- non-response to a particular question by a number of respondents;
- multiple answers being given when only one should be chosen;
- a large number of 'other' or 'not applicable' responses to a particular question;
- lack of variation in the responses to a question; and
- general misunderstanding of a question.

The solution to these problems may lie in the sequencing of questions, the instructions accompanying questions, the wording of questions and the answer categories provided for questions. Changing the answer categories can produce more variation in the responses given to a question. Some techniques for doing this include:

- increasing the list of answer categories (while taking care not to make lists too lengthy);
- changing the order of this list; and
- changing the emphasis of the question and/or the answer categories.

In addition to problems with questionnaire design, survey testing may also uncover problems with the:

- sampling frame;
- sampling methodology;
- sample size;
- assumptions regarding population variability used in designing the survey;

Implications for questionnaire and survey design *continued*

- sources of non-sampling error;
- survey administration; and
- processing of the survey data, particularly testing the suitability of forms for data preparation.

Implications for questionnaire and survey design *continued*

Once identified, these problems can be addressed and either eliminated or minimised before the full survey is conducted. When used in this way, pilot testing is an invaluable tool for maximising, within resource constraints, the quality of results obtained from the final survey.

'Previewing' survey results

The results of pilot testing and dress rehearsals can also be used to provide a 'preview' of the results of the full survey. The data gained from the test can be analysed in the same way as the final survey, incorporating tables, statistical analyses (e.g. correlations, scales, etc.) and discussion of the findings.

SUMMARY

Survey testing is an important part of preparing a survey as it enables problems to be identified and corrected before the full survey is conducted. This saves spending resources on a survey whose results may be invalid. Sufficient planning and funds should be allocated to the testing stage in order to ensure that the final survey produces meaningful and valuable results.

CHAPTER 7 SURVEY AND CONTRACT MANAGEMENT

INTRODUCTION

Survey management involves organising and controlling each aspect of a survey being undertaken, while contract management involves ensuring that the work done by a contractor who has been engaged to conduct all or part of the survey is done according to the agreed specifications.

Rather than taking on the responsibilities of directly managing all aspects of a survey, it may be advantageous to contract a consultant to undertake some or all of the associated tasks. Depending on needs and budget, this may range from questionnaire design and sample selection, through to data collection, data processing and report production.

Whether it is decided to conduct the survey totally in-house or to engage another organisation to undertake part or all of the survey development and implementation, it is worthwhile being aware of all the various aspects so that the process can be more effectively managed.

The various aspects of a survey include:

- estimating resource requirements, and monitoring and managing resources;
- developing the survey frame, developing the survey instrument, selecting the sample;
- systems development;
- developing a despatch and collection control system;
- determining employment conditions of interviewers and office staff;
- recruitment and training of interviewers and office staff;
- allocating and managing workflows;
- maintaining personnel records etc.;
- paying interviewers and office staff (including checking travel claims and any other expenses);
- establishing and maintaining office supplies and providing interviewer equipment;
- monitoring the survey's progress;
- undertaking a quality assurance program including adequate testing and evaluation;
- data processing;
- output—preparation and presentation; and
- establishing a survey authority process, e.g. primary approach letters, brochures, identification cards, etc.

FINANCE

The financial resources available are often a deciding factor influencing design of a survey. It is therefore important to make financial estimates for each aspect of a survey and to monitor spending closely. When preparing these financial estimates, it is also essential to ensure that sufficient time as well as funding has been allocated to each stage of the conduct of the survey with particular emphasis on activities such as systems development, training (including documentation) and evaluation.

Adequate resources should be allocated to survey management as it plays a central role in the conduct of a survey, particularly the most labour intensive part. Financial estimates for other aspects of a survey generally fall into three categories: overheads, salaries, and survey and processing costs. Specifically, some of the aspects for which financial estimates need to be made are:

- adequate testing of all facets of the survey;
- hire of rooms (for administration, training of staff, and processing of the survey data);
- systems development and data processing;
- office equipment, printing and postage; and
- salaries and any travel costs including a component for training.

TRAINING

The adequacy of training given to interviewers and processing staff has a strong influence on the quality of results obtained from a survey. Thorough training of interviewers is important because they have a wide range of tasks to perform and are the main point of contact between respondents and researcher. Comprehensive training of office staff should enable them to process the survey questionnaires as accurately and as quickly as possible.

Training can be provided in the form of manuals, formal training courses, and 'on-the-job' training. Topics covered in interviewer training should include:

- the purpose of the survey;
- the scope and coverage of the survey;
- a general outline of the adopted sampling approach;
- the questionnaire;
- recording answers;
- interviewing techniques;
- avoiding or reducing non-response;
- maintaining cooperation;
- field practice;
- quality assurance;
- editing;

TRAINING *continued*

- planning the workload; and
- administrative arrangements.

For processing staff, training should cover:

- the purpose of the survey;
- the scope and coverage of the survey;
- the questionnaire;
- recording of answers;
- coding;
- editing;
- data entry instructions, if appropriate;
- quality assurance; and
- administrative arrangements.

It is also useful to include some form of study exercise to test understanding of the topics mentioned above. Both interviewers and processing staff will improve as they gain practical experience 'on the job' and consolidate their formal training.

SUMMARY

The operational aspects of a survey require thorough planning and efficient management of financial and human resources. In the course of addressing survey management issues, a researcher may find that the survey needs to be modified before it can be conducted feasibly. Since survey management is an integral part of a survey, sufficient resources should be allocated to it to ensure that the survey runs smoothly and produces reliable, timely results.

CHAPTER 8 COLLECTING THE DATA

INTRODUCTION

The procedures to be followed in collecting survey data depend largely on the technique chosen, i.e. self-enumeration or personal interview (see chapter 2).

SELF-ENUMERATION SURVEYS

As outlined in more detail in chapter 2, self-enumeration surveys include:

- those where questionnaires are sent out and returned through the post (postal surveys); and
- those where questionnaires are delivered and/or returned by hand (hand-delivered surveys).

Postal surveys

For postal surveys a questionnaire is generally mailed out with a covering letter and a reply-paid envelope. The completed questionnaire is then returned in the envelope provided. Outstanding questionnaires can be followed up either by written reminders or by telephone.

Stationery requirements

The basic stationery requirements for postal surveys include questionnaires, covering letters, reminder letters, envelopes, reply-paid envelopes, and, if desired, adhesive address labels. It is a good idea to consult the post office on matters such as preferred article sizes, postage rates, and requirements for reply-paid envelopes.

To estimate the number of questionnaires, letters, and envelopes required, information from a previous, similar survey can be used (if available). If such information is not available, estimates must be based on the size of the sample and the expected response rate. For example, a survey obtaining a high initial response rate requires fewer reminder letters, envelopes, and questionnaires than a survey obtaining a low initial response rate. Enclosing an additional questionnaire and reply-paid envelope with reminder letters can boost the final response rate, especially where the original questionnaire has been misplaced or discarded by a respondent. Estimates of stationery requirements should therefore include a component for such additional questionnaires and reply-paid envelopes.

Labelling and dispatch

Before questionnaires are labelled and dispatched, a register (called a collection control register) should be compiled listing all respondents selected in the survey. The register should list each respondent's name, postal address, and some form of unique identification. (The identification, which is usually a number, enables outstanding questionnaires to be identified and followed up.)

When labelling questionnaires, the respondent's name, postal address, and identification number should appear on the covering letter and mail-out envelope (if window envelopes are not used). The identification number should also appear on the questionnaire so that returned questionnaires can be marked off the collection control register either manually or perhaps using OCR technology.

Labelling and dispatch *continued*

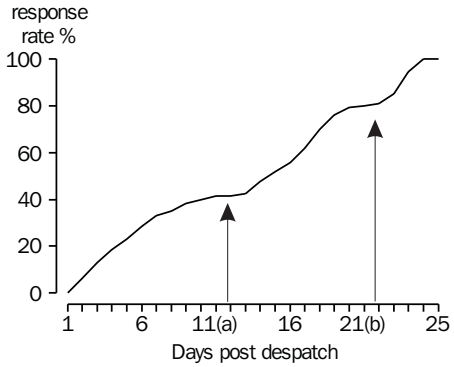
Adhesive labels are a commonly used means of labelling letters, envelopes, and questionnaires. Modern printing techniques also allow for direct printing onto questionnaires of label details. The labels can be printed from the collection control register, either by manual transcription or by computer. For surveys of moderate or larger size, computer generation provides the most efficient method of printing labels. Although computer systems can be costly to establish and maintain, the advantages of generating labels by computer are that names, addresses and identification numbers need to be entered only once, or can be generated directly from the collection control register. If the register is computer-based, labels can be produced quickly and if necessary, extra labels can be produced easily at a later date (e.g. for reminder letters).

When the questionnaires, covering letters, and envelopes have been labelled, the questionnaires and letters must be inserted into the envelopes. Although this is straightforward, mistakes can occur, e.g. the labels on the letter and/or questionnaire may not match the label on the envelope. One way of avoiding this is to use window envelopes, but care must still be taken to ensure the labels on the letter and questionnaire match. Another common mistake is for something to be omitted from the envelope. Errors such as these can create bad impressions and cause non-response. To avoid such problems, materials should be well-organised and spot checks should be conducted as a quality control measure.

Reminder action

As questionnaires are returned, their identification number should be marked off the collection control register. This can be done either manually or by computer, depending on the nature of the register. The control register can then be used to identify which questionnaires need to be followed up. Labels for reminder letters or reminder letters themselves can also be produced from the register, either manually or by computer.

Reminder action should be timed to coincide with the due date and/or a drop in the rate at which questionnaires are returned. To identify this time, the response rate should be calculated and updated regularly, e.g. daily (the rates can be used to plot a graph, as a direct visual aid).



(a) First reminder sent.
(b) Second reminder sent.

Reminders (whether by letter or telephone) should then be effective without being wasteful. The collection control register should also be annotated to show:

- which respondents have received reminders;
- the date(s) on which reminder action was taken;
- any comments or queries from respondents; and
- which questionnaires have been returned as unclaimed mail.

Hand-delivered surveys

In hand-delivered surveys, it is generally not essential to know respondents' names. A questionnaire is generally delivered personally by an 'interviewer' or collector who introduces and explains the survey to the respondent. The respondent completes the questionnaire in his/her own time and either returns it in the reply-paid envelope provided or gives it to the collector on his/her return. Outstanding questionnaires can be followed up by means of reminder letters or 'call backs' by the collector or both. In other respects, the collection procedures and processes for hand-delivered surveys are basically the same as for postal surveys.

INTERVIEW SURVEYS

As discussed in chapter 2, interview surveys can generally be conducted by one of two methods: face-to-face interviews and telephone interviews.

Face-to-face interview surveys

Many surveys are conducted by face-to-face interview because the units selected in the sample cannot be identified by name and address. In such cases, areas are selected and then, within these areas, dwellings/shops/factories/etc. can be further selected, according to the nature of the survey (see chapter 4 Cluster sampling and Two-stage and multistage sampling).

Workload allocation

Each interviewer is given a workload, or group of interview selections, to complete. When determining the size of a workload, consideration should be given to the:

- time taken for each interview;
- time available for interviewing;
- distances to be travelled;
- complexity of the questionnaire;
- number of interviewers available;
- total number of interviews to be conducted; and
- expected number of 'call backs' required.

Depending on how far interviewers live from the areas where interviewing is to be conducted, workloads can be distributed:

- at training or briefing sessions;
- by mail;
- by courier; or
- by interviewers collecting them from a central point.

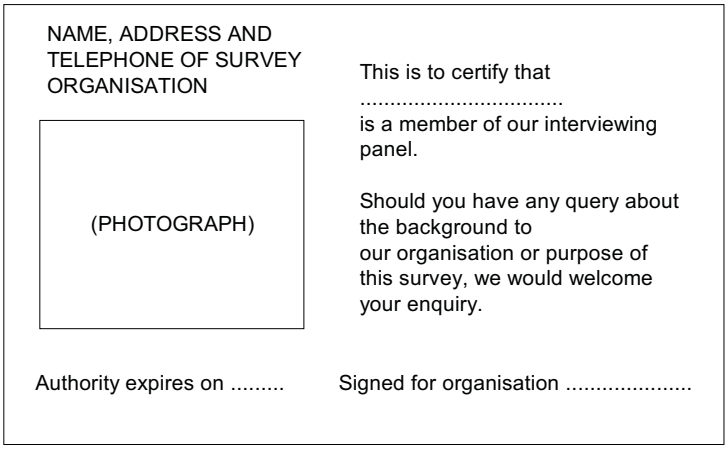
Interviewing

Interviewers should check that all necessary documents have been obtained before starting to interview. It is a good idea to try to complete as many interviews as possible early in the interview period. This allows time both for 'call backs' to unavailable respondents and for clarifying any problems on the questionnaires.

Interviews should be conducted at a time convenient to respondents, even if this means calling back at a later date. In particular, it is wise to avoid calling before 9.00 a.m. or after 8.00 p.m.

The interviewer's opening remarks and the manner in which they are made have a strong influence on respondents' reaction and their willingness to cooperate. Before any questions are asked, the interviewer should:

- give his/her name;
- explain that a survey is being conducted and by whom;
- provide an identification document and give the respondent time to read it—the document should include the telephone number of the survey manager or supervisor;



- explain that the respondent's household/business/etc. has been selected in the sample for the survey; and
- briefly explain the purpose of the survey.

Some respondents may wish to satisfy themselves that the survey and interviews are genuine. If respondents have questions about the survey, the interviewer should answer them genuinely, drawing on knowledge gained during his/her training.

In addition to the interviewer's attitude and ability to answer respondents' questions, the interaction between interviewer and respondent is crucial for gaining and maintaining respondents' cooperation. Some techniques the interviewer can use to enhance this interaction are to:

- listen attentively;
- allow a respondent to relate personal experiences;
- keep the interview time short;
- refrain from any suggestion that one answer is more acceptable than another to the interview.

A well-designed questionnaire should include instructions to guide the interviewer through the questionnaire. It is also important for the interviewer to have a thorough knowledge of the questionnaire so that the interview can proceed smoothly. It is essential that all questions are asked exactly as worded on the questionnaire. This avoids the possibility of a question taking on a different meaning and introducing bias to the results. If a respondent has difficulty understanding a question, it should be repeated more slowly and, if necessary explained further. However, the interviewer should avoid rewording the question in later interviews.

Interviewing *continued*

Respondents' answers should be recorded clearly so that they are unambiguous to office processing staff. Answers are usually recorded by inserting a tick or a number in the appropriate boxes, or by writing an exact account of the respondent's answer in the space provided on the form.

To close the interview the interviewer should thank the respondent for his or her cooperation and check to see if the respondent has any further questions about the survey. Respondents should be advised if any additional or follow-up interviews are planned.

Editing

After each day's interviews have been completed, interviewers should check questionnaires for completeness, accuracy, and correct sequencing of questions. If necessary, 'call backs' for any missing information can then be planned.

Non-response

Any cases of refusal should be notified to the survey's manager as soon as possible. The survey manager should also be notified of any questionnaires which are retained for 'call backs' after the date set for returning questionnaires to the office.

Telephone interview

Where sample members can be identified by name and telephone number, and survey objectives and sample design are compatible with telephone use, use of telephone interviewing can greatly reduce both the cost of the survey and the time elapsed before survey results are available.

Questionnaires for telephone interviewing generally need to be much briefer and simpler than for face-to-face interviewing as it is much easier for a respondent to end the interview prematurely (see chapter 2).

Workload allocation

The size of a telephone interviewer's workload should be determined realistically according to the:

- time for each interview;
- time available for interviewing;
- complexity of the questionnaire;
- number of interviewers;
- total number of interviews to be conducted; and
- expected number of telephone 'call backs' required.

As telephone interviewing is generally conducted from an office, workloads are generally distributed at the office.

Interviewing

Many of the principles of face-to-face interviewing apply also to telephone interviewing. If anything, the techniques for gaining and maintaining cooperation are even more crucial to the success of telephone interviewing than face-to-face interviewing because of the:

- greater difficulty in establishing rapport without the assistance of non-verbal cues; and
- greater ease with which respondents can end a telephone interview.

Editing

Following interviewing, telephone interviewers should check their questionnaires for completeness, accuracy, and correct sequencing of questions (as with face-to-face interviewing). With CATI, however, editing is conducted 'on line' during the course of the interview itself.

Non-response

The procedures for dealing with cases of refusal are basically the same for telephone interviewing as for face-to-face interviewing.

QUALITY ASSURANCE

The basic aim of any quality assurance program is to ensure that, within resource constraints, errors are minimised. The key to quality assurance and improvement is to be able to regularly measure the cost, timeliness and accuracy of a given process so the process can be improved when a fall in quality is indicated. The emphasis is on process improvement rather than correction.

Quality assurance should be undertaken at all stages of a survey, to enhance the quality of subsequent stages and the final results. For repeating surveys, changes in processes and procedures identified can be implemented in subsequent cycles of the surveys to improve the quality of the results.

The key elements of quality assurance are preparation and evaluation. In developing a survey, there are elements of the process which are essential to realising quality outcomes. In terms of preparation, researchers should test their proposed methodology and survey technique to ensure that the correct tools have been selected and that the procedures specified are appropriate. It is also essential to prepare documentation covering each aspect of the survey well in advance and to prepare comprehensive training programs for each aspect of the survey.

Continuing evaluation of the strategies, techniques and procedures employed for the survey is also necessary to ensure that the lessons available from the day to day work of conducting the survey are used to enhance the quality of the survey outcome.

Auditing is the final aspect of quality assurance activities with potential to impact on the quality of survey outcomes. While testing, effective preparation and evaluation are the crucial components of quality assurance, some auditing of processes will provide indicators of the

QUALITY ASSURANCE
continued

reliability and appropriateness of the techniques in use for the survey. This might take the form of probity checking of interview work or, perhaps, re-coding of survey responses. Both of these approaches can provide early and accurate sources of feedback about the performance of the techniques chosen to conduct the survey. This feedback can be used to improve these processes.

Please note that if monitoring of telephone interviews is a chosen quality assurance method, respondents must be warned that the telephone conversation may be monitored for quality assurance purposes.

Post-enumeration survey

A post-enumeration survey or study (PES) is a follow-up interview with a sample of respondents and non-respondents after a survey has been conducted in the field, with the aim of evaluating the quality of the data. This may either be done through face-to-face interviews or by telephone, using questions about how the respondent completed the form and comparing the original responses with those obtained in the PES.

A PES is conducted to uncover consistent errors made by respondents, and to find out why those errors are occurring. Particular aspects can be investigated in detail, if they are suspected problem areas.

In practice a PES sample will generally be selected from those who responded to the original survey or special study conducted. This will most likely be a list of 'potential' PES respondents from a particular area chosen to conduct respondent visits. Ideally this list should be randomly ordered so that the final PES respondents are a random sub-sample. If there are any other dimensions (e.g. size of business) other than area to be considered then the profile of the final selections should be checked as many respondents will decline. The representativeness of the final sample can be checked.

SUMMARY

Regardless of the method used to collect the survey data, the actual process of collecting data involves considerable preparation and organisation. Procedures need to be well planned and easily translatable into action. If sufficient resources are allocated to an effective quality assurance program, potential problem areas can be identified at an early stage and allowing for adjustments to the processes and procedures to take place at an early stage and minimising the negative impact on survey results.

CHAPTER 9 DATA PROCESSING

INTRODUCTION

Data processing involves translating the answers on a questionnaire into a form that can be manipulated to produce statistics. In general, this involves coding, checking, data entry, editing and monitoring the whole data processing procedure.

PROCESS CONTROL

The main aim of the various stages of data processing is to produce a file of data that is free from errors. Adopting a methodical and consistent approach to each task is important to ensure that the processing is completed satisfactorily and on schedule.

Documentation

Comprehensive written instructions are required to specify data processing procedures, addressing most issues which can arise. These instructions should include:

- code lists;
- clerical and computer editing guidelines;
- guidelines for using the computer system (if one is used);
- a timetable; and
- a list of contact names indicating who is in charge of the various aspects of the survey. This enables the survey processing staff to know whom to approach if problems arise.

Timetabling

A timetable is essential for planning purposes and for ensuring that adequate resources are allocated to the various stages of processing. For example, there may be time restrictions on the availability of key punch operators. This would require completed questionnaires to be available at the time key punch operators are available.

Distributing copies of the timetable to all processing staff helps to ensure that the data are processed on schedule. The timetable should be constructed realistically, taking into consideration the:

- number of processing staff available;
- number of questionnaires to be processed;
- length and complexity of the questionnaires;
- expected number of errors needing clarification with respondents;
- expected number of days off due to public holidays, sickness, etc.; and
- date by which survey results are to be available.

Process control register

A register containing information about the processing of the questionnaires is a useful method of enhancing the accuracy of survey results. The register should indicate which questionnaires have been:

- sent for punching;
- edited;
- declared, 'clean', that is, free from errors; and
- when 'clean', loaded on to the final data file.

The process control register can then be used to ensure that all questionnaires to be included in the final results have passed satisfactorily through the processing procedures.

Quality assurance

Quality assurance measures for the data processing stage include selectively checking that questionnaires have been correctly:

- coded;
- punched/entered into a processing system;
- edited; and
- acknowledged as being final or 'clean' after passing through the processing stages.

Other crucial aspects of effective quality assurance for the data processing stage include the preparation of accurate and comprehensive documentation and the provision of comprehensive training for staff involved in each stage of the survey. Once processing commences, analysis of repeating errors will assist in 'fine-tuning' editing procedures, to indicate where retraining may be necessary, and, for any subsequent iteration of the survey, will provide input to re-development.

During processing, checks can also be made on the performance of the interviewers and, to some extent, the questionnaire itself. Interviewers' error rates and any problems with particular questions or sequencing may indicate the need for some retraining of interviewers or amendments to instructions. For smaller surveys, this information may not be useful to the current survey but any subsequent surveys should benefit. Alternatively, conducting a pilot test before the full survey should enable this sort of information to be utilised.

The extent of non-response can also be monitored during processing, especially with respect to partial non-response. Questionnaires that are returned incomplete can be extracted for follow-up action with as little delay to the processing schedule as possible.

It is generally not possible for processing to improve the accuracy of data. At best, it may reduce some inconsistencies. It is important to incorporate adequate testing, training, documentation and evaluation at early stages to improve the quality of data.

CODING

Unless all the questions on a questionnaire are 'closed' questions, some degree of coding is required before the survey data can be sent for punching or analysed. The appropriate codes should be devised before the questionnaires are processed, and are usually based on the results of pilot tests (see chapter 6 Survey testing).

Most surveys are too large and complex to be analysed by checking questionnaires and counting responses, so the researcher cannot cope with the volume of answers. Surveys usually require a system by which the responses can be transferred onto a computer file for analysis. This system involves translating all responses into numerical codes.

Coding consists of labelling the responses to questions in a unique and abbreviated way (using numerical codes) so as to facilitate data entry and manipulation. Codes should be formulated to be simple and easy, for example if question 1 has 4 responses then those four responses could be given the codes 1, 2, 3 and 4.

The coding frame for most questions can be devised before the main interviewing begins. That is, the likely responses are obvious from previous similar surveys or through pilot testing allowing those responses and relevant codes to be printed on the questionnaire. An 'other answer' code is often added to the end of a coding frame with space for interviewers to write the answer. The standard instruction to interviewers in doubt about any precoded responses is that they should write the answers on the questionnaire in full so that they can be dealt with by a coder later.

In some cases, however, the final coding has to be done after fieldwork as part of the data preparation task. The open-ended responses on each questionnaire have to be assigned numerical codes according to either coding frames formulated from pilot tests and dress rehearsals or certain standard coding systems such as the Australian Standard Geographical Classification—see below.

Classification systems

A major function of the Australian Bureau of Statistics (ABS) is the development of statistical standards, classifications, and frameworks. These classifications cover a wide range of subjects. A list of some useful ABS classifications is presented in Appendix 4.

ABS classifications should always be considered when designing questions for a questionnaire because they are easily coded and allow for comparison with data from ABS and other sources. The ABS can provide assistance to organisations planning to use ABS statistical classifications through its Statistical Consultancy Service—see contact details on the last page.

CHECKING

During the data preparation stages of a survey the completed questionnaires have to be checked and transferred into a format suitable for analysis, whether it be clerical or computer analysis. The main functions involved in data preparation are coding and editing.

CHECKING *continued*

In most surveys there is both clerical and computer editing. This inevitably leads to some double checking, but to dispense with one of these edits would allow more errors to pass through to the data analysis stage.

The main purpose of clerical editing involves detecting and correcting errors made during enumeration. When carried out concurrently with interviewing, clerical editing can prevent errors by providing feedback to the interviewers on their mistakes. These mistakes could include writing down ambiguous answers, misunderstanding sequencing instructions or entering numerical answers incorrectly, e.g. 02.4 instead of 2.40.

Clerical editing can save time and money but it should be carefully targeted to ensure that the most effective use of resources is made. Commonly, editing is targetted to those respondents that make the largest contribution to estimates, and/or those respondents which come from large units such as businesses with a large number of employees.

Clerical editing should only be used to check for very obvious errors and in circumstances when information on the questionnaire may be needed to resolve a query. Comprehensive checking of questionnaires should be handled by computer. Checks that would be both tedious and uneconomic to handle clerically can be handled quickly, easily and more comprehensively by a computer edit. Further, the data preparation stages can produce errors made during clerical editing, coding or punching and a final check is necessary before the analysis to ensure the data is final or 'clean'.

DATA ENTRY

Up to this chapter, the questionnaire has been considered mainly as a means of communication between interviewer and respondent. Its other, and just as important, role is as a working document for coders and computer operators, and as a medium for the transfer of data on to a computer file. By using the questionnaire in this second role as a data input document we are removing the need for a separate data input form. This also removes a stage that could produce transcription errors.

Designing a questionnaire so as to facilitate data entry is discussed in chapter 3.

Optical Mark Recognition

Optical Mark Recognition (OMR) is a form scanning method whereby responses are read into a computer without a keyboard. These responses are then transformed into code. Both the 1991 and 1996 Censuses of Population and Housing were ‘data captured’ in this manner.

How it reads

The OMR’s software is programmed to read predetermined areas of a page on which responses are ‘expected’ to appear. The page is fed into the machine and the ‘clock tracks’ printed down the side of each page tells the OMR when to switch on its bank of ‘read heads’ to capture a response. The area in which a mark is expected may be scanned up to seven times in one second to detect a mark. This is called ‘mark sensing’.

How it reads *continued*

The number of clock tracks printed down the page is limited only by the question responses that can be given.

The paper forms are still required in later processing.

Intelligent Character Recognition

Intelligent Character Recognition (ICR) is similar to OMR but a computer image of the whole page is taken (both sides).

How it reads

The page containing responses is fed into scanning equipment and an image (either black and white or colour) is taken of both sides of the page. The images are then put through recognition software to interpret the responses. Both tickbox and hand written responses in specific areas of the page are recognised. The 'unrecognised' responses are sent onto a 'repair' stage of processing for amendment via human intervention. The responses, both text and tickbox, are reformatted into a code for later processing.

Advantage of ICR over OMR

The paper-based pages of a form are no longer required for further processing as this can all take place from the image. This is a huge advantage over OMR in that the paper forms can be stored offsite or destroyed freeing up space both within a building and on a workstation desk. The time and cost savings in not moving the pages physically from process to process around a building are quite substantial.

The ICR or Optical Character Recognition (OCR) machine can read the tickbox responses better than is the case with OMR. It achieves this because it takes an image of the page and this process is better for mark recognition, therefore increasing data quality and overall throughput.

Another advantage of ICR over OMR is the large amount of data that ICR can electronically capture from a page. The data are then input to an automatic coding program which saves on staff years and further increases quality.

ICR/OCR is rapidly becoming the industry standard solution for the capture of form-based data. This is heavily supported by the amount of software available and an ever increasing interest in faster and more accurate data capture methods.

EDITING

It is important to note that even though we go through comprehensive editing processes errors may still occur. Editing can identify only noticeable errors; it can correct items of information wrongly given by respondents or wrongly transcribed by interviewers only when there are clues that point to the error and provide the solution. Thus the final computer file will not be error-free, but should be internally consistent.

Records should only be transferred to the final computer file after they have passed through all the edit checks without a failure. A record that fails even one check should not be transferred.

EDITING *continued*

There are five main editing checks performed clerically or by computer that should be considered.

Structure checks

These are undertaken to ensure that all the information sought has been provided. Clerically this involves checking that all documents for a record are together and correctly labelled. For example, a household questionnaire and a separate questionnaire for each person in the household may have to be identified and linked. The computer edit could involve a check to see that all entries are present in a record.

Range edits

The range of possible codes for each question is known. In some cases only codes 1 (yes) and 2 (no) are possible while in other cases codes 1–9 or more may be used. The edit function in this case (mainly computer edit) is to check that no code outside the valid range has been entered.

Sequencing checks

For each question that should have been answered by only a subsection of the sample, two checks need to be made; first, that all those who should have answered the question (by virtue of a particular answer to an earlier question) have done so; second, that no-one else has.

Duplication and omissions

Editing problems can arise where responses have been omitted. If the omission is an isolated or minor one it can be dealt with by the insertion of a 'not answered' code unless of course, the answer can be deduced from other information on the questionnaire.

The data entry process is another area that should be monitored closely. Once the data have been entered the records should be checked for duplication. This can happen frequently if the data entry process is not documented fully.

Logic edits

In some cases precise logic checks can be specified in advance. For example a person under 15 cannot be in the full-time labour force or a male cannot be pregnant. In other cases scrutiny may be advisable to pick up unlikely occurrences such as a family of 18 people or a person over 15 at primary school. They may be genuine or they may be the result of a misunderstanding or incorrect transcription. Responses to other questions may be checked to see if there is a clue to the appropriate entry. Examples of other types of logical edits which can be used include the ratio of income to expenses (in a business survey), comparison with like data from similar or past surveys and checking of outliers (respondents who have reported values well outside the typical range of responses).

SUMMARY

The key points to address in developing an effective data processing strategy are:

- target the editing effort to large contributors and large units within the survey population;
- don't over-edit;
- automate the editing process where feasible; and

SUMMARY *continued*

- feedback information from the data processing stage to refine the conduct of the survey through changes such as improvements in question wording, questionnaire design, training and instructions.

The data processing stage is an integral part of the sample survey. It is a stage that ensures an acceptable accuracy through process control, checking and editing. Coding and data entry techniques will also help ensure acceptable timing, and therefore costs, for the survey.

CHAPTER 10 ANALYSIS OF RESULTS

INTRODUCTION

This chapter provides a brief outline of some methods commonly used in analysing the results of a survey. Consultation with an experienced statistician is recommended before any analysis work is undertaken. (Some common statistical terms used in the analysis of results are explained in Appendix 1.)

DESCRIPTIVE STATISTICS

It is often desirable to have summary measures to indicate the location of a frequency distribution on a scale, for example a time scale. This helps the researcher build up a picture of the distribution and facilitates analysis. Summary measures also enable the comparison of frequency distribution before and after a specified event (e.g. number of car accidents before and after a change in traffic laws). A change can indicate a shift in the frequency distribution.

Measures of location

Arithmetic mean

The arithmetic mean is the most commonly used measure of location and is the 'average' of a set of sample values. The formula for calculating the mean of a set of values is:

$$\bar{x} = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n}$$

where $\bar{x}$ is the mean value

$x_1, x_2, x_3, \ldots x_n$ are the observations

n is the number of observations in the sample

Median

In some frequency distributions the mean is not close to the concentration of values. In such cases the mean is not a good measure of the location of the distribution and the median which is more central, is generally used. The median of a set of values is the middle value when the values are sorted into order. (When there is an even number of values in the set the median is the arithmetic mean of the middle two values.)

Mode

The mode of a frequency distribution is the most frequently occurring value. In general the mean and median are better measures of location, however the mode is useful when the values are unevenly spread.

Measures of spread

In summarising datasets it is also important to know the variability of the values (i.e. how spread out the values are).

Range

The range is the difference between the largest and smallest value. It is a common measure in industrial quality control and meteorology because of its ease of computation. However a disadvantage of the range is that it tends to increase as the sample size increases. In addition, it does not provide any information about the distribution of values.

Variance

The variance describes the spread of data around the arithmetic mean and is the average of the squared differences between the value of the variable (e.g. height of each person) in the sample and the mean height of the sample. The variance can be used to make a statistical inference about the population from which the sample is drawn. It is possible to have two samples with the same mean but different variances. A larger variance indicates that the data are more spread out about the mean.

The sample variance is calculated by:

$$s^2 = \frac{1}{(n-1)} \sum_{i=1}^{n} (x_i - \bar{x})^2$$

where n = number of observations in the sample
x_i = value of the ith observation in the sample
$\bar{x}$ = arithmetic mean

NORMAL DISTRIBUTION

For many populations the distribution of values is a specific bell-shaped curve, called the normal curve. The normal distribution is the most useful in statistics as certain properties always hold and consequently the construction of confidence intervals (see chapter 4) is straightforward. Errors made in measuring physical and economic phenomena are often normally distributed. In addition, many other distributions can be approximated by the normal curve. In a normal distribution, 95% of the sample means lie within two standard deviations of either side of the population mean and 99% of the sample means lie within three standard deviations of either side of the population mean.

TABLES

Table production can give a researcher a clearer picture of what the data holds and can therefore help determine the type of statistical analysis that could be undertaken on the data. Tables can also be used to summarise the data enabling the reader to draw his/her own conclusions. Some examples of tables are given below.

UNIVARIATE

	%
Agree	59
Disagree	41
Total	100

BIVARIATE

	Males	*Females*
	%	%
Agree	57	61
Disagree	43	39
Total	100	100

MULTIVARIATE

		Males		*Females*
	Secondary	*Tertiary*	*Secondary*	*Tertiary*
	%	%	%	%
Agree	54	60	56	66
Disagree	46	40	44	34
Total	100	100	100	100

More complex forms of analysis are possible. For example, standardising for age and other variables when comparing data for different geographic areas may be relevant for health related variables.

For more information on tables and other forms of data presentation see chapter 11.

SUMMARY

The quality of statistical analysis depends not only on using the most suitable statistical method but also on the quality of the data. Good quality data will only be achieved with adequate planning before the survey is conducted, particularly if hypothesis testing is expected to form part of the analysis. Again it should be noted that analysing survey results can be a complex task and it is recommended that an experienced statistician be consulted. The Australian Bureau of Statistics can provide advice on the analysis of results through its Statistical Consultancy Service—see contact details on the last page.

CHAPTER 11 PRESENTATION

INTRODUCTION

Communicating the results of the survey to the people who commissioned the survey is the ultimate goal. A further important phase is involved—that of communicating the results in a clear and logical format, to the decision makers and information users.

The format of presentation should be tailored to satisfy the users. Consideration should be given to the level of statistical understanding of the users, particularly in regard to statistical terminology.

WRITTEN REPORT

In presenting the data some form of written report or paper is essential. Such a report is more likely to be a success if it conveys a number of specific messages rather than a broad spread of generalised information. The report should follow a logical progression, give precise statements on the conclusions which have been reached and if appropriate, make recommendations for future action. It should clearly distinguish between verifiable facts, and opinion and interpretation. Careful consideration should be given to language and grammar as well as the design and layout (for example graphs and tables may add to the quality of the report). A preponderance of graphs and diagrams however may be just as confusing as many pages of text so it is important to strike a balance. A careful study of other reports may be helpful in planning the design.

The contents of the report and its balance of words and tables will naturally depend on the subject, the conclusions and the likely readers. However, the following sections are generally included in a survey report:

- Introduction: states the purpose and aims of the survey and the aims of the report; gives the background to the research; discusses previous relevant studies; defines terms and concepts; states whether the survey is testing an hypothesis or is exploratory.
- Methodology: gives the method of sampling and information on the survey population as well as how the data were analysed and the statistical procedures which were used.
- Findings and analysis: the main part of the report which deals with details of the sample numbers, response rate, etc. and discusses possible courses of action.
- Conclusions: summarises the major findings of the report.
- Recommendations: states what actions are indicated on the basis of the conclusions.
- References: lists the books, journals and papers referred to during the study.
- Appendixes: consists of items which may be useful to the reader (e.g. the questionnaire) but are not essential to the report.

WRITTEN REPORT *continued*

A synopsis which summarises the report into one page is often worthwhile. Remembering that the report is likely to serve as a basis for discussion, some other important considerations are the title, use of headings and subheadings, the colour and design of the cover and the overall appearance of the report—it should stimulate the reader's interest.

STATISTICAL PRESENTATION

The form of presentation will depend on the data. Tables and graphs are the most common form of presentation but other types are available. In general, tables are more accurate—showing the actual values, whereas graphs are more useful in showing relationships—concentrating on form, shape and movement. Graphs are particularly useful in representing the change in the value of a data item over a period of time.

Tables

Tables are the most common form of statistical presentation and should show both additional and necessary information which could not be conveyed in general text. A good table is one in which patterns and exceptions are obvious at a glance and may be further enhanced by a short paragraph commenting on a major feature of the data. Headings must be clear and give descriptions of items and classes.

Some additional guidelines which may be helpful:

- rounding data to about four or five significant figures makes data easier to grasp and manipulate;
- reading down a column is easier than reading across a row, especially for a large number of items;
- row and column averages or percentages may help the reader interpret the data;
- widely spaced columns are difficult to compare and should be avoided; and
- totalling of rows and/or columns is usually helpful.

Graphs

A graph is a visually attractive way of presenting data. Although the amount of information which can be presented is limited, a graph is a useful adjunct to other forms of statistical presentation and can often reveal 'hidden' facts in complex data. Relationships and trends are more clearly grasped and therefore better remembered from a graph, rather than from a table or text. However, a graph is not always necessary and should not be included as a matter of course.

Constructing a graph

- Titles: a title is essential and is best placed at the top. It should indicate the 'what, where and when' of the graph as concisely as possible and should be larger than the lettering on the graph itself.
- Scales: the horizontal scale usually measures the time unit and the vertical scale the variable under consideration. Where possible the vertical scale should begin at zero to avoid over-estimating the differences of the variable between time periods. When the data cover a wide range, a break in the 'amount' scale may be useful but only if this will not distort the overall picture. The time scale should never be broken.
- Other considerations:
  - avoid clutter. It can lead to misinterpretation;
  - both axes should be named with scales and units marked;
  - care should be exercised in plotting multiple variables in the one graph. Labels and/or a legend may complicate the graph unnecessarily;
  - footnotes may be used to explain unusual features, such as breaks in the series.

Types of graphs

The decision as to which type of graph is to be used will depend on the field of study, the characteristics of the data, cost, study objectives, likely readers and the authors' expertise.

The following sections give a brief description of the various sorts of graphs which may be used:

Line or curve graph

These may be used when the emphasis is on the movement rather than the size of the data item or when several series are being compared. This type of graph shows variations in the data plotted over a period of time. It is widely used and easy to construct but should not be used when categorical variables are being plotted, e.g. comparing numbers of goats, horses and sheep.

Bar or column graph

This type of graph depicts numerical values over a given variable, for example time. The value is represented by the height of the column. This type of graph is especially effective for showing large changes from one period to the next. The columns may or may not be connected. Connected columns are best used when there are many columns and spacing would appear crowded.

Grouped columns/bars graph

These are used to compare two or three different categories on the same graph.

Semi-logarithmic graph

This graph is useful when comparing two series with widely different arithmetic values. In such a case it is the relative change which is of greatest interest. In this type of graph the arithmetic values are converted to logarithmic values. This enables easier comparisons as two series with the same rate of change will be parallel to one another.

Pie chart

This graph gives a comparison (in percentage terms) of components with each other and with the whole. This type of graph can be used when there are a small number of categories, say seven or less, and when the composition of the population is of interest. If the actual number, rather than the share, is of interest, other types of graph are more suitable as the human eye can read lines more effectively than angles.

Map

A map can be used to show boundaries of local government areas, State electoral provinces, etc. Maps can also be used to display survey results in a spatial context, for example, concentrations of particular variables in local government areas.

OTHER FORMS OF PRESENTATION

Depending on the circumstances (users, type of data, results), a written report may be inadequate or may need to be supplemented. Oral presentation of the results of a survey is often neglected as an important means of conveying information. Whereas a written report provides great detail with a wide range of results an oral session can only emphasise a few major points. However, this can often be most suitable depending on the audience. As with a written report poor presentation may cause the survey results to be rejected. The spoken word and visual aids can have a great impact on an audience. The presenter therefore should be aware of the nature of the audience and know what survey results may be contrary to existing ideas.

A poster is one way to attract attention but only one direct statement should be made. The message must be noticeable at a glance and the poster itself must be attractive to encourage possible users to inspect it.

A panel exhibit is an extension of the poster presentation. This type of presentation gives more details and expands several main ideas. Again it is important that the panels be colourful and attractive.

The use of videos or television can provide an additional means of communication of the survey results.

SUMMARY

The presentation of data in some form of report is the culmination of many weeks, months or even years of work. Thoughtful use of text, tables and diagrams can provide a document that is understood and can be used. It will inform the reader by presenting all that needs to be known to make an informed decision.

APPENDIX 1 STATISTICAL ANALYSIS TERMINOLOGY

Confidence Sampling error allows researchers to express the accuracy of sampling statistics in terms of levels of confidence. So, the higher the sampling error, the less confident the researcher can be about the reliability of his/her predictions or estimates.

Confidence interval A specified interval with the sample statistic at the centre which is expected to include the corresponding population value with a given level of confidence.

Frequency distribution Is the classification of the elements of a data set by a numerical characteristic.

Data set Data collected for a particular study is called a data set. A data set represents a collection of elements and for each element, information on one or more characteristics of interest is included. In the data set in the example below, the element is country and the characteristic is the birth rate. This data set is called a univariable data set as there is only one characteristic of interest. The birth rate is referred to as a variable of the data set as it takes on different values from country to country.

Country	*Birth rate per 1 000*
Greece	15.7
Italy	16.5
Australia	12.7
USA	11.9

Statistical tests A statistical test is designed to show (with a certain level of confidence) whether a sample estimate could have come from the population in question, or occurred due to 'chance'.

t-test The t-test or student t-test is usually used to test for significance of difference between estimated means.

Chi-square test This test can be used to test certain properties of the frequencies observed in a sample. It can be used to test whether the observed distribution of frequencies differs from a predetermined theoretical distribution.

Analysis of variance Just as the t-test provides a way of testing for differences between two samples, analysis of variance is a technique which enables tests for differences to be made simultaneously on three or more samples. This type of analysis is often used in agricultural experiments and manufacturing. Certain assumptions about the population/sample must hold for analysis of variance to be useful.

Parameter A parameter is the true value of a given variable in a population. For example the mean income of all families in a city is a parameter. An important part of survey research involves the estimation of population parameters on the basis of sample observations.

Statistic A statistic is the summary description of a given variable in a sample. Thus, the mean income computed from a sample survey is a statistic. Sample statistics are used to make estimates of population parameters.

Sampling error Probability sampling methods seldom if ever provide statistics exactly equal to the parameters they are used to estimate. Probability theory permits us to estimate the degree of error to be expected for a given sample.

Variables Characteristics such as sex, age, income and employment status are called variables as they can take on different values. Surveys often aim at describing the distribution of characteristics comprising a variable in a population.

APPENDIX 2 STATISTICAL CLEARANCE PROCESS

COMMONWEALTH GOVERNMENT STATISTICAL CLEARING HOUSE

Data collection activities by, or on behalf of, Commonwealth government agencies are subject to a formal clearance process.

In 1996, the Small Business Deregulation Task Force recommended that there should be a central clearance process for all Commonwealth government business surveys. Cabinet endorsed this recommendation, and during 1997 the Statistical Clearing House was established.

The goal of the clearance process is to ensure that surveys impose minimum loads on business respondents, and that the information collected will be of sufficient quality to meet the objectives of the survey.

The Statistical Clearing House mandate affects all Commonwealth government departments and agencies that conduct or commission surveys of businesses.

The Statistical Clearing House operates from within the Australian Bureau of Statistics (ABS), as part of its statistical coordination role, but operates independently of the ABS' own statistical collection activities.

WHICH SURVEYS NEED APPROVAL?

The Statistical Clearing House must review all surveys involving 50 or more businesses run by, or on behalf of, any Commonwealth agency. This includes ABS surveys. Surveys that satisfy the review criteria receive a registered approval number to be used on forms and explanatory material sent to businesses.

The review process includes both voluntary and mandatory surveys, as well as surveys conducted by a consultant on behalf of the Government.

The data collection phase of a survey must not begin until the survey is approved.

WHEN TO CONTACT THE STATISTICAL CLEARING HOUSE

Survey managers are encouraged to notify the Statistical Clearing House about their business surveys as early as possible in the development process, and to provide information as it becomes available.

For example, information about survey administration and objectives can be submitted early in the process, while sample design and questionnaire details can be submitted later when they have been finalised. In this way the review can be done in stages, avoiding delays in the survey development timetable.

THE STATISTICAL CLEARING HOUSE REVIEW

In general terms, the review process ensures that:

- there is no adequate alternative source of information available and no reasonable, alternative means of obtaining the required information with less respondent burden;
- the survey methodology is appropriate to meet the objectives of the survey, in that:
  - the list of businesses for the survey provides adequate coverage;
  - survey forms (questionnaires) have been appropriately tested; and
  - the expected levels and quality of response are justified and sufficient for the intended uses of the results;
- a group of businesses or business associations have been consulted about the nature and objectives of the survey and data availability, and there is an assessment of respondent burden; and
- there are adequate systems (both computer and people-based) to ensure the survey is conducted and processed in a manner that will provide output of appropriate quality.

The Statistical Clearing House provides advice and assistance at all stages of the review process. Specific requirements on the type of information required for the review can be found on the Internet, at http://www.sch.abs.gov.au

TURNAROUND TIME

The Statistical Clearing House guarantee to review a proposal for a survey within 20 working days of receipt of all the documentation required. Turnaround will be faster than this if notification is made in advance and if the required information is provided as it becomes available.

THE REGISTER OF SURVEYS

The Commonwealth Register of Surveys of Businesses is available as a by-product of the review process. The register includes information about each survey that has been reviewed—a survey contact person, the survey objectives, and a description of the survey procedures. At the discretion of the survey manager, it may also include a link to the actual survey findings.

FURTHER INFORMATION

The Statistical Clearing House can be contacted by:

Email:	statistical.clearing.house@abs.gov.au
Telephone:	Canberra 02 6252 5285
Facsimile:	Canberra 02 6252 8008
Or	visiting the web site at www.sch.abs.gov.au

APPENDIX 3 COLLECTING PERSONAL INFORMATION

If you collect personal information, it is recommended that you be aware of the following.

INFORMATION PRIVACY PRINCIPLES 1–3

When Commonwealth government agencies collect personal information they are regulated by the *Privacy Act 1998 (Cwlth)*.

There are eleven Information Privacy Principles (IPPs) in the Privacy Act. IPPs 1–3 are concerned with how government agencies collect personal information. A summary of IPPs 1–3 is included below.

Although organisations other than Commonwealth government agencies are not legally bound by these principles in the same way, it is suggested that the principles are worth consideration by all those collecting personal information.

SUMMARY OF INFORMATION PRIVACY PRINCIPLES

Principle 1 Agencies can only collect personal information:

- for a lawful purpose that is directly related to their functions; and
- if collecting the information is necessary for or directly related to that purpose.

Agencies must not collect personal information unlawfully or unfairly.

Principle 2 If an agency asks a person for personal information about himself or herself, it must tell the person:

- why it is collecting the information;
- whether it has legal authority to collect the information; and
- to whom it usually gives that sort of information.

Principle 3 When an agency asks for personal information, the agency must do its best to make sure that the information is:

- relevant to the agency's reason for collecting it;
- up-to-date; and
- complete.

APPENDIX 4 SELECTED ABS CLASSIFICATIONS

AREA	Australian Standard Geographical Classification Standard Australian Classification of Countries
INDUSTRY	Australian and New Zealand Standard Industrial Classification
COMMODITY	Australian and New Zealand Standard Commodity Classification Harmonized Commodity Description and Coding system
INSTITUTIONAL SECTOR	Standard Economic Sector Classification of Australia
RESEARCH	Australian Standard Research Classification
OCCUPATION	Australian Standard Classification of Occupations
CRIME	Australian Standard Offence Classification
LANGUAGES	Australian Standard Classification of Languages
RELIGION	Australian Standard Classification of Religious Groups
QUALIFICATIONS	Australian Bureau of Statistics Classification of Qualifications

More detailed descriptions of these classifications and a more comprehensive list of ABS classifications can be found in the ABS publication '*A Guide to Major ABS Classifications, 1998* (Cat. no. 1291.0).

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For the latest figures for National Accounts, Balance of Payments, Labour Force, Average Weekly Earnings, Estimated Resident Population and the Consumer Price Index call 1900 986 400.
These calls cost 75c per minute.

INTERNET www.abs.gov.au

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CONSULTANCY SERVICES

ABS offers consultancy services on a user pays basis to help you access published and unpublished data. Data that are already published and can be provided within 5 minutes is free of charge. Statistical methodological services are also available. Please contact:

City	*By phone*	*By fax*
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Sydney	02 9268 4611	02 9268 4668
Melbourne	03 9615 7755	03 9615 7798
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Perth	08 9360 5140	08 9360 5955
Adelaide	08 8237 7400	08 8237 7566
Hobart	03 6222 5800	03 6222 5995
Darwin	08 8943 2111	08 8981 1218

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