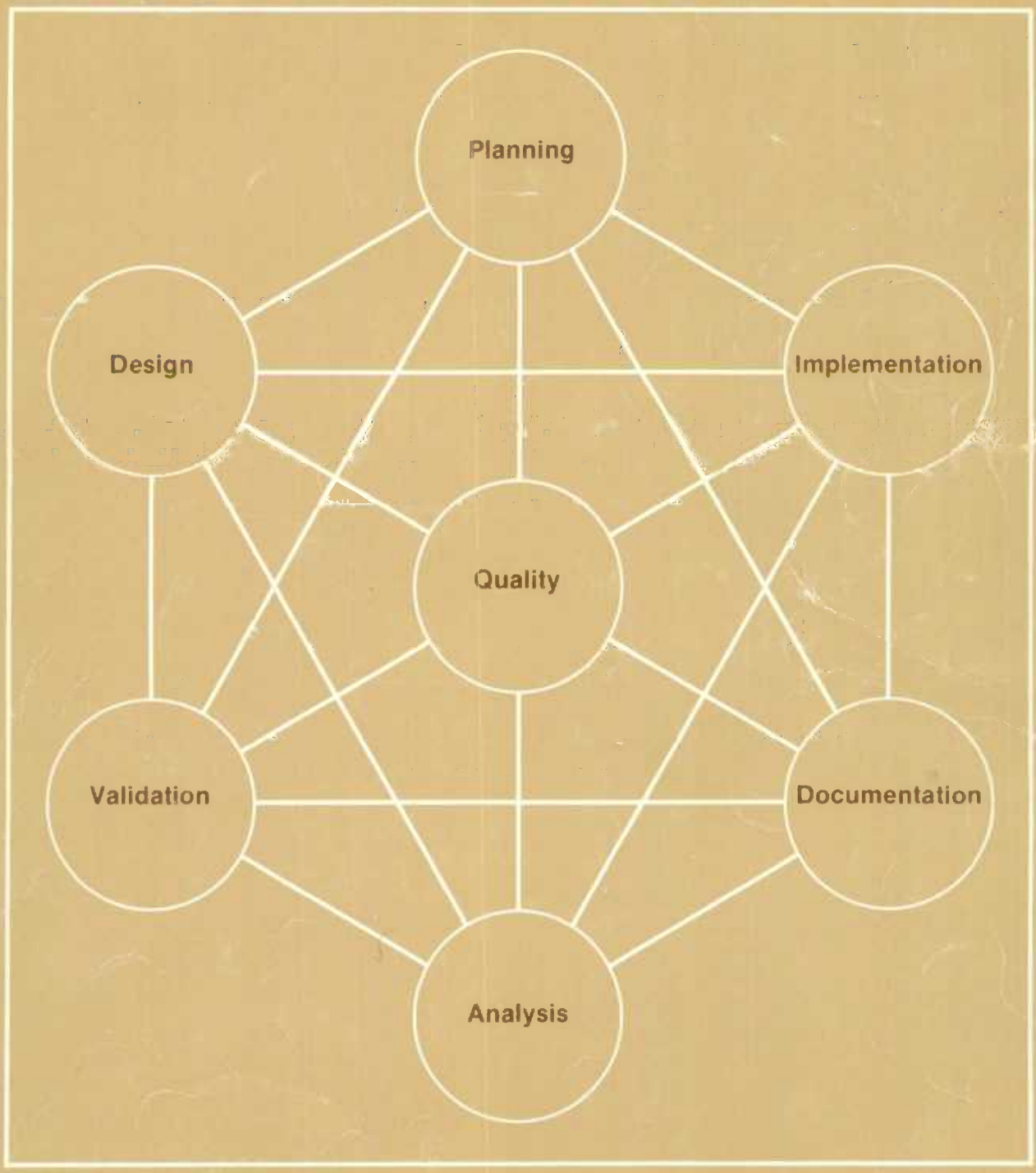
Statistics Canada Statistique Canada

QUALITY GUIDELINES

FIRST EDITION · SEPTEMBER 1985



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QUALITY GUIDELINES

FIRST EDITION · SEPTEMBER 1985

Published under the authority of
the Minister of Supply and
Services Canada

Ottawa

STATISTICS CANADA

QUALITY GUIDELINES:

A manual providing advice for the production, maintenance and promotion of quality for statistical processes.

Prepared at the request of the

Methods and Standards Committee

by

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September 1985
First Edition

CES LIGNES DIRECTRICES SONT AUSSI DISPONIBLES EN FRANÇAIS

PREFACE

The manual is a bringing together, in a comprehensive and summary form, of the collection of methods, procedures and practices that govern the pursuit of quality objectives in the execution of statistical activities. It encapsulates the expertise that has been developed in Statistics Canada into a series of guidelines that constitute a useful checklist for survey planners and survey managers alike.

It should be clearly understood that these are guidelines and not standards. They supplement, but are not a substitute for, informed subject matter expertise and judgement. No one would suggest that all the recommendations found herein were equally applicable to all statistical activities. Even where applicable, the decision to follow certain avenues and not others should be based on informed judgement of what would lead to the best net quality and would maximize benefits at an acceptable cost.

These caveats are intended to put this manual in perspective. They are not a licence to justify inaction.

Each statistical activity manager has an obligation to ensure that the Agency's concern for quality is adequately reflected in the statistical activity's methods and procedures.

I believe that the preparation of this manual is a landmark development in Statistics Canada's concern for quality, and I would like to commend the authors and those who initiated and assisted in its production. Of course a document such as this has to be dynamic. Experience with using this manual, as well as technical and methodological developments, will lead to requirements for updating. Comments or suggestions for modifications will be welcome at any time and should be addressed to Geoffrey Hole, Director, Institutions and Agriculture Survey Methods Division.

Ivan P. Fellegi
Chief Statistician

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0.1 INTRODUCTION

These Guidelines were prepared to serve as a tool for those concerned with the planning, management, development and implementation of statistical activities in Statistics Canada. They are guidelines to what constitutes generally accepted good statistical practice and are designed to assist staff in the maintenance and improvement of the quality of statistical products.

It is not the intention to suggest that all the guidelines listed must be rigidly observed. Many are common practice; others are there for completeness. Some apply only to particular kinds of activities; others are costly and the resource constraints of an activity may prevent their adoption. Indeed a full and consistent implementation of all the guidelines could well be self-defeating, if not prohibitively expensive, in that the volume of quality-related output would submerge the significant messages which clearly require attention. Nevertheless, it still may be useful to consider the guidelines as a checklist to identify obvious shortcomings. No attempt has been made to identify those practices that are more universally important than others. This ranking is left to the judgement of the management of each statistical activity.

It is expected that officers will make every attempt to follow the recommendations provided in this manual insofar as they are applicable and resources permit. As with every first effort it is likely that users of this manual will identify what they believe to be deficiencies as well as ambiguities. Comments and recommendations for amendment should be forwarded to Geoffrey Hole, Director, IASMD. Revised editions of this manual will be produced, as appropriate.

0.2 STRUCTURE AND CONTENT OF THE GUIDELINES

The Guidelines are organized with the operations of a statistical activity in mind. They were prepared to follow the flow of the statistical activity process as illustrated in Figure 1. - The General Model of the Statistical Activity (Survey) Process. The model attempts to reflect the complex planning process that precedes the decision to introduce (or redesign) a statistical activity. Then the various phases of the activity such as design and development, implementation, validation, dissemination, analysis and documentation follow, with some indication of the feedback between phases. Finally, the model shows that the process does not end with the release of final data, but extends beyond to the use of those data and subsequent feedback from users as a result of their "consumption" of the data product.

The phases described above are covered in separate chapters of the Guidelines. Figure 2, a simplification of Figure 1, identifies the coverage of each chapter. Additional chapters at the end address themselves to particular issues relating to administrative data based activities and derived activities. Chapters 2, 3 and 4 are more applicable for censuses and sample surveys, but the remaining chapters tend to be relevant for all activities. Chapters 8 and 9 should be read in conjunction with these other Chapters.

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Figure 1: General Model of the Statistical Survey Process

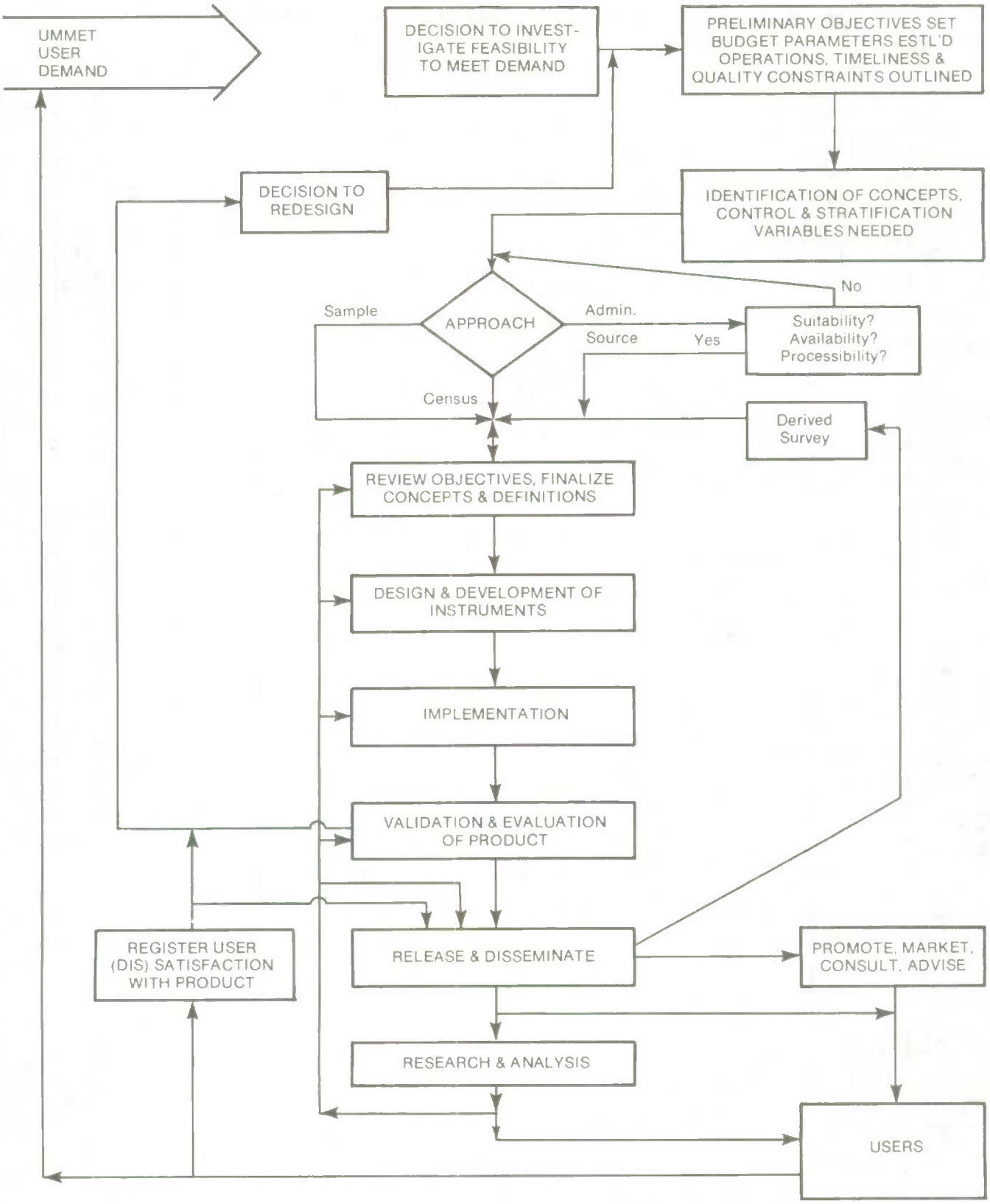
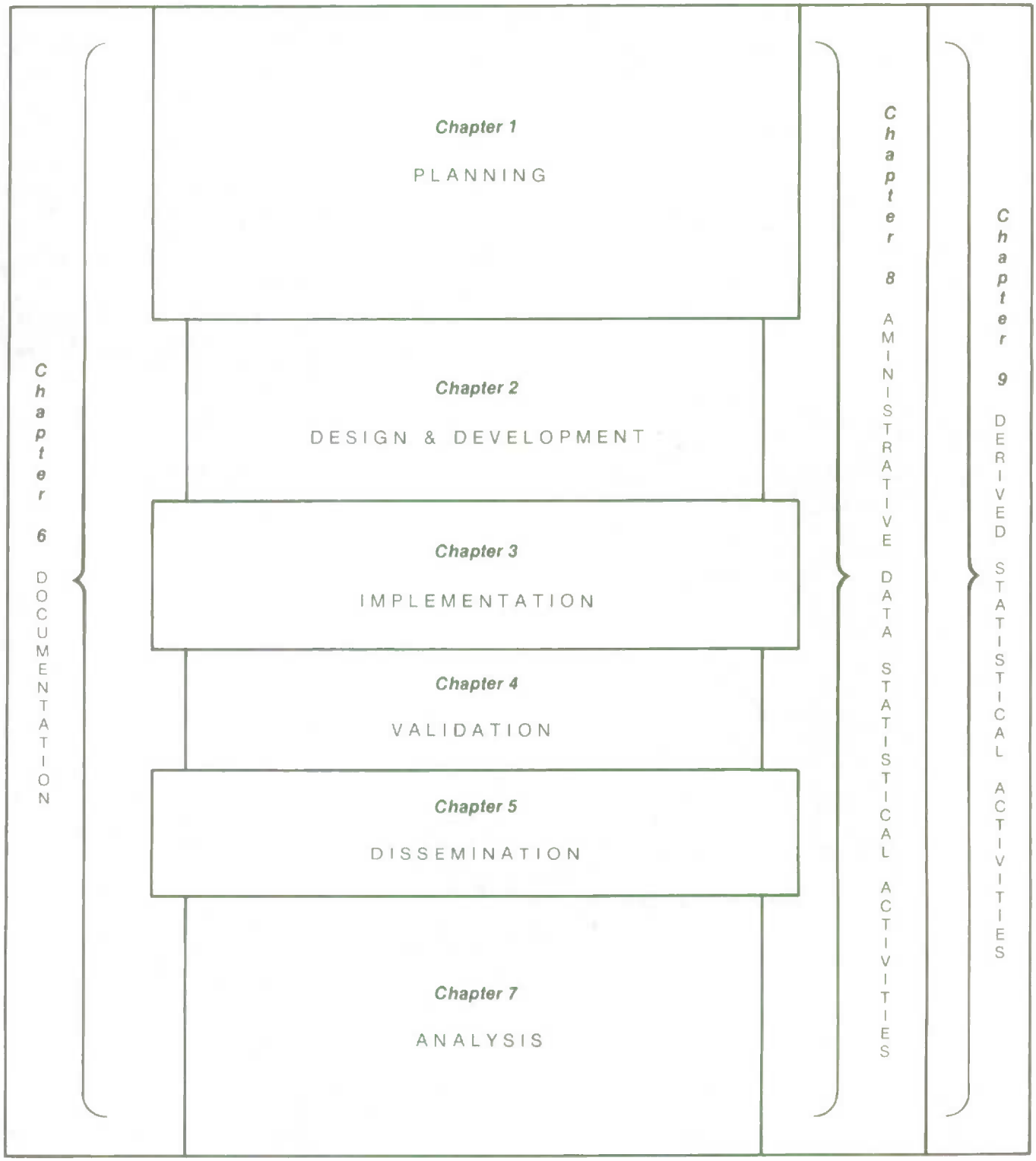


Figure 2: Simplification of the General Model & Illustration of the Structure of the Guidelines



INTRODUCTION

At this stage, it is presumed that the decision to go ahead with a new statistical activity or the redesign of an ongoing activity, has been taken and that the decision was based on a preliminary study, however cursory, which has identified, in broad terms, the problem to be addressed or the clientele and their analytical requirements to be served. Furthermore, it is assumed that the need for, and the overall feasibility of, the proposed project or activity has been established with some estimate of likely costs and resource requirements.

The next step, then, is the appointment of a Manager and the more detailed planning of the activity or project.

A Manager should normally be appointed, to be responsible for all aspects of the activity. In addition a working group or planning team may be put together to assist the manager in undertaking the planning phase. The Manager should be answerable to Senior Management (or to a Steering Committee consisting of Senior Management of Statistics Canada and, where possible, representatives of the user community). All expertise should be represented in the working group or planning team, such as experience and knowledge in the areas of subject matter, methodology, statistical quality control, field operations, systems design, standards, analysis and dissemination.

The planning process is typically an iterative process that involves a series of steps addressed one or more times. The following steps are normally included in this process:

- a clear understanding and statement of the precise purposes to be served in terms of the problem to be solved, hypotheses to be tested, or information to be collected (This is an ideal; the closer it comes to being realized the easier it is to determine how close the design and implementation satisfy the plans);

- the formulation of data requirements, concepts and definitions;

- an analysis of currently available statistics in the area, in terms of sources, frequency, quality, etc.; identifying data gaps in meeting the requirements specified above;

- the formulation of alternative methodological approaches and a feasibility study of means and modes of data collection, frequency, geographical detail, costs involved, time required and degree of precision anticipated;

- the examination of alternatives and choice of an action plan; after consultation with users, co-opting user representatives onto the planning team where feasible;

- trade-off between budget, response burden and privacy;

- detailed planning and scheduling.

On-going statistical activities need to be reviewed at regular intervals. The purpose of the activity or statement of objectives needs to be reviewed to assure the relevance of the statistical product to user needs which may be evolving or changing. Concepts and definitions being used also need to be reviewed to ensure their relevance in a changing world and relative to user needs and the ability of respondents to supply the information (Bonnen (1975), pp. 754-5).

If in the light of such a review the decision to redesign the activity is taken, a planning process similar to the one described above, will need to be undertaken.

The quality of the planning phase is crucial to the quality of the entire project. Though it is impossible to quantify the quality of the planning process it is apparent that if there is no consensus on objectives, definitions and concepts, there will be no common understanding of what is to be achieved. Consequently there will be problems with, for example, the design of questionnaires and publications and integration with data from other sources. If budgetary objectives are not explicit, rational decisions with respect to survey design cannot be taken. If the responsibilities of the members of the planning team are not clearly defined, there will be redundancy of effort or omission of certain key planning tasks.

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OBJECTIVE

- To ensure the quality of the planning process.

GUIDELINES

1.1 CONSULTATION

It is at the planning stage of a (potential) statistical activity that the requirements of the clientele are precisely elaborated and the means by which Statistics Canada hopes to meet those requirements, and the degree to which it expects to meet them, are established.

It is therefore important that organizational mechanisms are in place, and that consultation takes place, between Statistics Canada and its potential clients, at each stage of the planning process for the purpose of:

- clarifying the need for the activity, (or revision of the activity);
- agreeing on its objectives;
- elaborating user needs in detail;
- working out concepts and definitions; and
- assessing the extent to which the proposed activity is likely to meet those needs in the light of identified budgetary resource and time constraints.

1.2 PLANNING

1. The planning process normally proceeds iteratively through the stages of:
   - preparation of, and agreement upon, a statement of objectives describing the purpose of the activity and precise data requirements, including the level of quality expected, after examination of available data; and
   - the formulation of alternative methodologies including tradeoffs (for example between the content and geographic dimensions) and a feasibility study in terms of coverage, geographic detail, mode and method of collection, frequency, quality, associated costs and time required.

2. The process of discussion and consultation aims to establish:

   - the budgetary and other resource constraints;

   in the light of which,

   - a choice of plan is made, or the objectives are modified and a new plan of execution devised.

3. The planning process culminates in the production by the manager, of a well thought through and documented, Statement of Objectives and Plan of Implementation.

   The following topics would usually be outlined in such documents:

   PURPOSE:

   The purpose of the activity in terms of

   - the subject area(s) of concern;

   - the key policy, social, economic and/or other questions or issues, to the analysis of which, the activity is directed;

   - the underlying assumptions and description of the model or conceptual framework which forms the basis for the statistical activity, if such is the case.

   CONTENT:

   The nature of information required in terms of

   - concepts, definitions and degree of detail of that which is to be measured;

   - conceptual definition and level of geographical breakdown;

   - whether the emphasis is on data measuring level or change or both.

   COVERAGE:

   The definition of the target universe/population, whether the coverage will be complete or partial and how small units or problem cases will be covered.

   METHOD OF COLLECTION OR COMPILATION:

   Survey, administrative data or other source; census or sample and the mode by which the data will be collected or compiled.

   COHERENCE:

   How comparison and integration with related or existing data will be effected through the use of standardized concepts and definitions.

FREQUENCY:

The frequency of observation and reporting - Single or recurrent. Timing should take into account what is known about the cyclical, seasonal or other changes over time, in the phenomena to be measured.

SCHEDULING:

When the results are expected to be made available, the anticipated time lapse between the start of the activity and the date when the data will be made available to users. Allowance should be made for pretesting and for the various phases of design, editing, coding, processing and tabulating.

TIMELINESS:

How soon after the end of the period being measured, the data will be released.

MODE OF DISSEMINATION:

Form in which the data will be made available.

QUALITY:

Where feasible, the target level of data quality in terms of measurable aspects of quality (e.g. response rates, sampling error, coverage rates). In the case of administrative data and derived activities, quality of output may be directly related to the quality of inputs.

ORGANIZATION:

Proposed organization in terms of staff, functions, lines of responsibility, etc. Every effort should be made to maintain continuity between staff involved in the planning process and in the implementation of the activity.

PLAN OF ACTION:

Proposed activity broken down into a sequence of tasks. This plan may be revised during the course of implementation of the activity, but it is necessary to analyse the programme in detail, in order to plan the work and estimate resource requirements.

COST ESTIMATE OR BUDGET:

Anticipated costs in terms of financial and resource requirements, which should be arrived at by costing each stage of data gathering and processing and allowing for pretests and quality control.

CONSTRAINTS:

Relating, for example, to the methods of implementation chosen or availability of data.

For ongoing statistical projects a similar planning process should be undertaken for revisions, leading up to the formulation of a revised statement of objectives,

concepts and definitions, data and data quality requirements and detailed plan of implementation on the lines indicated above. Revisions require an additional item of consideration:

CONTINUITY:

Plans and procedures to permit the bridging or reconciliation of data prior to and after the revision, in order to minimize the adverse effect of the break in the series, are a necessary component of the revision planning system.

A clear statement of objectives and plan of implementation along the lines outlined above, provides the means by which users can assess the degree to which the statistical activity will fulfill their requirements. Subsequently users with different objectives have the means to assess the extent to which the product may meet their own needs. It is also an important means of communicating to (potential) users what they can expect from the products of a statistical activity and the degree to which they ought to exercise caution because their application extends beyond that which the activity set out to achieve.

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INTRODUCTION

Having agreed upon the objectives of the activity and a plan of implementation, the next stage is that of design and development of procedures. At this stage, the methods whereby the required output will be produced are considered and specified in detail. It is important that all aspects of the activity be considered, so that the methods and procedures specified be consistent. Also, to be effective, procedures to control the quality of the statistical processes, and to assess the quality of the statistical product, must be considered at the design stage and built into the implementation stage.

In general, any data collected at periodic intervals are likely to be used to examine changes over time in the phenomenon being measured, whether or not this is an explicit objective. This fact should be kept in mind during the design phase of the activity, particularly with respect to the choice of frame and sampling method.

For some types of activity, some of what follows may not apply. For a derived activity only estimation methodology and systems development may be relevant. For activities which use administrative data as input, the collection methodology may not be necessary, but it might be necessary to seek some amendment of the administrative process to fully meet the statistical need.

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The overall objective of the design stage of a statistical activity is to find the set of methods and procesures that achieve an appropriate balance of quality objectives and resource constraints. This implies that an overall view of design must be adopted in which the total net effect of all operations on quality and costs is considered. This concept of total design must be considered when using the following guidelines which describe the manner in which quality can be ensured for each aspect of the design of the activity.

2.1 FRAME

OBJECTIVE

- To choose a frame and/or to design a set of procedures to create or update a frame to meet the coverage objectives.

GUIDELINES

1. The suitability and quality of alternative frames should be evaluated with respect to conformance to the target population, extent of under coverage, overcoverage (including duplication), quality of classification, and compatibility with cost and operational constraints. This may require special evaluation studies, pilot tests, etc.

2. Wherever necessary, procedures should be incorporated to improve and/or maintain, and monitor the level of quality. Possible techniques include:

   - matching with alternative sources;

   - use of multiple frame techniques;

   - eliminating duplication;

- updating procedures for births, deaths and changes in classification;

- the inclusion of special questions on the questionnaire to provide direct or diagnostic information on possible coverage problems such as classification questions (including checks on out of scope units), or a question that would be used in matching with other sources.

- the use of evaluation information obtained from other surveys using the same frame;

- profiling for business surveys.

3. For area frames, map checks should be carried out to ensure clear non-overlapping delineation of areas used as sampling units.

2.2 SAMPLING

OBJECTIVES

- To design sampling procedures that take into account target levels of reliability and cost constraints.

GUIDELINES

1. Special studies should be carried out to evaluate alternative sampling schemes, stratification variables, sample sizes and allocation taking into account requirements with respect to the level of sampling error. Such studies typically make use of data from previous censuses, surveys, administrative data, and pilot tests.

2. For ongoing surveys, it is highly desirable to design the sample in such a way as to allow a certain degree of flexibility in modifying certain aspects of the design, should this be required in the future, e.g. increasing or decreasing the sample size, updating selection probabilities.

3. Rotation sampling schemes should be used in situations where efficient estimates of change are required, while minimizing response burden.

4. Methods should be developed to deal with units that change stratum/classification.

5. When determining sample size, some allowances should be made for births, deaths and non-response and other sources of non-sampling variance.

6. For ongoing surveys, procedures should be incorporated to monitor the efficiency of the sample design over time.

7. The final choice of sampling scheme should take into account the conditions under which it is to be implemented. This is particularly important in surveys where the selection is to be carried out in the field. In many cases, it is worth sacrificing some efficiency in order to avoid errors in sample selection that may lead to biases.

2.3 CONCEPTS (See also 2.4 Questionnaire)

OBJECTIVES

- To design and develop concepts (e.g., statistical populations, variables, indices, rates, reference periods, spatial units) that satisfy the stated objectives of the statistical activity, and for which it is possible to obtain accurate and consistent responses.

GUIDELINES

In order to draw valid conclusions from a set of data it is essential that users have both a knowledge of the concepts and definitions underlying the data, and a knowledge of the quality of those data. In other words they most know what exactly the data purport to measure and how well they measure it. Therefore:

1. The labels used for concepts, and their associated definitions, should accurately reflect the statistical information collected.

2. In cases where the concept is clear (e.g., calendar year) but "real" world practice is sufficiently variable that it is operationally impractical to insist on its use, one should either:

   - plan to collect sufficient data to adjust response to fit the concepts; or

   - develop procedures to measure the impact on quality due to deviation from the concept and publish the results in association with the estimates; or

   - change the concept label to comply with the practice thus removing the potential misinterpretation error; or, if none of the above are feasible;

   - not use the concept.

3. Before a label is chosen for a concept it should be determined whether:

   - it communicates the intended meaning to a user;

   - that concept, or a close approximation thereof, is already used by another statistical activity. If it is, one should attempt to use the same concept, label, and definition to enhance the consistency of the two series;

   - that label is already used for a different concept (i.e., the definitions are different). If it is, the label should be modified in order to avoid interpretation error between the two series.

2.4 QUESTIONNAIRE

OBJECTIVES

- To design a questionnaire (or more generally a collection instrument) from which the required information can be derived according to the concepts and definitions previously developed;

- To ensure that the questionnaire is compatible with and takes into account the requirements of all phases of the survey design (collection, coding, data capture, etc.);

- To ensure that the questions asked can be answered by respondents accurately while minimizing response burden.

GUIDELINES

1. The questionnaire is the means of communication between the respondent and the statistical compiler. It is essential that the former understands what the latter wants and that the latter knows what the former is able to supply (including record - keeping systems in the case of business surveys). (See also Section 2.3 Concepts). The consequences of poor communications in the questionnaire are avoidable response error.

2. Questionnaire design standards and guidelines (e.g. Platek, et. al. (1983), Statistics Canada (1979)) should be followed with respect to content, wording, format, and administrative requirements.

3. The possibility of having several versions of a questionnaire, each aimed at a different segment of the population, or even a customised questionnaire (e.g., the Labour Force Survey Questionnaire) may be considered in terms of respondent relations, costs and benefits. Care should be taken, however, to ensure that the different versions do not introduce response bias due to format and wording variations of the several questionnaires.

4. The questionnaire in draft form should be subjected to thorough review by project participants (sponsor, subject matter specialist, methodologist, systems analyst, regional operations staff, etc.). In addition, the review process should be extended to persons associated with the operations (e.g., data capture staff) and as many professional staff as possible.

5. It is recommended that field tests be conducted to test one or more versions of the questionnaire. This is particularly important when dealing with new concepts or types of questions.

2.5 COLLECTION

OBJECTIVES

- To design a collection methodology which will yield data of adequate quality (typically measured by response rates).

GUIDELINES

1. The collection method should incorporate verification and follow-up procedures for partial and total non-response in order to achieve levels of response which are compatible with the data quality objectives. In addition, the reason for non-response (refusal, no contact) should be recorded in order to assist subsequent analysis.

2. Some attention should be given not only to the overall response rate but also to possible variations in the level of response in different segments of the population. Large variations should be minimized to the extent possible. Some consideration

should be given to assigning priorities to areas of high non-response or to certain units (e.g. large businesses).

3. Pilot tests may be conducted with a view to developing an effective collection methodology with respect to the approach taken, number of call backs necessary, costs, etc. Such tests also serve the purpose of verifying procedures, training, the questionnaire and other collection instruments.

4. For statistical activities that are based on administrative records, it is important to understand thoroughly the concepts and methods underlying their creation and maintenance for the administrative purpose, in order to use and interpret them correctly for statistical purposes.

2.6 MANUAL EDITING, CODING AND DATA CAPTURE

OBJECTIVES

- To design manual editing, coding, and data capture methods to ensure that the data, once captured, reflect the data collected sufficiently well to meet the project objectives.

GUIDELINES

1. Alternative approaches to Manual Editing, Coding and Data Capture should be evaluated. If possible this should be based on live questionnaires obtained as a result of a pilot test, although artificially created data may in some cases be sufficient.

2. Standard classes and code lists should be used whenever possible.

3. Referrals (e.g., to expert coders) should be available for the handling of problem cases.

4. On-line edits, such as range and validity checks, should be incorporated into the data capture operations to the extent possible and feasible. Complex manual edits that require interpretation as part of the operation, or that slow down production on the part of the operator, should be avoided.

2.7 EDIT AND MANUAL CORRECTION

OBJECTIVES

- To identify all data elements that contain data which are not within the specified field limits or relationships.

- Wherever possible and feasible, to manually correct rejected data using logical relationships from within the questionnaire or, in exceptional cases, by following up with respondents.

GUIDELINES

1. Great care must be taken, in designing and elaborating guidelines 2-7 which follow, to ensure that a proper balance exists between the detection of error and the possibility of over-editing (which may result in excessive resources being spent on modifying values which are extreme, but valid).

2. The edit and validation checks typically involve:

   - the application of edit rules to identify missing, invalid or in-consistent data;

   - comparisons with alternative data sources at the micro-level;

   - outlier detection.

   Some of these checks involve logical relationships which follow directly from the concepts and definitions. Others however, are more empirical in nature and/or are obtained as a result of the application of statistical tests or procedures (e.g. outlier analysis techniques). Data from previous censuses, surveys or other sources should be used whenever possible to develop and evaluate alternative edit and validation checks.

3. Care must be taken to ensure that the edit and validation checks are consistent with one another. Certain generalized programmes such as CANEDIT incorporate an edit rule analyser which can be of assistance in this respect.

4. Whenever economically feasible, all cases rejected as the result of the application of edit and validation checks should be reviewed with associated documentation. Manual corrections should only be made for cases where the source of the problem can be identified and where the "correct" value can be determined (e.g., data capture error or comment on the questionnaire makes it possible to determine the correct response). Other cases should be referred for review by subject matter experts or passed on for automatic imputation.

5. If it is not feasible to review all edit rejects it may be possible and advisable to reduce the volume of cases to be reviewed by setting priorities according to types or severity of error and/or according to importance of the variable or the reporting unit. In either case, it is recommended that at a minimum, a sample of rejects be examined to analyse the problems, to check the reasonableness of the procedures and to provide feedback to earlier operations.

6. Edits and validation checks should be re-applied to units to which corrections were made, to ensure that no further errors are introduced directly or indirectly. However, the correction system should have an 'override' feature to handle exceptional cases.

7. The edit and validation process should be monitored on an ongoing basis with respect to the frequency of edit rejects, the number and types of corrections. This will often point to problem areas that require investigation and which may lead to corrective action being taken. This should be produced as a by-product of the computer system developed for this process.

2.8 IMPUTATION AND ESTIMATION

OBJECTIVES

- To develop a method of imputation to minimize the effect of missing or rejected data elements;

- To design and develop estimation procedures that are approximately unbiased and that will minimize standard errors or coefficient of variations.

GUIDELINES

1. Wherever possible, alternative imputation, weighting and estimation procedures should be evaluated using data from a previous census, survey, pilot or administrative data.

2. The imputation process should be designed so as to facilate its monitoring and allow tracing of problems should this be required. The use of flags and traces is recommended. Also tables showing the frequency of imputation actions are useful for analysis on an ongoing basis.

3. Procedures should be developed to deal with outliers, misclassification, births and deaths.

4. A variance estimation procedure should be developed. The estimation technique should be appropriate to the design. It may incorporate other sources of variation such as interviewer, coding, imputation, etc.

2.9 PROCEDURES

OBJECTIVES

- To develop a set of procedures for each survey operation which correctly and consistently meets all aspects of the survey design. This includes the operational procedures for executing systems programs.

GUIDELINES

1. Procedure manuals for all operations should be prepared and reviewed thoroughly by all project participants to ensure that the concepts, definitions and the design are implemented correctly, that there is consistency between all operations, and that the procedures are clear, concise and easy to understand and follow.

2. To ensure proper application, adequate training with well designed training material for each procedure, should be provided to persons responsible for the application of the procedures. Training should be planned, designed and implemented in advance of the actual operations. Training sessions should be observed or monitored by design staff whenever possible.

3. Procedure manuals and training material should be tested in an environment which simulates, as closely as possible, the actual survey conditions.

2.10 SYSTEMS DEVELOPMENT

OBJECTIVES

- To develop a set of specifications which are correct, complete, and consistent with all aspects of the design, are flexible and have low maintenance costs;

- To develop computer systems to meet these specifications;

- To develop operational procedures for executing the systems programs.

GUIDELINES

1. Specifications should be reviewed thoroughly by all project participants to ensure that they correctly and consistently reflect concepts, definitions, and the design.

2. Wherever and whenever possible, standardized (generalized) and existing software should be used when developing computer systems.

3. Systems should be designed in such a way as to facilitate changes and updating.

4. Systems should be designed to minimize maintenance costs.

5. The computer system should undergo logic and volume testing using data created by (or under the direction of) the originator of the specifications and/or personnel responsible for production.

6. The computer system should produce reports to facilitate the monitoring of the process and the tracing of problems.

7. Operational procedures for executing systems programs should be developed on the lines indicated under 2.9.

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3. IMPLEMENTATION

INTRODUCTION

The adequacy of the survey coverage and the quality of the obtained and processed data determine the potential uses and benefits to be derived from survey data. These two important aspects of any survey are enhanced when survey methods and the operational procedures that were developed, at the design stage, are complete, up-to-date (i.e. consistent with the current objectives) and applied correctly.

QUALITY GUIDELINES

The guidelines describe activities which ensure that the survey operations conform to the designed methods and procedures.

OBJECTIVES

- To ensure adequate levels of response from the selected respondents;
- To prevent, minimize or limit the errors that could be introduced in the processing of the collected data.

GUIDELINES

3.1 ERROR ASSESSMENT

Non-sampling errors can and do occur at any stage of a census or survey and they can generally be classified as coverage, response, measurement or processing errors. Each of these error sources could have a different impact on the quality and usefulness of the survey results. Therefore it is important that the most important error sources of a survey be identified and appropriate attention given to them.

To meet the survey data quality objectives (i.e. by minimizing or preventing errors in survey operations that are high or potentially high error sources), methods to identify, measure and assess these errors should be developed and incorporated in the overall survey plans. Reaction to the results of these assessments should be an integral part of the implementation procedures.

3.2 COVERAGE

The following activities may be undertaken to help to assess and correct, over- or under-coverage of surveys.

1. The knowledge base and experience in the regions can be drawn upon, by providing the regional offices and field survey staff, with training and information on the purpose of the survey and the importance of coverage, including the frame to be used, the units on the frame and how to identify the units directly related to the survey. This will assist in identifying non-existent, out of scope and missing survey units.

2. The areas selected can be checked against local up-to-date maps and/or by field inspection. Survey unit counts can be compared with local lists such as Post Office addresses. etc.

3. Field listing information can be provided to create and/or update universe frames. This includes the periodic field verification of selected areas from the universe frame.

4. Training sessions particularly those held for trainers of operational staff, should be observed by knowledgeable subject-matter and survey design personnel.

5. Business or Economic surveys are characterized by a high degree of volatility in the frame. Constant maintenance of the frame is necessary. Births, deaths and structural or classification changes should be incorporated in the most timely manner possible. Frequent checks of the information on file should be made on a sample basis and certain classification data should also be requested on survey forms for updating purposes. Feedback from survey to frame should be fast and efficient. All surveys concerning the same sector of the business universe should be run from the same frame, so as to avoid inconsistencies.

6. Methods to evaluate coverage are suggested in Section 4.2.

3.3 SAMPLING

During the implementation of sampling, the sample yield should be monitored to ensure that it agrees with the expected sample size at all levels of the design. In addition the precision of estimates should be monitored to ensure the planned objectives are met. It may still be possible to adjust the sample size at this stage.

3.4 DATA COLLECTION

Very important to a survey is the level of response and the quality of the collected data.

The activities to ensure that both of these requirements are met are listed below according to the type of data collection operation.

Respondent Completed Questionnaires

1. Whenever feasible, good publicity in the various media and by personal letters can be undertaken to create a willingness on the part of the selected respondents to respond to the questions addressed to them.

2. For self-completed questionnaires, respondents should be informed about purposes of the survey and uses of the data requested. For all surveys, respondents should be given clear instructions on how to complete the questionnaire and, where possible, a contact for help should be indicated.

Enumerator Completed Questionnaires

3. Detailed procedures should be provided for all enumerator operations, which should emphasize the purpose and importance of the survey as well as all the edits that must be evoked when collecting the data. These procedures should be updated whenever any changes in the operation requirements and/or methods are introduced.

4. In depth training should be provided on all requirements of the collection operation. Emphasis should be placed on the importance of achieving a high level of response and the role the initial edits play in ensuring that the data are complete and correct.

To ensure that the data quality and the level of response requirements are fully understood by the enumerator, these training sessions should be monitored or observed and the observers should be required to document their findings for feedback into the training process.

5. Training and the competence of the data collection staff is specially important for complicated surveys. It is recommended that training with mock interview and/or written exercises should be used.

6. A quality check on the completeness and accuracy of each enumerator's work should be incorporated as a part of the implementation procedure. The frequency and depth of these checks is directly related to the complexity of the operation as well as to the capability of the individual staff members. This data quality activity will also ensure that the procedures are being followed. The results of these checks should be documented for future use.

Follow-up Operations

7. Procedures on how to approach non-respondents should be provided. This includes initial contacts through follow-up letters, single or repeated telephone calls right up to a personal visit. Procedures to be used for concentrations of non-respondents should also be identified. These checks are the main input to future improvements, such as improved procedures, usefulness of letter follow-up, etc.

8. Follow-up procedures for partial non-respondents should be provided. These should highlight the important data elements so that follow-up operations can tackle the most important cases first.

9. Good records management is necessary to ensure that data collection staff are aware of all previous follow-up attempts when they contact the negligent respondent.

10. Guidelines with respect to the required or expected levels of response by area and type of respondent may be provided to data collection staff. The degree of follow-up to be undertaken should be influenced by a comparison of actual to expected response. Documentation on these comparisons should be provided.

11. Supervisors should periodically check the work of their staff. The frequency and depth of these evaluations should be related to the complexity of the operation, the importance of the specific data elements and the competence of the staff. This check will identify how well the procedures are being followed and if not, what changes must be incorporated.

12. Survey management should be provided with frequency counts on response rates - questionnaire & questions.

3.5 DOCUMENT PREPARATION AND CODING

These operations will ensure that the collected data are reviewed, transcribed and/or converted into a format that is suitable for data capture. These operations are people oriented and as such are subject to the introduction of error. It is therefore important that:

1. Standardized code lists be used wherever possible.

2. In depth training be provided on all requirements of the operation with emphasis on the importance of data quality and the potential impact of errors. The initial training sessions should be monitored to ensure that all staff clearly understand the objectives of the operation and the procedures to achieve them.

3. Experts be available for referral purposes.

4. Because of the potential level of coding error input, data quality standards or requirements for the operation be specified and these quality goals be included in the training material.

5. Complete and easily understood procedures be provided for all clerical operations and these procedures be updated whenever any changes in the operation requirements and/or methods are introduced.

6. Supervisors periodically check the work of their staff to ensure that the procedures are being followed. They should also evaluate how well the coders are meeting the specified data quality requirements. They may start with 100% verification to determine the quality of each coder's work. These results (i.e. error rates and their potential impact) will then determine, when to convert to statistical quality control, quality checks or schedule future evaluations.

   Existing statistical quality control methodologies provide assurance that the survey operations' data quality objectives will be met. They identify the errors introduced, control and limit these outgoing errors with minimum resources, provide coder and operation feedback information, and provide documentation on the outgoing data quality of the operation. The feedback information helps in the improvement of each coder's work and quality control, in general, will create a positive attitude to data quality.

7. Verification procedures be provided. Independent verification is recommended. These procedures should include both 100% and sample inspection routines and they should attempt to continuously meet the operation's data quality requirements with minimum resources.

8. Documentation be provided on the data quality achieved in those operations expected to contribute significantly to the overall error levels.

9. Feedback on data quality be provided to all levels of the operation, from the individual coders right up to the survey managers.

10. Good document control procedures be provided to ensure that these are suitable for both the main and the verification operations.

3.6 DATA CAPTURE

This operation is also people oriented and is subject to the introduction of keying errors. Usually this operation does not require an in-depth knowledge of the survey subject matter and in these cases it consists mainly of a "KEY WHAT YOU SEE" operation. To ensure Data Quality in this type of operation:

1. On-line edits should be incorporated whenever possible and these edits should be related to error conditions that the data capture operator can correct (i.e. edits of the preliminary type that will identify their keying errors). The opportunity for

inputing data that do not exist on the document or questionnaire (i.e. manual imputation) should be eliminated or minimized. These cases should be documented for later review and analysis.

2. Because of the potential level of keying error input, an attempt should be made to set data quality standards or requirements for this operation. These requirements must be in line with the quality requirements set for the preceding operations. How well the operators are meeting these quality requirements should be evaluated.

3. Where appropriate, survey experts for referral purposes should be made available.

4. Data capture instructions with detailed procedures for all edit failure situations should be provided.

5. Training for all data capture operators should be provided, ensuring that they completely understand how to handle all edit failure conditions. This training should also emphasise the importance of data quality and the potential impact of keying errors.

6. Verification procedures should be provided. This will start with 100% verification to determine the quality of the operator's work and then, based on the results, conversion to statistical quality control, quality checks or scheduling the next operator evaluation.

7. Documentation on the data quality achieved in this operation should be provided.

8. Feedback on data quality should be provided to all levels, from the operators up to the project managers.

9. Good document control procedures should be provided ensuring that these are suitable for both the capture and the verification operations.

10. It is important to ensure that the data capture equipment has software or operational programs that will allow sample inspection. With this capability the quality of any combination of the data elements can be achieved with optimum resources.

3.7 EDIT AND MANUAL CORRECTION

The detailed edit program identifies all data elements that contain data which are not within the specified field limits or relationships. The corrective process can be through manual review or by imputation through an automated process.

1. Detailed procedures should be provided for all clerical operations and it should be ensured that these procedures are updated whenever any changes in the operation requirements and/or methods are introduced.

2. In-depth training should be provided on all requirements of the operation with emphasis on the data elements in error that should receive priority treatment and the procedures, including follow-up if necessary, that must be followed for these.

3. Tables showing the frequency of edit rejects and corrections by type should be monitored on an on-going basis. Any unusually high incidence should be investigated.

4. Procedures to ensure that all corrected data are reprocessed through the edits that caused their rejection should be provided.

5. The opportunity for imputing data at this stage should be eliminated or minimized and the before and after data in these cases should be documented for later review and analysis.

6. All data that are received through telephone follow-up procedures should be added to the respondent's questionnaire and it should be noted how and when they were obtained.

7. As the work load may exceed the capabilities of the staff, all error reject information should be classified as to its seriousness and its correction priority.

8. Supervisors should periodically check the work of their staff to ensure that the procedures are being followed. As well they should evaluate the quality of their work. These quality results (i.e. errors made and their potential impact) will then determine if there is a need for some form of quality control.

9. Good document control procedures should be instituted and it should be ensured that these are suitable for all aspects of the correction operation and any evaluation checks that the supervisor implements.

10. The data capture operation for the correction data should take into consideration the data quality activities listed in section 3.5.

11. All operational activities that interface with computer programs should consider the data quality activities listed in section 3.8.

3.8 IMPUTATION AND ESTIMATION

Imputation is the final operation for the replacement of missing or inconsistent survey data and the estimation procedures produce the final survey tabulations and publication reports and tables.

Imputation

1. Indicators of the amount and incidence of imputation actions should be incorporated in the imputation programs or documents if this is a manual operation. Some examples of these indicators are:

   (a) Cell non-response identifiers.

   (b) Edit failures counts.

   (c) Identify corrected or imputed data and/or type of imputation when there is more than one option.

   (d) Keep before and after data for imputed data cells.

2. Detailed procedures should be provided for all manual operations or interfaces that are associated with these two important survey operations. The imputation procedures should include the handling of special cases such as outliers when necessary.

3. In-depth training should be provided on all requirements of these operations.

4. The imputation process should be monitored on an on-going basis. Typically this involves:

   - Analysing the frequency of imputation actions and the effect of imputation on the final estimates;

   - Producing and comparing distributions before and after imputation.

   Unusually high incidence or difference should be investigated.

5. A periodic check of these operations should be made to ensure that the procedures were followed and that due consideration of all supporting data was included.

Estimation

6. Before implementing the estimation technique, the survey data should be analysed to ensure:

   - That the expected conditions for a minimum mean square error of the estimates still exist (e.g. in ratio estimation, the trade-off between sampling variance and the size of the bias should still exist);

   - Adequate treatment of the outliers;

   - Adequate treatment in cases where large numbers of units are changing strata.

7. A procedure that has frequently to be adopted to create time series data, is 'benchmarking' i.e. the adjustment of values obtained from one source (usually a sample) to make them accord with totals which are obtained at less frequent intervals but which may be considered more reliable (benchmarks).

   The method of benchmarking chosen should aim at distorting as little as possible, the general movement of the indicator series (i.e. the characteristic pattern of the original series) while shifting the level to that of the control series (i.e. the level of the more reliable data series) (E.B. Dagum (1977)).

3.9 AUTOMATED DATA PROCESSING

These are the computer processes that the captured data are subjected to, in order to achieve what is called a "Clean Data File". For this statistical activity phase the data quality guidelines are:

1. Detailed documentation on each designed, tested and accepted computer program used in the survey should be provided. This is in order to provide the operational staff with:

   (a) A good understanding of the objectives of each program.

   (b) Instruction for submitting and executing each program. This will include the preparation of the input data - this is important in cases where there are different processes for different regions and/or type of data.

(c) A good knowledge of the data files used in each program and how to set up file controls to ensure that the correct files are used.

(d) Instructions related to the outputs of each program. This will include the importance of each output, how they relate to the total operation, and who is responsible for them.

2. Instructions on how to handle operational or system problems that may occur should be provided. The documented results of the program and system testing will be a big help here.

3. All operational staff should be given the EDP training necessary for their work.

4. In-depth training on all aspects of the manual operations that are directly associated with the computer system should be given.

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4. *VALIDATION*

INTRODUCTION

Validation is the term used to describe the process of determining the extent to which there is conformity between the original objectives of the statisticial activity and the final product.

Some validation studies (e.g. coverage studies, macro-edit) should be done routinely, while others (e.g. validation of concepts, responses by in-depth re-interview) should be done where feasible or where perceived to be important. In the case of an ongoing survey or data exercise, validation studies to determine whether the project is still on course, should be undertaken periodically, not simply when problems arise.

QUALITY GUIDELINES

The guidelines describe activities directed at validating the statistical product and evaluating the extent to which the objectives have been realized.

4.1 CONCEPTS AND DEFINITIONS

OBJECTIVE

- To determine if, and to what extent, the concepts and definitions, as originally stated, have been understood and been measured by the data or estimates.

GUIDELINES

Micro-level

In-depth, on site interviews, with a sample of respondents may be conducted to determine:

(i) if the respondent meets the definition developed;

(ii) if the respondent was correctly classified;

(iii) whether the respondent understood the concepts and definitions presented to him as he was intended to understand them;

(iv) whether the respondent supplied the correct information.

Also, a sample of out-of scope units may be interviewed to determine:

(v) if some possible respondents have not been identified.

Note that (i) (ii) and (v) are points which are also covered in a validation of coverage while (iv) is also covered in a validation of response. Note also that the validation study is done after the survey exercise. A similar study done at the planning stage would constitute a test of the frame, of the questionnaire and the ability of potential respondents to supply information.

The proportions of cases in which conditions (i)-(v) are satisfied constitute measures of the quality of realization of concepts.

Macro-level

In some instances, statistics are based on classification systems which assume homogeneity for essentially heterogeneous units. Thus, for example, businesses are assigned to an industry class according to their principal activity and secondary activities are not represented. When data are collected for such a universe, part of the total specific industry activity is reported for activities which lie outside the relevant industry class. Similarly, part of the relevant industry activity occurs in classes outside that specific industry.

Two measures of the quality of the classification (the system as applied to the entire universe rather than the coding operation) may then be calculated:

- the **specialization ratio,** or the proportion of industry-specific activity (e.g. value of shipments) to total activity reported by that industry; and

- the **coverage ratio,** on the proportion of total industry-specific activity accounted for by the firms coded to that industry.

These measures are difficult to estimate and steps need to be taken to collect sufficient data to do so[1]. Otherwise some proxy must be found.

4.2 COVERAGE

OBJECTIVE

- To determine if and to what extent the coverage, as originally defined, has been achieved.

GUIDELINES

Micro-Level

1. After identifying comparable lists or even sublists, the current survey list (or appropriate subset) can be matched with the alternativelists. When the results of the matching are analyzed the percentage of unexplained non-matches on each list acts as a measure of coverage (undercoverage or overcoverage) error. The number of units not appearing on any list can be estimated by using capture-recapture estimation techniques (see Bishop, Fienberg and Holland, **Discrete Multivariate Analysis**, Chapter 6). The technique may shed light on the causes of undercoverage.

2. A very reliable external source for some subset of the current population can be sampled and then matched to the current list. The sample units not matched provide an estimate of undercoverage in the current list (e.g. reverse record check).

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[1] Examples of these measures may be found in:
U.S. Dept. of Commerce, Bureau of the Census **1977 Census of Manufactures** (numerous industry-specific reports);
Dept. of Consumer and Corporate Affairs, **Concentration in the Manufacturing Industry of Canada,** Ottawa 1971;
U.S. Dept. of Commerce, Bureau of the Census, **1977 Census of Manufactures: Concentration Ratios in Manufacturing** (Washington D.C., U.S.G.P.O., May 1981).

3. Survey returns can be analysed for deaths, duplicates, changes in classification and out of scope units. Simple percentages of occurrence will act as measures of quality of the frame. Deeper analysis may reveal particular problems with the frame construction.

4. Data from specially designed replicates expected to yield the same number of units can be analysed. Large discrepancies may reveal problems of frame construction.

5. In the case of business surveys, discrepancies in coverage may occur because of births, deaths or changes in classification which have taken place since the sample was selected. (Not all these changes may yet be reflected in the updated frame.) The extent of the coverage error may be assessed by:

   (i) the use of an area frame - a sample of areas would be visited and all businesses in these areas listed and compared with all businesses listed in these areas in the original frame;

   (ii) comparison of the frame updated to the time of the survey reference period with the frame at the time of sampling (this is less satisfactory than (i), but much cheaper);

   (iii) re-profiling - the determination of the structure and the classification of the components of a sample of businesses from the original frame (this method does not detect births);

   (iv) comparison with commerical lists (as in 4.2.1).

Macro-level

6. Estimated counts can be compared with estimated counts from another source. Estimates from a reliable external source, possibly an earlier version of the same survey, can be adjusted for births, deaths, migration and differences in target populations. These adjusted estimates can then be compared with the estimates from the current survey. The percentage deviation in each estimate can be used as a measure of quality or reasonableness. It must always be borne in mind, however, that the adjusted external source may be less than a perfect reflection of the truth.

7. Consistency checks (e.g. the ratio of males to females in the Census) can also be used to evaluate coverage error.

In 3 and 4, the analysis could also reveal problems in frame maintenance, sample selection and actual changes in the population.

4.3 RESPONSE

OBJECTIVE

- To evaluate whether, and to what extent, the responses are accurate.

GUIDELINES

Micro-Level

1. Overall and stratified frequency distributions of output variables, scatter plots, and tabulations of combinations of variables, can be constructed. This analysis is done at a more detailed level than the usual survey macro-level output. Variables to be included in this analysis are the control variables and indicator flags. Attention should be paid to codes which are expected but which do not occur, or occur with low frequency as well as to obvious pathology e.g. invalid codes. This analysis will reveal problems with data capture and data entry as well as response.

2. Analysis of edit failures and missing data should be undertaken. Part of this analysis should be concerned with possible associations between the failure of a particular edit (or the non-occurence of a certain item or items) and other items or classification variables.

3. Results can be compared with data from another source. The data file should be matched with another which contains similar data on similar units. Although the rate of non-matches may be high, the individual matches can indicate possible systematic biases or differences which require explanation.

4. A sample of respondents can be re-interviewed, with or without reconciliation. A sample of respondents can be selected and re-interviewed possibly with a more detailed questionnaire, or possibly with the interviewer trying to reconcile the original response with the new response. When an in-depth re-interview is used, an estimate of the reliability of the response can be obtained. With a simple re-interview, which should attempt to recreate the original conditions of the survey as much as possible, an estimate of response variance and some of its components may be obtained.

5. Analysis of data from evaluation studies designed to measure response error can be undertaken. These studies, similar to (4), should be part of the original survey design and should be conducted nearer in time to the original survey.

Macro-Level

6. Results should be compared with macro-data from another source or historic data (for ongoing surveys). External sources which carry equivalents or good proxies for items collected by the survey can be used, provided that there are no problems with differences in coverage. With historic data, estimates of items which are not expected to change very much can be used, or these estimates can be updated. If the coverage of the two sources is not equivalent, often the ratios between certain estimates on the two files can be compared. This is one of the most important means of validation.

7. Macro-level edits should be performed. The estimates themselves have to satisfy internal constraints or "reasonable" conditions. Also, events which would appear to be rare should occur with very low frequency.

8. Precision estimates should be analysed, at all levels. An estimate of precision which is unexpectedly large or small could indicate response problems.

9. Precision estimates should be monitored, for ongoing surveys. If a series of precision estimates shows a sudden change, a possible response problem should be investigated.

4.4 NON-RESPONSE

OBJECTIVE

- To evaluate the extent of non-response and the effects of non-response on the bias and precision of the estimates.

GUIDELINES

Micro-Level

1. The characteristics of non-respondents should be determined from sample frame data.

2. The characteristics of non-respondents can be determined by matching to an external data file or by means of follow-up.

3. The patterns of partial non-response (items typically missing together) and their associated characteristics should be determined.

4.5 DATA CAPTURE, CODING AND DOCUMENT PREPARATION

OBJECTIVE

- To evaluate the impact of the data capture, coding and document preparation procedures on the quality of the data.

GUIDELINES

Micro-Level

1. Data from quality control procedures should be analysed. This gives information on which items gave the most trouble in coding or keying, or which operators require retraining. Over time, changes in the quality of the data are documented and improvements in the data capture may be developed on the basis of this information.

2. Work-flow data should be analysed. This indicates the presence or persistance of bottlenecks in the work-plan which require action. The presence of bottlenecks frequently leads to the adoption of short cuts which impair the quality of the data.

3. Expert recoding studies can be undertaken. A sample of the original returns is recoded by expert coders and the resulting codes are compared with those originally assigned. The percentage error in coding can thus be estimated as well as the contribution to the total error due to coding.

4.6 ESTIMATION

OBJECTIVE

- To evaluate the stability and efficiency of the estimation techniques given the peculiarities of the actual data observed. Estimation techniques are frequently formulated in "ideal" conditions; but in practice the data behaves differently to what was expected and thus the estimation procedures do not always perform as expected.

GUIDELINES

Micro-Level

1. Validation studies for synthetic estimates can be undertaken. A synthetic estimation technique may be used to produce estimates at levels for which the survey was not designed, typically a very detailed level. A validation study would be a survey of limited scope intended to estimate some of the details directly (e.g. for small areas), and thus evaluate the technique or model used to derive the synthetic estimates.

Macro-Level

2. Re-estimation using alternative techniques, such as alternative outlier treatments, alternative imputation treatments and alternative variance estimation techniques can be undertaken. Too much departure from the original estimates may indicate instability which needs investigation. Ideally, this kind of study should take place in the planning phase when techniques of estimation are being developed. If suitable historic or test data are not available, plausible synthetic data, generated by a suitable model, can be used, but the results should be confirmed when real data becomes available.

3. Analysis of the imputation process should be undertaken. The nature of this analysis depends on the type of imputation used. Imputations using a decision-table approach need a breakdown of the frequency with which each set of options was used. Imputations using the donor-recipient (hot deck or nearest-neighbour) approach need statistics on the frequency of donor usage, the number of attempts made to complete the imputation before the edits were satisfied, the number of imputations which failed (and which, presumably, were subject to some default process or manual imputation), and the initial and final distributions of the variables.

4. The effects of imputation should be analysed. This can be done by simulation, or by matching to an external data file with similar or good proxy variables.

4.7 SAMPLE DESIGN

OBJECTIVE

- To monitor the efficiency of the sample design over time. As the population or survey frame changes, the design will degrade. In an ongoing survey, degradation of the design would signal a need to revise the design.

GUIDELINES

Macro-Level

1. The design effects for a variety of estimates should be re-estimated, and compared with the original design effects.

2. Alternative designs (e.g. alternative constructions of primary sampling units, alternative sampling plans, alternative stratifications) can be simulated and the design effects compared with those of the current design.

Many of the guidelines outlined in this section are discussed in more detail in Gosselin et al, 1978.

4.8 MODELS

OBJECTIVE

- To ensure that the model used is appropriate, or that the model in use is still valid.

GUIDELINES

Inasmuch as the term "model" has different meanings in different disciplines, it is difficult to provide concrete guidelines for model validation. We assume here that a model is "something" which "behaves like" reality but which is far simpler in structure (because it eliminates certain sources of variation, for example).

Depending on the context, one might consider the following:

1. Verification of the assumptions underlying the model.

2. Testing the predictive power of the model by using historical data to "predict" known quantities.

3. Comparing the results generated by the model with other related sources of data.

4. Use of screening and cross-validation studies (See: 5.2.13).

5. Testing the sensitivity of the model to its parameters.

6. Validation of the data inputs to the model.

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INTRODUCTION

Analysis is the process of summarizing and interpreting the data. It involves a deeper study of the data than is provided by the usual survey estimates. Analysis is important for the provision of feedback from previous surveys and pilot studies to the planning process of new statistical activities, providing essential information for survey design, the formulation of realistic objectives regarding quality, the identification of problems and the requirements of data processing. Independent files of related or auxiliary data may often also be utilized for these purposes.

The validation process also requires analysis, such as in the explanation of the differences between the results of the activity and related data.

Analysis may also involve the exploration of social and economic issues through the examination of data from one or several sources.

QUALITY GUIDELINES

OBJECTIVE

- To ensure or improve the quality of the analysis.

GUIDELINES

The intention is not to cover all the ways in which data are summarized statistically, but to provide a guide to techniques by which the suitability of the analysis of any given data set should be examined. The techniques are listed below with a brief description of why they are considered useful.

5.1 PREPARATION OF DATA

1. **Study of the documentation on concepts and definitions, data collection, sample design, data quality, etc.** It is necessary to understand thoroughly the background and methodology used to produce the analyst's input data in order to interpret them correctly and to analyze them appropriately. Separate data sets which appear to deal with the same characteristic are often really covering variables with the same name but different definitions. If a sophisticated method of data collection is not taken into account in the analysis, the validity of the analysis can be seriously compromised. Data which have already been massaged may not be appropriate for the desired analysis (e.g. the purpose of the analysis will determine whether it is appropriate to use the raw data or the seasonally adjusted data in analyzing time series).

2. **Study of the documentation of the data file, checking the meaning of all flags and codes.** Generally, a great deal of information which is not statistical is stored on a record. This may include the response status of the unit, the date the response (if any) was received, which items were missing, which were accepted by the edit and which imputed, the sampling weight, etc. Codes used for certain data items may include special values for unavailable data.

In the case of numeric-valued items, there may be no distinction between a legitimate value of zero and a missing value. It cannot be assumed that all records are equally good and the documentation must be examined to determine which records should be included for a given analysis.

3. **Contact with personnel involved in the planning, design and data collection.** Documentation is (unfortunately) often incomplete or not up to date. "Adjustments" to procedures may have been made on the fly, or human error may have resulted in some procedures being inexactly carried out. It is important for the analyst to be familiar with as much of this kind of oral tradition as possible. It is also useful to know why certain parts of the activity were done the way they were rather than in the way that, in hindsight, would appear more sensible.

4. **Study of the imputation procedures used** if there is imputed data on the file and evaluation of the suitability of such data for inclusion in the analysis. Imputation is usually undertaken with the immediate needs of the survey activity in mind: imputation of miss-ing or defective data keeps the estimation procedures relatively simple and provides consistent estimates. However, some methods of imputation could bias the analysis, especially if a relatively large amount of data has been imputed. For example, if a linear model is used to impute, a subsequent analysis will rediscover the same linear model, probably with the relationship appearing to be much stronger (Sande, 1982).

5. **Elimination from the analytic working file of all records not suitable for analysis.** The master data file is often too large and poorly organized for purposes of analysis. Also, it is too easy to "forget" just which records were to be used for analysis. It is usually simpler to construct a working file (perhaps several) which contains all the relevant information, as well as derived information (such as adjusted sampling weights). Of course, such a file should be properly documented.

5.2 DISTRIBUTIONS, RELATIONSHIPS, MODELLING, SUMMARIZATION

1. **Use of descriptive statistics such as quantiles and histograms.** Any analyst with a sophisticated technique in mind should not neglect to produce these simple data descriptions which make no assumptions about the underlying models and are readily comprehensible.

2. **Use of exploratory data analysis.** (See Mosteller and Tukey, 1977.)An analyst uncertain of which direction to take or what assumptions are realistic might use these techniques to get a better feel for the data.

3. **Use of probability plots to assess the appropriateness of theoretical distributions in fitting the data.** Though, there may be theoretical tests (e.g. Wilk-Shapiro test, Kolmogorov-Smirnov test) for distributions, a probability plot (which plots the ordered data against the corresponding expected quantiles for the hypothesized distribution) shows the quality of fit and, if there are any problems, just where those problems are. A poor fit may be due to just one outlier, poor theory or an artifact of the data collection exercise. (Wilk & Gnanadesikan, 1968; Shapiro and Wilk, 1965).

4. **Plots and diagrams.** This point is related to points 1, 2, 3. It cannot be stressed too much that graphical work, not necessarily very high quality graphics, has an important part to play in the analysis of data as well as in its presentation. (Tufte, 1982, Chambers, et. al., 1983, Schmidt, 1983).

5. **Robust techniques for parameter estimation.** Classical methods may lead to poor estimators in the presence of outliers or anomalies. Outliers cannot always be identified easily, either because the data set is too large or there are too many variables under consideration. We note that many survey estimation systems now include procedures to identify and accommodate outliers without manual intervention.

6. **Regression diagnostics.** The uncritical use of regression packages on data can lead to estimates which do not represent the data very well. Regression diagnostics point to the observations which have the most influence on the regression. (Belsey et al, 1980; Hocking, 1983).

7. **Accounting for a complex sample design.** Complex sample designs result in varying weights for, and dependence between, the observations. Most statistical analysis programs assume independence and equal weight for the observations, assumptions which are violated in complex samples. In particular, the usual techniques for contingency table analysis do not apply. In the case of regression analysis, the usual techniques are sufficient for the estimation of coefficients, but not for assessing their significance. The problem may be overcome by the use of replication techniques (such as jack-knife) or by uses of other special methods. (Scott and Holt, 1982; Rao and Scott, 1982; Shah, 1978, Fellegi, 1980; Binder, 1983; Binder, et al., 1983; Hidiroglou and Rao, 1981).

8. **Assessing goodness of fit.** When a model is fitted to data either to "explain" variation or for purposes of prediction, the analyst should not rely on the formal test of significance for confirmation or rejection of the model, but should use other techniques, both graphical and theoretical, to judge the quality of the fit (see points 2, 3, 6, 9-13). The analyst should not forget to check the physical plausibility of his fitted model, e.g. should a fitted regression line pass through the origin?. Deviations from plausibility may indicate problems with the data.

9. **Analysis of residuals,** such as residual plots, plots of residuals against dependent and independent variables, normal plots of residuals and partial residual plots. Such analysis may indicate deficiencies in the model, violation of assumptions of normal errors, or problems with the data (see points 2, 3, 4, 8). (Mosteller and Tukey, 1977; Hocking, 1983).

10. **Detection of outliers.** Undetected outliers may lead to poor estimates (see points 2, 3, 4, 5, 8, 9). The detection of outliers may, in itself, lead to reformulation of the model where the out-liers are accounted for by some previously unutilized independent variables, or may indicate problems which require investigation.

11. **Use of transformations of both dependent and independent variables.** Transformations are commonly used to improve fit in a model, to exhibit a stronger relationship between variables, and to stabilize the variance of an independent variable. If a transformation markedly improves fit, insight is often gained into the basic structure underlying the model. (Mosteller and Tukey, 1977; Hocking, 1983).

12. **Use of non-linear regression to fit models.** A non-linear model may offer a more rational explanation of the relationship between variables and modern statistical packages are well equipped to handle them.

13. **Use of screening and cross-validation studies.** The inferences drawn from an analysis may not be as general as one would like to believe. In this technique, the data are

divided into two parts: the analysis is done on the first part and confirmed on the second (Mosteller and Tukey, 1977.)

14. **Consultation with a specialist** in statistical data analysis. This may be useful for the subject matter specialist, both to become acquainted with a wider range of techniques than they may be aware of as well as to be warned of, and perhaps offered solutions for, the problems that may be encountered in applying certain techniques to the data.

15. **Peer review.** The exchange of ideas and discussion of one's work with one's colleagues will often result in constructive suggestions as to techniques and new lines of enquiry.

5.3 LONGITUDINAL ANALYSIS

The comments of Sections 5.1 and 5.2 apply generally to longitudinal analysis, in which a time element is present. Occasionally this is referred to as "time series analysis", but usually the latter term is reserved for a more formal and sophisticated set of procedures which seek to explain and predict fluctuations over time using frequency or autoregressive methods (or both) under a fairly rigid set of assumptions and generally requires a large amount of data (i.e. a long series).

If a longitudinal analysis is planned as an eventual outcome of an ongoing survey or data-collection activity which is not a census, we suggest:

1. Inclusion of a longitudinal sample in ongoing surveys. This will decrease the variance of the parameters which measure change. Even if longitudinal analysis is not seen as a primary goal, it is usually required to make some estimates of change, and for this, a rotating sampling design is usually employed.

When a population is sampled at regular intervals (e.g. LFS, SEPH), longitudinal analysis can be expected to play a part in quality assessment, shedding light on population behaviour and thus guiding decisions as to sample design, questionnaire design, editing, imputation and tabulation. For these purposes the following should be considered:

2. Investigation of population stability over time, for example with respect to distribution of ages, of industry, etc.

3. Investigation of the rates of migrations, births and deaths in the population.

4. Investigation of individual unit behaviour over time.

When one of the objectives is longitudinal analysis, the analysis may be improved by such measures as:

5. Plots of data against time.

6. Use of smoothing to get rid of noise.

7. Use of robust methods.

5.4 TIME SERIES ANALYSIS

1. If formal time series analysis is being considered it is advisable to consult an expert and make sure that the data are suitable for the purpose (D.G. Horvitz, 1978).

Many of the periodic cross sectional surveys conducted by Statistics Canada lead to the production of data for consecutive periods and these data are generally regarded as constituting a time series of observations which are used to examine change over time in the social or economic phenomena being observed, whether they were originally designed for the purpose or not. In fact, when formal time series analysis is an objective of a survey, it is important that this be taken into account at the design stage of the survey as the design or estimation procedures used should not confound the effects, such as seasonal effects, which the time series are used to analyse.

2. Many of Statistics Canada's data series are disseminated both in their original form and after deseasonalisation or decomposition (into the trend, the cycle, seasonal and irregular fluctuations). Since the process implies the use of statistical modelling for estimation, the procedures introduce a further source of error, into the final data. Seasonally adjusted data play an important role in the analysis of economic conditions whose efficacy depends either on how well the data reveal the characteristics and turning points of the business cycle or the stage of the cycle which has been reached. Reliable estimation of seasonal patterns per se, in economic and social indicators is relevant for policy. As a consequence, knowledge of the reliability of the adjusted data is of importance to the user (Dagum, 1974).

3. To ensure the quality of seasonal adjustment or time series decomposition:

   - the data series should first be examined for the presence of seasonality to determine whether there is seasonality in the data and, if there is, whether it is additive or multiplicative (Lothian and Morry, 1978a);

   - If the presence of seasonality is established and it is decided to isolate seasonal variations, the identification and estimation of the model used should aim at a high degree of accuracy. The most appropriate options for model decomposition (additive, multiplicative or log additive) should be applied, as also the selection of weight systems to estimate stable and/or moving seasonal patterns, trends with structural changes, identification and replacement of outliers etc (E.B. Dagum, 1983);

   - Criteria of quality should be chosen. There are various criteria of quality against which the seasonally adjusted series can be judged among which are; the production of smooth seasonally adjusted series; no residual seasonality to be left in the series; minimisation of the size of revisions;

   - Quality control statistics should be produced and examined, to check the quality of the data series after they have been adjusted or decomposed (Lothian & Morry, 1978b);

   - The seasonal adjustment procedure chosen or in use should be reviewed periodically, as the seasonal variations contained in the phenomena being observed, may be changing over time.

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INTRODUCTION

Documentation constitutes a record of the project. Ideally it should be possible to reconstruct the progress and decisions of the project from the documentation. It is important to know not only what decisions were made, but why they were made. Similarly, the theoretical basis for the methodology is as important as the methodological specifications, etc. Documentation of any part of the project may be aimed at one of several different groups such as management, technical staff, planners of other surveys, outside users requiring documentation at varying levels of complexity etc.

QUALITY GUIDELINES

OBJECTIVE

- To produce complete and readable documentation of the project.

GUIDELINES

With respect to different aspects of the statistical activity, the particular areas which should be documented are listed below. (Documentation for the Planning and Dissemination phases are also described in Chapter 1 and sections 7.3 and 7.4).

The documentation suggested here would be voluminous and probably not always practicable to produce in its entirety. The survey manager has to decide which documentation is essential and which can be omitted with negligible effect on the information and record-keeping requirement. It should also be recognized that documentation, however complete, is more useful when it is up to date, well organized and retrievable (section 6.11), and well written and technically sound (section 6.12).

COMPLETENESS

6.1 OBJECTIVES AND CONCEPTS

(i) Objectives in terms of information required regarding coverage, detail, timeliness, frequency, precision of estimates, data quality targets.

(ii) Concepts, definitions, standards, relationship to other surveys or projects and other subject-matter related areas.

(iii) Evolution of objectives over time, which usually takes the form of minutes or accumulated documentation. Objectives frequently change as work proceeds on the project, due to budgetary constraints, perceived feasibility, the results of new pilot studies, new technology, etc. It is important that these changes as well as their rationale are documented and do not reside only in the accumulated folklore of the activity.

(iv) Questionnaire development, with special reference to how the questionnaire reflects the definitions and concepts adopted. Documentation here may include a test of the questionnaire and subsequent analysis of test results.

6.2 METHODOLOGY

(i) **A proposal setting out design alternatives.** A proposal discussing alternatives can include recommendations, but should not anticipate the final decision. This is necessary, before any decisions are made, so that all options are considered and discussed and the reasons for the final decision are thoroughly understood. The rationale for the final decision must also be documented.

(ii) **Studies related to methodological decisions,** e.g. relating to stratification, estimation, etc., including pilot tests.

(iii) **Papers on:**

Design		Methodologists (mathematical
Estimation		statisticians)
Outlier treatment	**for**	Subject matter specialists
Editing		Systems personnel
Imputation		Senior management.

These papers, which should be revised as necessary, are important for internal information, especially for new arrivals on the project at all levels. Obviously, the size and complexity of the project will determine to what degree topics may be combined for a particular target group. Papers aimed at different levels and categories of personnel should emphasize different aspects of the methodology, at different levels of detail with appropriate usage or avoidance of technical terms.

(iv) A **final consolidated document on technical issues** aimed at professional personnel. This document would bring together all the pieces described above, into a coherent whole as a final definitive reference document.

(v) A **methodological overview** suitable for inclusion in the publication in which the survey results appear.

(vi) **Documents suitable for publication in professional journals.** Scrutiny and acceptance by one's professional peers is an important form of validation of one's work. Furthermore, it makes available to those facing similar problems the benefit of one's experience.

6.3 TESTS

(i) Documentation relating to **field tests** or **pilot surveys** done within the mandate of the project. Each will be a miniproject in itself; but with very limited objectives. Thus the same care in planning and execution is warranted as in the major project itself.

(ii) Test procedures for **systems** and reports on the results. A system is constructed to meet certain specifications. A test of the system supplies input data in the form the system expects as well as the output that system is supposed to produce. Test data should exercise all possible contingencies which might arise. A report on the results details how far the specifications were met. (The system which does not meet specifications as revealed by the test, is normally revised until it does.)

6.4 SYSTEMS

(i) Documentation of data files - layouts, explanations of codes, basic frequencies, edit procedures. These are obviously necessary so that the files are generally readable and usable.

(ii) Systems documentation - construction, algorithms, use. This is essential if any part of the system must be changed.

(iii) Revisions. Any revision, no matter how large or small must be documented and its documentation merged with the system documentation. A series of memos making corrections appended to the main system documentation is very poor and only just better than nothing.

(iv) Monitoring reports. This covers a collection of book keeping functions (how much time is being spent where, which parts give the most trouble, etc).

(v) Scheduling. In a complex system, the timing of the various components of the system is critical to the timely appearance of the results. It is important that the various runs be scheduled so that it can be quickly assessed whether the processing is on time or not.

6.5 QUALITY CONTROL

(i) Options, eventual choice and justification. The particular choice of QC procedures for any operation is not obvious and the factors which had to be taken into consideration should be discussed.

(ii) Procedures. A set of instructions and/or a manual for supervisors and those performing the verification should be produced.

(iii) Reports. Periodic reports on the results of the QC procedures and the performance of individual operators should be produced so that the quality can be reported or individual operators identified for retraining.

6.6 OPERATIONS

(i) Training manuals need to be produced to ensure completeness and uniformity of the training process and as a guide to planners in future revisions.

(ii) Operator and interview manuals. These would reflect the accumulated experience of operators or interviewers and could be updated to reflect changing circumstances. They are essential as references to future planners or trouble-locators.

(iii) Performance reports on operators or interviewers. These are of interest to survey managers and future managers in revising training procedures or manuals as well as in determining which operators or interviewers require retraining or should be withdrawn.

(iv) Feedback and debriefing reports. These are of interest for revising procedures, manuals or questionnaires.

6.7 IMPLEMENTATION

(i) **Procedures.** The procedures involved in implementation are at a higher level than those involved in operations. Nevertheless the various operations themselves need to be sequenced, with inputs and outputs clearly specified, as well as procedures to be followed in each contingency. Such detailed specifications are essential to the smooth running of a large activity where time is a scarce commodity, and the lack of documented implementation procedures can lead to such "mistakes" as steps being omitted, the wrong files being submitted for jobs, etc.

(ii) Schedules. The amount of time available for each step in the implementation is often limited and the various procedures have to be carefully fitted into the time available. This is also crucial in the assigning of personnel to various tasks.

(iii) Reports on problems. No matter how meticulous the planning, there will be problems. Analysis of problem reports will enable managers to identify sources of trouble and decide whether revisions are required to the operations, the system or the methodology and with what urgency. Sometimes an ad-hoc fix my be necessary until more substantial revision can be implemented; but the statistical activity manager should guard against his activity becoming a patchwork of ad-hoc fixes.

(iv) Reports on workflow. These document how the scheduling is working, whether the resources available are sufficient or if there are bottlenecks. For any activity, these reports should be fairly frequent - at least weekly, sometimes daily during peak periods.

6.8 VALIDATION

Reports on all studies. Obviously any study or analysis undertaken for the purpose of validation is wasted unless there is a written report on the outcome. An oral report is not sufficient. Even a study which gets into trouble or proves impossible and has to be abandoned deserves a write-up of some description, if only to document that a particular approach was tried and why it failed. This warns future investigators to try something else or to do it differently. Even in the case of an aborted study, some useful information may have been gained.

6.9 ANALYSIS

Reports on findings. An analytical study should include a complete discussion of the data sources, the assumptions made, the techniques used and the findings. However, papers for particular audiences should emphasize the information of interest to that audience at an appropriate level of detail.

A study should include the more interesting and relevant plots and diagrams. The reader should be convinced that appropriate steps for assuring the quality of the analysis have been taken. There is usually too much output generated in the course of an analysis to include everything and the analyst has to choose judiciously what to include without biasing the conclusions. For example, details of studies confirming models do not generally need to be included unless they are of technical interest, but a general outline of how the model was arrived at should be included. Often, interesting details can be covered in an appendix. The study should not appear to emphasize procedures unless it is being directed at an audience which is interested in procedures.

The analyst should never suppress results which do not support his theories or conform with the perceived political climate. He or she should be scrupulously objective and present his (her) results in a scientific and impartial manner and avoid injecting his (her) opinions or prescriptions.

6.10 RESOURCES

Reports on actual resources consumed, as a function of time. A complex activity will rarely meet its budget. It is obviously important to account for all expenditures in terms of money and personnel. It is also essential to use this information for better budgeting, in terms of personnel, finance and time, in the future.

6.11 DOCUMENTATION

(i) Compile a list of references: theoretical and general papers and documents relevant to, but not produced by, the project. The list would be compiled during the lifetime of the project and would be of use to those who wished to enlarge their knowledge of the general area or who wanted details such as the derivation of the methodology, etc.

(ii) Organize and index all documentation produced. Documentation is not useful if it cannot be found. Too frequently, the only copies of certain documents are in the possession of the person who wrote them or, if he has left the project or the bureau, in some disorganized general file. It is quite possible that the existence of certain documents is forgotten and work may actually be repeated because no-one can remember the original.

(iii) Organize an efficient and systematic documentation updating system, e.g. for manuals, systems documentation. A systems change is not adequately documented by a memo requesting a change appended to the regular documentation. Furthermore, such a system must continue for the lifetime of the project, even after the development work has been done.

READABILITY

6.12 READABILITY, PROFESSIONAL ACCEPTABILITY

1. The authors of documents should consider carefully the readership for which each document is intended. Once the document is drafted it should undergo extensive review by management, by representatives of the intended readers and by peers, both to ensure the quality of its content and its readability.

2. All documents should be meticulously edited. Word processing (rather than typing) is recommended where feasible to promote ease of editing and so that each new version does not give rise to a new set of errors (P.S. Don't forget to date the different versions). Word processors which accommodate mathematical symbols are particularly desirable.

3. Lists of references should be checked. It is quite easy to misquote a page number, mix up titles of journals or misspell authors' names. Since references are often added, removed or rearranged in the text, it should also be checked that each reference in the text can be found in the list of references and vice versa.

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7. DISSEMINATION

INTRODUCTION

The preceding chapters dealt with the steps required to produce a quality product. All this effort can be largely negated unless the same attention is paid to deliver the information to users in a mode and manner that makes it easy to find, understand, use and use correctly.

QUALITY GUIDELINES

OBJECTIVES

- To provide users with sufficient information on the what and how of the statistical products being disseminated to permit them to interpret and use the information correctly;
- To ensure that the products respect the confidentiality of the original respondents;
- To package statistical products in ways that facilitate their use;
- To market the products effectively (i.e. provide the products users want);
- To market the products efficiently and economically (i.e. streamline the dissemination process and present the information in packages that are commensurate with the value of the product as reflected by demand and willingness to pay).

GUIDELINES

7.1 PLANNING AND DESIGN

Planning and design of dissemination packages should reflect what is known or can be determined about:

who uses the data?
what they use them for?
how they use them?
how large the clientele is (actual and potential)?

The answers to these questions permit the planning and design of delivery systems and content that facilitate use of the information provided.

For example:

1. Timeliness

Some users may be very timeliness conscious. The production of gross summary indicators of key variables in release media such as the **Daily Bulletin, Infomat, or Service Bulletins**, well in advance of final data may be appropriate. Such data are likely to be provisional and subject to some modifications. The use of measures such as coefficients, ratios, etc, if appropriate, might be used since they may mask some of the uncertainty of the data. These advance releases should include a timetable for the release of more detailed data to reduce the number of solicitations for more detailed information. Since this medium is not conducive to detailed documentation only a footnote is necessary indicating that metadata, concerning these data, are available upon request.

2. Regional Packaging

In areas where users appear to utilize a broad spectrum of data at a regional level it is recommended that regional or geographicallyspecific packaging be considered (e.g. some surveys have provincial publications and there are also CMA and even city publications). In some cases a number of surveys with the same periodicity and produc tion schedules may combine to produce a number of geographically structured publications.

3. Machine-Readable Data

Many researchers and analysts who use our data as an input for analysis would welcome products that they can easily transfer to their electronic devices in machine readable form. Many surveys make use of CANSIM, some produce micro-data tapes, summary tapes, tabulation tapes etc. Demand for data on micro-computer diskettes or for delivery systems such as TELIDON is likely to grow. All of these products require the transmission of documentation. At the moment these may consist largely of technical information on how to transfer and access the data. The addition of quality documentation will allow a user to know what he is using, as well as how to capture it.

4. Traditional Publications

Traditional publications are still the most significant means of disseminating survey information. However, given their expense and the limited demand for many of them, decisions to continue them should be reviewed periodically. Where a publication is largely used in libraries the alternative of producing microfiche publications direct from the computer may be considered. Where demand no longer appears to warrant the continuation of all or part of a publication, it is recommended that:

1. The decision to discontinue and the date of discontinuance be announced in the publication concerned, with as long a lead time as possible.

2. Other sources for that information should also be included to minimize user disruption.

3. The information should continue to be produced in a less expensive form (e.g. computer printouts, XEROX 9700 output, service bulletins, etc.) for a transition period to cover off the possibility that an underestimate of demand was made and prevent the loss of continuity should it prove to be needed.

4. That the information be published "historically" in a publication of lesser frequency.

5. Special Requests

As users get more sophisticated, more and more of them will find our pre-packaged products inadequate for their needs. They will desire, and should be prepared to pay a reasonable price for, output that is tailored to their needs. This will require efficient and flexible retrieval systems that will produce output economically and test for confidentiality. Procedures for testing will need to be carefully devised to eliminate the possibility of disclosure of confidential information.

7.2 IMPLEMENTATION

As a result of its market research, each statistical activity should have developed a marketing strategy in which it has allocated a proportion of its resources and effort to the various means of dissemination. This exercise should be recorded and made available on request.

7.3 DOCUMENTATION

Each dissemination mode should include the following information in its quality documentation, at a level of detail that is pragmatically possible:

- identification of the statistical activity;
- objectives of that statistical activity;
- a copy of the questionnaire(s) used to obtain the data;
- identification of the type of statistical activity type (e.g. census, sample, administrative, hybrid, derived);
- general characteristics of the type of statistical activity and any special characteristics that it might have;
- frame and statistical population, errors resulting from misalignment between theory and practice (ideal vs actual);
- definitions of universe(s) and variables. Where it is not practical to include a definition for all of them, the most important ones (including those most likely to be misinterpreted) should be defined but all the definitions should be available and the existence of this additional information should be noted;
- an overview of the methodology used to obtain the data including the analytical differences between this method and others that are used to produce 'similar' or related data either within the bureau or elsewhere;
- a discussion of the data quality. This should include identification of problems in the data and what, if anything, was done about them. It should also include qualitative and/or quantitative measures of quality for the different stages of the statistical activity process.

Typically, this would include:

- a judgement of overall quality;
- the nature and impact of non-response; bias effects;
- error rates (results of the quality control procedures, etc.);
- measures of precision for all major variables;
- impact of the sampling and weighting strategy on subject matter or areal disaggregation, where applicable;

- quality impact of remaining non-sampling errors or biases;

- caveats with respect to the use of the data for analysis (e.g. in the case of data that are known to be used in time series form, it is important to point out the impact of changes in concepts, coverage discontinuities, breaks in time series, and other features that affect temporal comparability);

- the existence of corollary documentation, its nature, and how to obtain it (including cost), should be noted.

In the case of derived series or information compiled from secondary sources, the documentation included with the dissemination medium should:

- explain the model or framework if such exists;

- explain the concepts and definitions used;

- explain the methodology of compilation;

- mention all sources of data;

- discuss the reliability of estimates;

- mention caveats with respect to the use of the data for analysis (e.g. in the case of data that are known to be used in time series form, it is important to point out the impact of changes in concepts, coverage discontinuities, breaks in time series, and other features that affect temporal comparability).

In the case of statistics or analysis derived from administrative data, the dissemination medium should:

- describe the data source(s);

- discuss for what purposes the data were originally collected;

- discuss the merits and shortcomings of the data for the purposes for which they are being used (e.g. in terms of conceptual and coverage biases);

- describe how the data are processed after being received and what, if anything, is done to correct for the problems in the original data set;

- discuss the reliability of the estimates, including caveats where necessary.

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8. *ADMINISTRATIVE DATA STATISTICAL ACTIVITIES*

INTRODUCTION

Administrative data are data collected for an administrative purpose, e.g. tax returns, unemployment insurance records, documents on imports and exports, etc. Such data are frequently exploited at Statistics Canada for statistical purposes, either because they are the only sources of such information or because they are sources of relatively high quality information without any additional respondent burden or additional collection expenditures.

In general, administrative data records contain only the limited set of variables required for the administrative purpose and thus their use is constrained to particular applications rather than general analysis. In addition, the concepts and definitions employed in the administrative system do not always co-incide with those in use by, or of importance to, statistical analysts. Administrative data are sensitive to changes in legislation or regulation which affect the programme. Quality assurance programmes may be concentrated on variables which are critical to the administrative programme, rather than those of interest to the statistical analyst. Administrative files kept at a muncipal or provincial level may be incompatible with each other. Comprehensive administrative data files, such as income tax files, do not identify families, although for some purposes, family-based data would be more meaningful than individual data.

The administrative data may be supplied in the form of copies of the original administrative questionnaires, as micro-data files, or as aggregates. Thus many of the procedures associated with "traditional" data collection activities are circumvented, reduced, or in some way transformed. The secondary statistical function of the data rarely plays much of a role in the process of planning the collection. Statistical objectives are usually of less importance than the administrative objectives. Thus the problem of the quality of the statistical product derived from administrative sources, although in principle the same as that of other statistical activities, needs to be viewed from a different angle.

"The agency that plans, designs and implements the collection of the administrative data has the responsibility for quality assurance and for the evaluation and documentation of quality, but with respect to the original administrative purposes". Statistics Canada "is in the position of an external user of the data and therefore must determine their suitability for statistical purposes" (Swain, 1981). This is obviously easier for data in a relatively unprocessed state (e.g. tax returns) than for processed data in the form of macro-data files.

Thus ensuring quality when administrative data are used differs from ensuring the quality of "normal" activities, in that the supplier's documentation must be obtained, examined and validated, i.e. the incoming quality must be assessed. Quality for subsequent processing and documention is, as before, the responsibility of the statistical activity managers, and the guidelines of chapter 1-7 are applicable.

QUALITY GUIDELINES

OBJECTIVES

- To ensure and assess the quality of the administrative data used as input.

GUIDELINES

8.1 DATA CREATION

The user should obtain such documentation as exists regarding the data from the supplier: concepts, definitions, coverage, collection procedures, coding, data capture, editing, error correction, imputation, processing, updating, quality control procedures and the overall quality reports. If the supplier has conducted any evaluation studies, these should also be included. The user should, if possible, have a personal contact in the supplier's office who could answer questions on the specific details of the processing and interpretation of the documentation and who would keep the user informed of any changes in policy, regulations, concepts, methodology or procedures.

It should be noted that the documentation described is not only useful for the assessment of quality, but also for the structuring of subsequent edits and imputation at the micro-level and to the resolution of problems at the macro-level.

8.2 STATISTICAL AND QUALITY OBJECTIVES

The objectives of the administrative data activity must be defined as in Chapter 1.

8.3 COVERAGE

An assessment must be made of the degree to which the coverage of the administrative data meets the objectives of the statistical activity and what adjustments are required to improve the relationship. Such adjustments may involve re-weighting the file or obtaining supplementary data from elsewhere, or other adaptations (see 8.6).

Methods of assessing coverage are suggested in Chapter 5.

8.4 DESIGN AND IMPLEMENTATION

The quality procedures described in Chapters 2 and 3 should be observed.

8.5 EDITING AND IMPUTATION

The rates of item non-response (usually blanks) and edit failures on the documents or files received should be determined. The data should then be re-edited, since the edits which the user would consider essential will almost certainly differ from those imposed by the supplier. Appropriate flags should be added to the file, if necessary. Suitable imputations may then be made, as required.

The edit and imputation systems should be flexible enough to accommodate changes in regulations, statutes and concepts over time and also to accommodate updates resulting from better knowledge and understanding of the data creation process.

Special attention should be paid to the way the geographic areas are defined on administrative records or derived from them. In particular, the following are potential sources of problems to be evaluated and appropriately handled:

- missing address and/or postal code information;

- address and/or postal code information not up to date;

- address and/or postal code information given for a location other than the one desired (e.g. a place of business rather than a residence, or vice versa, or the accountant's address);

- non-correspondence between the address and/or postal code information and the geographic area of interest.

8.6 ESTIMATION PROCEDURES

If the administrative records supplied constitute a statistical sample of the universe, the adequacy of the sampling should be verified by comparing the estimates with corresponding estimates derived from universe files, where available, or other sources. Other verification procedures such as those described in Chapter 5, may apply.

Adjustment procedures will often be required in situations where administrative records are subject to known deficiencies that limit their usefulness for statistical purposes. Such procedures may vary from simple scaling to benchmarks at various levels of aggregation, to the development of estimation models that relate the variable of interest to the variables available for administration records.

8.7 DOCUMENTATION

The documentation and information supplied to the user should be summarized and referenced. Documentation should be regularly updated and reviewed. Changes in policy, interpretation, methodology and procedures should be noted.

8.8 QUALITY ASSESSMENT

Assessment of the quality of the input data is an important element in the utilization of administrative data, given that the original data collection and assembly was not designed for statistical purposes. Careful review of the collection instruments and procedures, quality control and editing procedures, and underlying concepts and definitions is a minimum. Comparisons of data from other sources, either on a macro or micro basis, should also be undertaken wherever possible.

The quality of input data should be documented and a description included in the publication or document which results from the activity.

8.9 CONTINUING COMMUNICATION WITH THE SUPPLIER

If administrative data are regularly received as part of an ongoing programme, there will be occasions when the supplier will review the administrative functions and want to implement revisions to the programme. The statistical user should be ready to exploit these opportunities to persuade the supplier to introduce changes in the data collection or the processing which could be of benefit to the statistical programme, and to recognize the importance of the statistical objectives.

The supplier should also be kept informed of problems found with the data since these may be symptoms of fundamental problems with his own operation. The supplier may also be sent copies of documents produced as a result of the statistical programme which uses his data as input in order to show appreciation for the supplier's efforts and make him aware of the uses to which his data are put. This in turn might make the introduction of changes, which benefit the user, more acceptable. On the other hand, it may result in the clarification of misunderstanding on the user's part regarding the data collection and processing activities.

Ultimately, a co-operative collection or processing programme may be set up between user and supplier whereby the user contracts to perform specific functions (e.g. industry coding, quality control procedures) for the supplier by virtue of the user's greater experience with these functions. A user representative might participate in planning or steering committees in the supplier's area.

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9. *DERIVED STATISTICAL ACTIVITIES*

INTRODUCTION

Derived activities are those which draw on data collected by others to produce new information relating to a particular subject, subject area or geographic region, by means of a model or framework and analysis, synthesis or theoretical transformation. Activities such as the System of National Accounts are model-based accounting frameworks which use Statistics Canada data and data from other sources to compile and estimate measures of certain economic and social phenomena. Other activities use statistical and econometric analytical techniques to relate and analyse diverse Statistics Canada and other series to produce estimates, indicators, indexes, forecasts, etc.

For this genre of activities, their quality depends to a large extent upon the quality of data used as inputs and may be limited by the quality of those inputs. Thus the quality of a derived activity is dependent upon the degree to which the objectives of the data collection programmes whose data they use meet the needs and requirements of the derived activity.

At the same time, the analysis undertaken and methodology used to produce the derived data may serve as a method of validating the quality of the original data.

Where the process leads to modifications being made to the original data (for reasons of consistency for example), the derived activity may improve the quality of its input data (or reduce error). Whether this is the case has to be established through an assessment of the methodology of the derived activity.

To the extent that the derived activity modifies or changes the original data, the quality of the derived data is not purely a function of the quality of its inputs.

QUALITY GUIDELINES

Maintaining and ensuring the quality of a derived activity is primarily the responsibility of the managers of derived activities but managers of source statistical activities, also have a role to play.

9.1 FOR THE DERIVED ACTIVITY

1. Concepts, definitions and the collection methodology, for the data used as inputs, should be carefully examined. Where the data do not fully meet the requirements of the derived activity, differences and shortcomings should be documented so that users or assessors of the derived data can be made aware of the strengths and weaknesses of the underlying data and the extent to which they have been compensated for. Where feasible, attempts should be made to describe or measure the bias introduced into the derived data as a consequence of using inputs which were not originally designed to serve this purpose.

2. Every effort should be made to communicate the particular needs of the derived activity to the source statistical activities so that, where possible, they can make suitable modifications to their data collection programmes.

3. Where derived activities compare and utilise data from various sources and try to reconcile differences between them, the process can serve as a valuable input for the validation of the series in question, as it usually raises questions concerning the accuracy of the series being compared.

It is important that two-way lines of communication remain open, between analysts of the derived activity and those of the source of inputs. Keeping the source divisions informed of the exercise and its results, will enable them to improve the source data when necessary. It will also ensure that the comparison is done properly and adjust ments made by the staff of the derived activity are based on the best understanding of the data being used as inputs.

4. Certain derived activities use actual data and statistical estimation techniques to produce data. They may use a combination of data from current surveys, relationships between variables derived from occasional surveys, and model-based estimates. It is important that documentation should be produced, which explains the assumptions made, the methodology used and the relative reliability of the derived data produced.

5. From time to time, the assumptions underlying the model and framework of the derived activity and the methodology used should be validated.

6. With respect to planning, analysis, documentation and dissemination, guidelines have been provided in chapters 1, 5, 6 & 7 which can be applied to derived activities. With respect to documentation accompanying the dissemination of data, guidelines for derived activities which are shown separately in Section 7.3 are repeated below.

   The documentation included with the dissemination medium should:

   - explain the model or framework if such exists;
   - explain the concepts and definitions used;
   - explain the methodology of compilation;
   - mention all sources of data;
   - discuss the reliability of estimates;
   - mention caveats with respect to the use of the data for analysis (e.g. in the case of data that are known to be used in time series form, it is important to point out the impact of changes in concepts, coverage discontinuities, breaks in time series, and other features that affect temporal comparability).

9.2 FOR THE SOURCE STATISTICAL ACTIVITIES

1. Through on-going consultation, statistical activity managers should make every effort to be aware of, and understand, the needs of the derived activities within Statistics Canada which use their data.

2. Source statistical activity managers should keep client statistical activity managers informed of all changes to concepts and definitions, coverage, etc., and of changes planned in the future.

3. Of particular importance to derived activities is a knowledge of the reliability of data being provided to them. Weaknesses in the data or problems being faced by source statistical activities should be communicated to client statistical activities, as the effectiveness of any methodology adopted by the client to compensate for known deficiencies in the data depends upon precise knowledge of the nature of those deficiencies.

4. When the objectives of data collection programmes are reviewed, the needs of the derived activities should be kept in mind and modifications made to whatever extent is practically possible, given the financial and resource constraints of the program and its other priorities.

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