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The Preparation of  
Sampling Survey  
Reports



LAKE SUCCESS, N. Y.

**15 FEBRUARY 1950**

## **FOREWORD**

This document was originally prepared by the Sub-Commission on Statistical Sampling of the Statistical Commission at its second session, 30 August to 11 September 1948. In its report to the Statistical Commission the Sub-Commission stated:

“The Sub-Commission considered that if accounts of sampling investigations included the points enumerated, and if they dealt with the technical aspects of sampling processes in accordance with the recommended terminology, it would become increasingly possible to improve sampling practices in many important respects. The Sub-Commission believed that the wide circulation of reports, prepared generally in accordance with the suggestions contained in the memorandum, will foster international exchange of experience, and will suggest the use of sampling in various undertakings now being carried out by complete counts or by non-random partial surveys.”  
(Document E/CN.3/52).

The document was revised by the Sub-Commission at its third session, 12 to 23 September 1949 and is now presented with these revisions.

The members of the Sub-Commission are: Professor G. Darmois, Dr. W. E. Deming, Professor P. C. Mahalanobis (Chairman), Dr. F. Yates, and Professor R. A. Fisher (Consultant).

**Statistical Office of the United Nations  
Department of Economic Affairs  
Lake Success, New York**

**February 1950**

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## RECOMMENDATIONS CONCERNING THE PREPARATION OF REPORTS OF SAMPLING SURVEYS

These recommendations have been prepared by the Sub-Commission on Statistical Sampling in the hope that they will be of assistance to those engaged in the preparation of reports of sampling surveys. They necessarily involve technical terminology, the use of which will foster clarity, comprehensiveness, and international comparability in reports that deal with aims, methods used, and accuracy attained. Information supplied on the lines suggested will enable those making use of the report to utilize the results obtained to full advantage, to assess for themselves the reliability of these results, and to utilize the experience gained in the conduct of the survey in planning future surveys on similar material. The recommendations are not intended to be final, but are to be regarded as an outline of the various points which require description and analysis in the application of sampling methods in censuses and surveys. Comments should be addressed to the Statistical Office, United Nations, Lake Success, N.Y., U.S.A.

### 1. General Description of the Survey

A general description of the survey should be given for those who are primarily interested in the results rather than in the technical statistical aspects of the sample design, execution, and analysis. These technical aspects should be described in fuller detail in separate sections or appendices; the ground to be covered has been indicated in the subsequent sections of this memorandum. The general description should include information on the following points:

- a. Statement of Purposes of the Survey: A general indication should be given of the purposes of the survey and the ways in which it had been expected that the results would be utilized.
- b. Description of the Material Covered: An exact description should be given of the geographical region and the categories of material covered by the survey. In a survey of a human population, for example, it is necessary to specify whether such categories as hotel residents, institutions (e.g. boarding houses, sanatoriums), vagrants, military personnel, were included. The reporter should guard against any possible misapprehension regarding the coverage of the survey.
- c. Nature of the Information Collected: This should be reported in considerable detail, including a statement of items of information collected but not reported on. The inclusion of copies of the schedules and relevant parts of the instructions used in the survey (including special rules for coding and classifying) is often of value. If this is impracticable, it may be possible to make available a limited number of copies which may be obtained on request.
- d. Method of Collecting the Data: Whether by interviewers, investigators, mail, etc.

- e. Sampling Method: An indication should be given in general terms of the type of sampling adopted, the size of the sample, the proportion it forms of the material covered, and arrangements for follow-ups, if any, in cases of non-response.
- f. Repetition: State whether the survey is an isolated one undertaken without intention of repetition, or is one of a series of similar surveys.
- g. Date and Duration: The date or period of time to which the data refer should be stated, and also the starting date and period taken for the field work.
- h. Accuracy: A general indication of the accuracy attained should be given.
- i. Cost: An indication should be given of the cost of the survey, under such headings as preliminary work, field investigations, analysis, etc.
- j. Assessment: The extent to which the purposes of the survey were fulfilled should be assessed.
- k. Responsibility: The name of the organization sponsoring the survey should be stated; also the name of the one responsible for conducting it.
- l. References: References should be given to any published reports or papers relating to the survey.

## 2. Design of the Survey

The design of the survey should be carefully specified. The following terms are believed to cover the main types of design, and to conform in the main with current terminology in so far as this has been established:

- a. Frame: The frame or "substrate" consists of previously available descriptions of the material in the form of maps, lists, directories, etc., from which sample-units may be constructed and a set of units selected. The specification of the frame should define the geographical scope of the survey and the categories of material covered; also the date and source of the frame. Frames that are initially available often require emendation, particularly in the later stages of multi-stage sampling, before they may be considered adequate; at times a frame may need to be constructed ab initio. In such cases the method of emendation or construction should be described.
- b. Elementary Units: Units which are the smallest parts of the material capable of possessing a particular characteristic. Elementary units

may, therefore, be of different types (e.g. number of children is a characteristic of a family, age is a characteristic of an individual), for example, at different stages of multi-stage sampling.

- c. Sample-units: The units which form the basis of the sampling process. The sample-units may be (i) the same as the elementary units or (ii) groups of such units capable of possessing all the characteristics required. A group may consist of a cluster of contiguous elementary units, or a number of units arranged in an assigned configuration. A systematic pattern of elementary units may, for instance, constitute a sample-unit.

It is conceptually convenient that the sample-units be so defined that the totality of sample-units contains every elementary unit once and once only.

If this condition is departed from (e.g. by the use of circular areas in area sampling) attention must be paid to the question of whether bias is likely to arise owing to boundary conditions or other factors.

It is important to specify the quantitative and qualitative characteristics of the sample-units which have been recorded in the enquiry, as these form the basis of all subsequent analysis, and in the cases of multi-stage and multi-phase sampling, may also have been used in determining the sampling procedure.

Sample-units may be of the same or different size. They may contain the same or approximately the same number of elementary units or they may contain widely differing numbers. The estimation of the population values and of the sampling errors is simplest when the sample-units within a stratum are of approximately the same size, or contain the same number of elementary units.

- d. The Sample: The aggregate of the sample-units selected constitutes the sample. A sample supplies both objective estimates (of means, totals, etc.) and information for estimating their precision. The word sample may be used either for the aggregate of sample-units chosen from a single stratum, or in a wider sense, for the whole of the sample-units chosen in a complete enquiry. In the first sense the sample is usually a specified fraction of the stratum it represents.

- e. Domain of Study: Any sub-division about which the enquiry is planned to supply numerical information of known precision may be termed a domain of study. It is desirable to indicate the smallest domains of study about which the enquiry may be expected to provide information of adequate accuracy.

- f. Block of Domains: A group of two or more domains of study, contrasts between which it is required to evaluate, may be termed a block of domains.
- g. Field of Enquiry: The entire field of an enquiry is coextensive with the frame used as its basis, and will often consist of a number of blocks of domains.
- h. Stratification: The totality of elementary units included in the frame may be divided into groups or "strata", each stratum being sampled separately so that a specified number of sample-units is obtained from each stratum. Such strata may be geographic sub-divisions, divisions depending on some quantitative or qualitative variate appertaining to the sample-units, etc.
- i. Uniform and Variable Sampling Fractions: The numbers of sample-units specified may be such that from each stratum the same fraction of units is selected, in which case the term stratification with uniform sampling fraction, or proportionate sampling, is used; or the numbers specified may be such that different fractions of the different strata are selected, in which case the term stratification with variable sampling fraction is used.
- j. Multiple Stratification: In certain cases the totality of elementary units may be divided simultaneously according to two or more classifications, each of which depends on one geographic, quantitative, or qualitative variate. Each cell determined by the two or more way classification itself potentially constitutes a stratum of the totality of elementary units. If each of the cells is sampled separately, as in an ordinary stratified sample, the term multiple stratification may be used without qualification. If the available information is not adequate for this to be done, so that the numbers of sample-units in the main strata only can be pre-determined, this is termed multiple stratification without control of sub-strata or marginal stratification.
- k. Multi-Stage Sampling: In multi-stage sampling the material is regarded as made up of a number of first-stage units each of which is made up of second-stage units, and so on.

There is thus a hierarchy of different types of units, each first-stage unit being divided (or potentially divisible) into second-stage units, etc. At the first stage of sampling, a number of first-stage units are selected; from each of the selected first-stage units, a number of second-stage units are then selected and so on.

For example, a country may be considered as divided into a number of districts; each district into a number of villages; each village into a number of farms. In multi-stage sampling a number of districts is selected in the first-stage; within each such selected

district a number of villages is selected in the second-stage, and from each selected village a number of farms is selected at the third-stage for enquiry. In the case of a crop-cutting investigation, the work may be carried further by the selection of fields from each selected farm and by plots within a field.

In multi-stage sampling a frame will be required at each stage for the units that have been selected at that stage. Initially, a frame is required by which first-stage units may be defined and selected. For the second-stage of selection, a frame is required by which second-stage units may be defined within the first-stage units which have been selected. One of the advantages of multi-stage sampling is that second-stage frames are only required for selected first-stage units and so on.

The devices of stratification and a variable sampling fraction may be used at any stage. If a variable sampling fraction at the first stage is used, the sampling fractions at the later stages may be adjusted so as to give a uniform overall sampling fraction. If selection is with probability proportional to size at the first stage (see Section 3), the sampling fractions at the later stages may be similarly adjusted to give equal probability of selection to all elementary units.

1. Multi-phase Sampling: It is sometimes convenient and economical to collect certain items of information on the whole of the units of a sample, and other items of information on only some of these units, these latter units being so chosen as to constitute a sub-sample of the units of the original sample. This may be termed two-phase sampling. Information collected at the second or sub-sampling phase may be collected at a later time, and in this event, information obtained on all the units of the first-phase sample may be utilized, if this appears advantageous, in the selection of the second-phase sample. Further phases may be added as required.

It may be noted that in multi-phase sampling, the different phases of observation relate to sample-units of the same type, while in multi-stage sampling, the sample-units are of different types at different stages.

An important application of multi-phase sampling is the use of the information obtained at the first-phase as supplementary information to provide more accurate estimates (by the method of regression or ratios), of the means, totals, etc., of variates obtained only in the second phase. This is sometimes called correlated variate sampling.

Information obtained in a complete census may be used in this manner to improve the estimates obtained from a sample, in which case the complete census and sample are analogous to the first and second phase sample respectively.



Multi-phase sampling may be combined with multi-stage sampling. In a scheme for the estimation of the acreages and yields of an agricultural crop, for example, a two stage sample of villages and farms may be taken for the estimation of acreages, and a sub-sample of these farms may be taken for the estimation of yields. This is two phase at the second stage.

A more complicated example is the following: 100 villages are selected at random out of 5,000 villages (first-stage selection); and the number of trading establishments is counted in each selected village (first-stage observation). A selection is then made of a fraction of (or perhaps all) villages which have one or more trading establishments (first-stage second-phase selection); and in each such village, a selection is made at random of 10 farms (second-stage selection based on first-stage observation). An enquiry is made about crops grown in the selected farms (second-stage observation). A selection is then made of a fraction of (or perhaps all) farms which grow cotton (second-stage second-phase selection); and an enquiry is made among these farms whether the cotton is sold through the village trading establishments or otherwise (second-stage second-phase observation).

- m. Interpenetrating (Networks of) Samples: Whatever be the method of choosing the sample-units (with or without stratification; single or multi-stage; single or multi-phase), it is possible if desired to arrange the sample-units in sets of two or more interpenetrating (networks of) samples within each domain of study, and to collect the information for each such sample in an independent manner so that each sample would supply an independent estimate of the variates under study. In such cases the interpenetrating samples may be regarded as analogues of plots in the theory of design of experiments, and an analysis of variance can be carried out in the usual way. Another term for this procedure is replicated sampling.

It is possible to keep some of the sample-units the same in two (or more) interpenetrating networks of samples so that information for such sample-units are independently collected twice (or more than two times). It is then possible to make detailed comparisons between the two (or more) sets of observations. Such sample-units which are observed more than once are called duplicated (triplicated, quadruplicated, etc.) sample-units.

Interpenetrating samples can be used to secure information on non-sampling errors such as differences arising from differential interviewer bias, different methods of eliciting information etc.

The interpenetrating network therefore provides a means of control (i.e. appraisal) of the quality of the information. For example, in a family budget enquiry, in each domain of study the sample units may be chosen in the form of two or more independent sets each of

which covers the whole domain, and the information for every such set may be collected by a different investigator. In this way, an independent estimate for the whole domain would be obtained based on the material collected by each investigator, and a comparison of such independent estimates (by analysis of variance) would show whether there were significant differences between different investigators which may often indicate appropriate action for improving the planning of similar surveys in the future.

- n. Composite Sampling Schemes: There are occasions on which different methods of sampling are required for different parts of the material. In sampling a human population, for instance, some form of sampling of areas (in which the sample-unit is a small area) may be most suitable for the rural parts of the country whereas some form of sampling based on lists of households may be best in the towns. This may be termed a composite sampling scheme.
- o. Successive (or Repeated) Surveys: Sometimes a sample survey of the same kind is repeated at suitable intervals to constitute a series of successive surveys. In such cases it is possible to choose entirely independent sample-units in each survey, or to keep a certain number (or a certain proportion) of sample-units the same in two or more surveys. This latter procedure is particularly useful for the study of changes. The continuing operation of a survey agency on successive surveys of the same type usually also leads to a gradual improvement in the quality of the information.
- p. Pilot and Exploratory Surveys: In undertaking large scale surveys, particularly of unexplored material, it is usually advisable to conduct pilot and exploratory surveys to test and improve field procedure, and schedules, and to train field workers; at the same time to obtain information which will enable the sample-design to be planned more efficiently, and to obtain an estimate of the cost. For example, the results of a pilot survey may be used to estimate the first and second stage components of variance relevant to some two-stage sampling process which is envisaged for the main survey and also the relevant components of cost, from which it is possible to determine the optimum intensity of sampling at each of the two stages.

### **3. Method of Selecting Sample-Units**

The reporter should describe the procedure used in selecting sample-units, and if it is not a random selection he should indicate the evidence on which he relies for adopting an alternative procedure. Purposive selection and quota sampling cannot be regarded as equivalent to random sampling.

A process is properly described as random if to each unit has been initially assigned an independent and determinate probability of being selected. One expeditious way of effecting a random selection is by the use of random sampling numbers;

equally, with more labour, this may be done by any of the apparatus used in games of chance. Systematic selection is often used when the person responsible for the planning of the survey is satisfied that it is in practice equivalent to a random selection in the respects required. In such cases he accepts personal responsibility for the judgment on which his plan is based.

Ordinarily all units within a given stratum are assigned an equal probability of selection, sampling being "without replacement", i.e. no unit is included more than once in a sample. In certain cases it may be advantageous, or convenient, to select the sample-units with probabilities proportional to some known quantitative characteristic of the units, such as size; if more than one unit is to be selected from the population (or from individual strata) exact probabilities proportional to size can only be simply attained if the sampling is "with replacement", units selected twice or more being counted twice or more.

The methods of calculating the population estimates appropriate to samples selected with probability proportional to size differ from those for samples selected with uniform probability.

#### **4. Personnel and Equipment**

It is desirable to give an account of the organization of the personnel employed in collecting, processing and tabulating the primary data, together with information regarding their previous training and experience. Arrangements for training, inspection and supervision of the staff should be explained; as also should methods of checking the accuracy of the primary data at the point of collection. A brief mention may be made of the equipment used.

#### **5. Statistical Analysis and Computational Procedure**

The statistical methods followed in the compilation of the final summary tables from the primary data should be described. If any more elaborate processes of estimation than simple totals and means have been used, the methods followed should be explained, the relevant formulae being reproduced where necessary.

The steps taken to ensure the elimination of gross errors from the primary data (by scrutiny, sample checks, etc.) and to ensure the accuracy of the subsequent calculations should be indicated in detail. Mention should be made of the methods of processing the data (punched cards, hand tabulation, etc.) including methods used for the control of errors.

If a critical statistical analysis of the results embodied in the final summary tables has been made, it is important that the methods followed should be fully described. A numerical example is often of assistance in making the procedure clear.

It frequently happens that the quantities of which estimates are required do not correspond exactly to those observed; in a crop-cutting survey, for example,

the yields of the sample plots give estimates of the amount of grain etc., in the standing crop, whereas the final yields will be affected by losses at harvest. In such cases adjustments may have to be made, the amount of which is estimated by subsidiary observations, or otherwise. Account should be given of the nature of these adjustments and the ways in which they were derived.

The amount of tabular matter included in the report, and the extent to which the results are discussed, will depend on the purposes of the report. Mention should be made of further tabulations which have been prepared but are not included in the report, and also of critical statistical analyses which failed to yield results of interest and which are therefore not considered to be worth reporting in detail.

The inclusion of ancillary information which is not of immediate relevance to the report but which will enable subsequent workers to carry out critical statistical analyses which appear to them to be of interest should be carefully considered. If, for example, in addition to the class means of each main classification of the data, the sub-class numbers (but not the means) of the various two-way classifications are reported, a study of the effects of each of the main classifications freed from the effects of all other classifications can be made (provided the effects are additive) without further reference to the original material.

#### **6. Costing Analysis**

An important reason for the use of sampling (instead of complete enumeration) is lower cost. Information on costs is therefore of great interest. Costs should be classified so far as possible under such heads as preparation (showing separately the cost of pilot studies), field work, supervision, processing, analysis, and overhead costs. In addition, labour costs in man-weeks of different grades of staff, and also time required for interview and journey time and transport costs between interviews, should be given. The compilation of such information, although often inconvenient, is usually worth undertaking as it may suggest substantive economies in the planning of future surveys. Efficient design demands a knowledge of the various components of cost, as well as of the components of variance.

#### **7. Accuracy of the Survey**

- a. Precision as Indicated by the Random Sampling Errors Deducible from the Survey: Standard deviations of sample-units should be given in addition to such standard errors (of means, totals, etc.) as are of interest. The process of deducing these estimates of error should be made entirely clear. This process will depend intimately on the design of the sample survey. An analysis of the variances of the sampling units into such components as appears to be of interest for the planning of future surveys, is also of great value.

The term "sampling error" has been used to denote both sampling standard error and limits of sampling error at some assigned

level of probability, e.g. twice the standard error corresponding approximately to the 1 in 20 level of probability. The sampling standard errors and the limits of sampling error should be clearly differentiated and the multiples used in the latter should be specified.

- b. Degree of Agreement Observed Between Independent Investigators Covering the Same Material: Such comparison will be possible only when interpenetrating samples have been used, or checks have been imposed on part of the survey. It is only by these means that the survey can provide an objective test of possible personal equations (differential bias among the investigators).
- c. Other Non-Sampling Errors: Errors which are common to all investigators, and indeed any constant component of error (or "bias") in the recorded information, will not be included in the estimates of the random sampling errors deducible from the survey results. Another source of error is that due to incorrect determinations of the adjustments (referred to in Section 5) arising from observation of quantities which do not correspond exactly to the quantities of which estimates are required.
- The existence and possible effects of such errors on the accuracy of the results, and of incompleteness in the recorded information (e.g., non-response, lack of records, whether covering the whole of the survey or particular areas or categories of the material), should therefore be fully discussed. Any special checks instituted to control and determine the magnitude of these errors should be described, and the results reported.
- d. Accuracy, Completeness and Adequacy of the Frame: The accuracy of the frame can and should be checked and corrected automatically in the course of the enquiry, and such checks afford useful guidance for the future. Its completeness and adequacy cannot be judged by internal evidence alone. Thus, complete omission of a geographic region or the complete or partial omission of any particular class of the material intended to be covered cannot be discovered by the enquiry itself and auxiliary investigations have often to be made. These should be put on record, indicating the extent of inaccuracy which may be ascribable to such defects.
- e. Comparison with other Sources of Information: Every reasonable effort should be made to provide outside comparisons with other sources of information. Such comparisons should be reported along with the other results, and the significant differences should be discussed. The object of this is not to throw light on the sampling error, since a well designed survey provides adequate internal estimates of such errors, but rather to gain knowledge of biases, and other non-random errors.

- f. Efficiency: The results of a survey often provide information which enables investigations to be made on the efficiency of the sampling designs, in relation to other sampling designs which might have been used in the survey. The results of any such investigations should be reported. To be fully relevant the relative costs of the different sampling methods must be taken into account when assessing the relative efficiency of different designs and intensities of sampling.

Such an investigation can be extended to consideration of the relation between the cost of carrying out surveys of different levels of accuracy and the losses resulting from errors in the estimates provided. This provides a basis for determining whether the survey was fully adequate for its purpose, or whether future surveys should be planned to give results of higher or lower accuracy.

- g. The critical observations of the technicians in regard to any part of the survey should be given. These observations will help others to improve their operations.

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