

Developing and Implementing Data Quality Standards at the U.S. Census Bureau

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Abstract

To ensure consistent quality across all its programs and products, the Census Bureau began developing formal data quality standards in 2001. As of April 2007, eleven quality standards have been published. In 2006, the Census Bureau accelerated its efforts to develop a comprehensive and cohesive set of data quality standards. These standards will customize the Office of Management and Budget's (OMB) *Standards and Guidelines for Statistical Surveys* to reflect the issues affecting the Census Bureau's processes and products.

This paper discusses the Census Bureau's efforts to develop and implement data quality standards. It describes the development approach, which includes defining data quality, constructing a framework of standards, and conducting focus groups to gather program area input. This paper also discusses the challenges encountered in developing and implementing these standards.

Keywords: quality, standards, framework

1. Background

The Census Bureau has always had a strong commitment to quality in its data products. In fact, the Census Bureau's reputation largely depends upon the quality of its products and their value to users of its census and survey-based data. For decades, Census Bureau managers and employees have employed practices that promote high quality. In 1974, the Census Bureau issued standards on informing its data users of the important limitations of its estimates, due to sampling and nonsampling errors (Commerce, 1974). But only recently has the Census Bureau decided to formalize all these practices in a complete set of bureau-wide standards.

In 1998, the Census Bureau began developing a quality program and a foundation of quality documents: principles, standards, and guidelines. The Census Bureau's Methodology and Standards (M&S) Coun-

cil has high-level responsibility for the quality program and guides the Census Bureau's program directorates on issues relating to methodology and quality. The M&S Council consists of the division chiefs of the methodology and research areas and the Census Bureau's senior statisticians and methodologists. Landman, et al., (2001) describes the beginnings of the Census Bureau's Quality Program.

The United States Office of Management and Budget (OMB) issued Information Quality Guidelines in 2002, calling for all federal agencies to issue their own information quality guidelines (OMB, 2002). In October 2002, the Census Bureau issued its information quality guidelines and performance principles (U.S. Census Bureau, 2002).

1.1 Purpose of the Standards

The information quality guidelines motivated the Census Bureau to begin formalizing their quality practices as data quality standards. The Census Bureau's data quality standards document the Census Bureau's expectations for quality in all its programs and products. These standards also promote consistent practices for producing high quality data products throughout the Census Bureau. The Census Bureau issued the first data quality standard, *Describing the Sources and Accuracy of Tabulations and Estimates* in March 2001 (U.S. Census Bureau, 2001). As of April 2007, it has published eleven standards (U.S. Census Bureau, 2001-2007).

In 2003, the Census Bureau expanded the Quality Program and created the Quality Program Staff (QPS). The mission of the QPS is to support the Census Bureau's quality initiatives, including development and implementation of data quality standards and providing support to programs undertaking process improvement activities. The QPS also evaluates the implementation of the data quality standards and provides recommendations to the M&S Council on ways to improve compliance and reduce burden on the Census Bureau's programs.

1.2 Benchmarking Study

In mid-2005, responding to recommendations from the Government Accountability Office (GAO, 2004) and the forthcoming OMB statistical standards (OMB, 2006), the QPS performed an informal benchmark of its existing standards against the OMB's draft standards, Statistics Canada's *Quality Guidelines* (Statistics Canada, 2004), and the National Center for Education Statistics' *Statistical Standards* (U.S. Department of Education, 2003). This study identified gaps between the Census Bureau's standards and all three sets of benchmark standards. The benchmarking study also identified areas of overlap and duplication within the existing Census Bureau standards. Finally, the benchmarking study revealed that other organizations had developed formal definitions of quality.

The M&S Council decided to use the OMB standards as the main source of requirements for a new comprehensive set of Census Bureau standards. Although based on the OMB standards, the Census Bureau standards will be written to address the circumstances, some of them newly arisen, that the Census Bureau faces in developing data products, including products derived from administrative records. In addition, the Council decided to ensure that the new standards would be cohesive by eliminating the areas of overlap and duplication within the existing Census Bureau standards. Finally, based on the OMB definition of quality, the Council decided to develop a definition of quality to help our customers and employees understand the foundation of our data quality standards.

2. Development Approach

The Census Bureau's current quality standards were developed using an unstructured approach. However, problems with this approach led the Census Bureau to change to a more structured approach for developing the new set of quality standards. These approaches are described in the following sections.

2.1 Original Approach

Originally, an ad hoc process existed to determine the need for a standard. A Census Bureau manager or the Associate Director for Methodology and Standards would identify a need. Then the M&S Council would charter a team to develop the standard. The team represented all the affected areas of the Census Bureau, to ensure that the concerns of these areas were addressed as the standard was developed. The teams followed this general process:

- 1) A manager identified the need for a standard.
- 2) The M&S Council chartered a team with expertise on the issue to develop a standard.
- 3) The team developed and drafted the standard.
- 4) The M&S Council and the affected program areas reviewed the draft and provided comments.
- 5) The team revised the standard and addressed the comments.
- 6) The M&S Council and the Program Associate Directors approved and signed the final version.
- 7) The QPS published the new standard on the Internet and Census Bureau's Intranet.

The four most recently issued standards averaged about three years from when the team was chartered to when the standard was published. The major reason for the long development times was that the teams carried out work on the standards in addition to their normal work assignments. Participation on these teams wasn't accounted for when work plans were drawn up. Further, supervisors of the team members did not place a high priority on the task, so team members did not feel a strong sense of urgency, especially when tasks assigned by their supervisors needed attention.

Another cause of the long development times was the review and approval process for the standards. Because the standards are written as prose (as opposed to a more abbreviated style), many cycles of review occurred, and much effort and time was expended to ensure signatories were satisfied not only with the content, but also with the wording of the standard.

2.2 New Approach

A major difference in the new approach is that the goal is not to address individual issues as they arise, but to develop a complete and cohesive set of standards. This goal means the Census Bureau no longer makes ad hoc decisions about which standards to develop. Instead, the Census Bureau decided to develop a framework of standards based on the OMB *Standards and Guidelines for Statistical Surveys*. The purpose of the framework is to identify the standards to be developed and briefly state the purpose of each standard. Using this framework also promotes cohesion among the standards, and reduces the chance for overlap and duplication.

A second difference is dropping the team approach. The development will not rely on a team of volunteers working on a standard in their "spare time." Instead, the QPS, working with a contractor, has the primary responsibility for developing the standards. Since developing the standards is a key assignment

for the QPS, they will have fewer conflicting demands on their time, promoting faster development of the standards.

The contractor will conduct a focus group for each standard, with Census Bureau managers affected by the standard participating in the focus group. These managers are experts in the topical area of the standards and will provide input and feedback. For example, Census Bureau experts on estimation will provide feedback on the requirements for the standard *Providing Estimates from Samples*. Using focus groups to obtain input from Census Bureau employees on the content of each standard provides the expertise that the team of volunteers provided in the original approach.

The standards will be written in “requirement form” to promote brevity and clarity. This approach also may allow faster drafting of the standard and reduce the editorial and style comments received during the review.

The general process followed is:

- 1) Develop a definition of quality (M&S Council and QPS).
- 2) Develop a framework of standards (M&S Council and QPS).
- 3) Draft a preliminary list of requirements for each standard (contractor with QPS input).
- 4) Perform an initial review of the preliminary requirements and comment (focus group participants, the M&S Council, and affected program areas).
- 5) Compile comments and forward to the contractor (QPS).
- 6) Develop focus group materials based on comments and conduct the focus group with key Census Bureau managers (contractor).
- 7) Produce a focus group report containing the recommended requirements for the standard (contractor).

To ensure that the standards are cohesive and don’t overlap, the QPS decided to wait until after all the focus groups were conducted to draft the final standards. The remaining steps in the process are:

- 8) Draft the standard and submit it for review to the M&S Council and affected program areas (QPS).
- 9) Review the draft standard and comment (M&S Council and affected program areas).
- 10) Address comments, produce final standard, and submit to the M&S Council for approval (QPS).

- 11) Approve the standard (M&S Council and Associate Directors).
- 12) Publish the standard (QPS).

The Census Bureau’s Quality Assurance Working Group will review the requirements of all the standards to determine whether they are “verifiable.” In other words, can an auditor determine whether or not a program is in compliance?

3. Development Progress

To date, the Census Bureau has developed and published a definition of data quality; developed an organizational framework of standards based on the OMB standards, but customized for the Census Bureau’s products and processes; and developed a prototype standard in “requirement format” to serve as a template for developing the new standards.

We have a schedule for conducting 15 focus groups, beginning in April 2007 and finishing in January 2008. The first five focus groups have been completed and recommendations for the standards delivered to the M&S Council.

3.1 Definition of Data Quality

To lay the groundwork for its data quality standards, the Census Bureau developed a formal definition of data quality that builds on the OMB definition. The OMB defines “quality” as an encompassing term, with “utility,” “objectivity,” and “integrity” as components of quality. According to OMB, “‘Utility’ refers to the usefulness of the information to the intended users. ‘Objectivity’ focuses on whether the disseminated information is being presented in an accurate, clear, complete, and unbiased manner, and as a matter of substance, is accurate, reliable, and unbiased. ‘Integrity’ refers to security—the protection of information from unauthorized access or revision, to ensure that the information is not compromised through corruption or falsification” (OMB, 2002).

The Census Bureau’s definition expands the three OMB components of quality into six dimensions: relevance, accuracy, timeliness, accessibility, interpretability, and transparency.

- Relevance refers to the degree to which our data products provide information that meets our customers’ needs.
- Accuracy refers to the difference between an estimate of a parameter and its true value. We characterize the difference in terms of systematic (bias) and random (variance) errors.

- Timeliness refers to the length of time between the reference period of the information and when we deliver the data product to our customers.
- Accessibility refers to the ease with which customers can identify, obtain, and use the information in our data products.
- Interpretability refers to the availability of documentation to aid customers in understanding and using our data products. This documentation typically includes: the underlying concepts; definitions; the methods used to collect, process, and analyze the data; and the limitations imposed by the methods used.
- Transparency refers to providing documentation about the assumptions, methods, and limitations of a data product to allow qualified third parties to reproduce the information, unless prevented by confidentiality or other legal constraints.

This definition is published on the Census Bureau's Information Quality Page on its web site (U.S. Census Bureau, 2006).

3.2 Organizational Framework of the Standards

Next, we developed the organizational framework for the standards. The framework is organized along the lines of the life cycle of a project designed to develop a data product, from planning through dissemination. The framework includes two types of standards, process standards and supporting standards. The process standards reflect the phases of a project life cycle. The framework groups the eighteen process standards into five major categories: Planning and Design, Obtaining Data, Processing Data, Providing Estimates, and Analyzing Data and Disseminating Products. The five supporting standards generally apply to all phases of the life cycle: Protecting Confidentiality, Managing Data and Documents, Pre-testing, Ensuring Quality, and Applying for a Waiver.

Table 1 contains the complete framework.

3.3 Prototype Standard

Before beginning work on developing all the standards in the framework, the QPS developed a prototype standard, *Providing Metadata to Accompany Data Products* (see Standard E5 in Table 1). We choose this standard from the framework because we already had several existing Census Bureau standards that contained requirements on specifying the metadata that must accompany data products released to the public. We used requirements from existing standards to give employees a realistic view of how the

new standards would be organized and the level of detail they would contain.

The purpose of the prototype standard was to vet the format of the standards and the level of detail needed in the standards. Also, the prototype illustrated how we proposed to handle variations in the requirements among different data sources (e.g., administrative records) and data products.

The M&S Council and the program directorates reviewed the prototype and provided feedback to the QPS. In general, the comments received were favorable. The reviewers liked the straightforward, checklist approach versus the verbose approach of our existing standards.

3.4 Focus Groups

To date, the contractor has facilitated focus groups for the first five standards in the organizational framework. Prior to each focus group, the participants are given a preliminary set of requirements for the standard. This preliminary list of requirements addresses the requirements of the OMB standards and the Census Bureau's existing standards. This list also includes useful requirements from the Statistics Canada Quality Guidelines and the NCES *Statistical Standards*, as appropriate.

The participants have a couple weeks to review the requirements and provide their feedback to the QPS. They are instructed to provide feedback on the scope of the standard, as well as on the individual requirements. For each requirement, they must decide whether a requirement should be included or excluded from the requirements list. If they decide to exclude a requirement, they must provide the reason(s) for their decision. In addition, the participants are asked to give feedback on problems with the requirements, such as unclear terms and vague requirements.

Based on the feedback received from the focus group participants, the contractor and the QPS staff determine which requirements and issues need further discussion. Focusing the discussion on the problematic areas of the standard allows the focus group time to be utilized in the most efficient manner. The focus groups are scheduled for a two-hour time frame for each standard. Typically, the focus groups contain between seven to ten participants who are mid-level managers from the various directorates.

Though the framework contains 23 standards, the contractor will facilitate focus groups for 15 of the 23

standards since not all standards will be reviewed by a focus group. Two current standards will remain substantially unchanged, and therefore do not need a focus group: *Correcting Information that Does Not Comply with Census Bureau Section 515 Information Quality Guidelines*, and *Applying for a Waiver*. The Census Bureau's Quality Assurance Working Group will provide input on the supporting standard, *Ensuring Quality*. Experts in privacy and confidentiality at the Census Bureau will develop the standard on *Protecting Confidentiality*. The standards on *Capturing Data, Editing and Imputing Data*, and *Coding Data* were split into separate standards after the focus group. Lastly, the standards on *Providing Metadata to Accompany Data Products* and *Reviewing Data Products* do not need a focus group since most of their requirements are part of existing Census Bureau standards.

The focus group approach brings advantages and disadvantages. The input received in the written comments and in the focus group discussion has been very helpful. However, sometimes two hours is not enough time to thoroughly cover the issues. Also, because we must schedule the focus group meeting a month in advance, last-minute conflicting commitments sometimes require participants to miss their focus group. If possible, we bring in a back-up participant from the same directorate to obtain input from that program area. Finally, the focus group approach certainly promotes faster development of the standards. We are conducting about one focus group a month. While we will have to review and revise the standards to ensure a complete, cohesive set upon completion of all the focus groups, we plan to publish the final set of standards by early 2009.

4. Implementation Issues

Implementation of the standards is an important responsibility of the program directorates, while evaluations of the implementation of the standards are the responsibility of the M&S Council. The following sections discuss these issues.

4.1 Directorate Procedures

The Census Bureau has three program directorates: Demographic Programs, Economic Programs, and Decennial Census. Although the standards apply to all three program directorates and the quality issues they encounter often are similar, each directorate faces methodological and operational circumstances that are unique. For example, respondent cooperation and response rate problems in the decennial census differ from those for panel surveys where respon-

dents may be interviewed eight or more times. Surveys of establishments must deal with respondents of varying importance – in some industries, one or two respondents may generate 90 percent of an estimate, so the respondent cooperation problems require different strategies.

To allow the flexibility needed to address this wide variety of situations, each program directorate is responsible for implementing the Census Bureau's data quality standards. Each directorate uses procedures and practices that carry out the requirements of the standards and each directorate is responsible for enforcing the standards and verifying compliance.

The program directorates have begun developing and documenting procedures to implement the standards consistently. Currently, the Demographic Programs Directorate is developing consistent directorate-wide procedures to review and approve documents before they are released to the public. The Decennial Census Directorate is developing a standard process for the statistical review of American Community Survey reports. In each case, developing formal procedures helps ensure consistent adherence to the standards and reduces the likelihood of releasing data with serious quality problems.

The Economic Programs Directorate has instituted an audit program to verify compliance of every survey program with the OMB *Standards and Guidelines for Statistical Surveys* (Bushery et al., 2006). This audit program assesses every economic survey once every five years. The Economic Programs Directorate (EPD) conducts about 40 surveys, so it plans to complete eight audits each year. The EPD created a Lead Auditor position, to ensure that audit program tasks are carried out.

To audit a survey, the lead auditor selects two auditors from the EPD who do not work on that survey. They verify a specific survey's compliance with all the standards. The audited survey responds to the audit findings with a corrective action plan. This plan includes a timetable for correcting any noncompliance issues in the survey.

Other benefits result from this audit program – the auditors and survey staff often identify areas for improvement, even when noncompliance issues do not surface. The audit program also can help the different surveys share best practices. The audits have found that for every survey with a noncompliance issue, another survey has a "best practice" that would eliminate the noncompliance.

A typical audit takes about 100 person hours all together for the auditors and about 120 person hours total for the audited survey's staff to complete. The other two program directorates do not yet have formal programs to verify compliance, but the Demographic Programs Directorate intends to develop an audit program after the new standards are in place.

The Economic Directorate's audit program checks each program once every five years. A more timely approach would be for a directorate to establish a quality assurance function that would verify compliance with the standards before products are released. The Decennial Directorate has developed a "quality process" for producing evaluation reports, which includes quality assurance verifications that the steps of the process have been followed.

4.2 Evaluation Audits

The M&S Council evaluates the implementation of the standards to identify broad problems with the standards. The QPS performs these evaluations and reports to the M&S Council. The goal of the evaluations is to identify aspects of the standard that need improvement. These evaluations have identified some noncompliance problems, but the reports do not identify the noncompliant surveys or products. The intention behind reporting only summary information is to obtain better cooperation and feedback from the managers and employees who are trying to comply with the standard.

To date, the QPS has completed evaluation audits on two of the Census Bureau's existing standards: *Minimal Information to Accompany Any Report of Survey or Census Data* and *Review and Approval of Census Bureau Documents and Presentations*. Both evaluations found that compliance needed improvement. The causes for imperfect compliance were similar for both standards:

- Most of the Census Bureau's divisions lack procedures to implement the standard. Generally, unwritten practices are followed, but the lack of standard procedures causes inconsistent implementation.
- Low awareness of the requirements of standards is another cause of noncompliance issues. If people are not aware of a standard or requirement, they are unlikely to comply with it. Standard procedures consistently followed would render the lack of awareness irrelevant.
- Parts of the standards are difficult to read and understand, so employees may misinterpret the requirements of the standard, leading to non-compliance issues. Overlap between standards

also promotes confusion, because related requirements appear in different standards.

The reports recommended revisions to the standards to improve clarity. They also recommended substantive changes to the standards – sometimes suggesting requirements be relaxed, other times recommending more comprehensive requirements. The revisions to the standards will be incorporated when the equivalent new standards are written. The reports also made recommendations on implementation issues, for the M&S Council members to forward to their program areas. The QPS maintains a log of action items from the recommendations, to ensure that all accepted recommendations are implemented.

4.3 Waiver Procedure

Sometimes a program may not be able to comply with one of the Census Bureau's data quality standards. An example of this situation occurred in October 2005, when the Census Bureau included special questions in the Current Population Survey (CPS) for 13 months to help assess the effects of Hurricane Katrina. The period between Katrina's landfall on August 29 and the beginning of the October interviews didn't allow time to pretest the new questions, as required by the Census Bureau's pretesting standard, so the CPS had to field the questions without pretesting. By June 2006, the Census Bureau performed cognitive testing on the special questions (Cahoon et al., 2006).

This incident revealed the need for a waiver procedure to address situations where a Census Bureau program is unable to comply with one of the standards. In response, the Census Bureau developed the waiver procedure and issued it as a data quality standard. The procedure requires a program manager to justify the need for the waiver and to present a plan for bringing the program into compliance. The M&S Council reviews the waiver application and makes a recommendation for approval or disapproval to the Associate Director over the program. The M&S Council documents the decision and maintains the documentation.

5. Challenges

The Census Bureau faces challenges in developing the standards and later on in implementing them.

One challenge is the difficulty in obtaining adequate input on the content of the standards from the Census Bureau program areas. Step 3 of the development process calls for the focus group participants and the

affected program areas to review the requirements of each standard and provide written comments. This input is crucial. If employees are rushed due to their regular work assignments, the review may be cursory rather than thoughtful, and the resulting input will be less helpful.

After the standards have been issued, each program area must implement and comply with the standards. Program managers naturally are concerned about how compliance will affect costs, schedule, and resources. The QPS evaluations and other audit programs have shown that while the program areas generally follow practices that would lead to compliance with the standards, these practices are not documented and not always followed consistently.

Although most programs can comply simply by continuing their current practices, managers worry about the costs and delays that may occur when special efforts are needed to comply with the standards. Certainly in the short run, costs will result from complying with the new data quality standards. Verifying compliance also will generate costs. However, in the long run, with good standards and good processes to implement them, costs should not increase, and have a good chance of decreasing, as fewer mistakes occur and less rework is needed.

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Table 1. Framework of Census Bureau Data Quality Standards	
A. Planning and Design	
A1 Planning the Data Program	The purpose of this standard is to ensure that plans and justifications are developed when initiating a new or revised data program.
A2 Developing Data Collection Instruments and Supplemental Respondent Materials	The purpose of this standard is to ensure that data collection instruments and supplemental respondent materials are designed to promote the collection of high quality data from respondents, within the constraints of budget, resources, and available time.
A3 Developing and Implementing a Sample Design	The purpose of this standard is to ensure that the sample design will yield the data required to meet the objectives of the survey.
B. Obtaining Data	
B1 Establishing and Implementing Data Collection Methods	The purpose of this standard is to ensure that methods are established and implemented to promote the collection of high quality data from respondents, within the constraints of budget, resources, and available time.
B2 Acquiring and Maintaining Administrative Records	The purpose of this standard is to ensure accuracy and timeliness in acquiring administrative records and survey data maintained by other government agencies and commercial entities.
C. Processing Data	
C1 Capturing Data	The purpose of this standard is to ensure that data are captured accurately and the data capture activities are documented to allow users to appropriately analyze the data.
C2 Editing and Imputing Data	The purpose of this standard is to ensure that methods are established and implemented to promote accurate and timely correction of missing and erroneous values through editing and imputation.
C3 Coding Data	The purpose of this standard is to ensure that methods are established and implemented to promote accurate and timely assignment of codes to convert text and numerical data to categories, to facilitate the analysis and tabulation of data.
C4 Linking Data from Multiple Sources	The purpose of this standard is to ensure that methods are established and implemented to promote the accurate linking of data from multiple sources.
D. Providing Estimates	
D1 Providing Estimates from Samples	The purpose of this standard is to ensure that appropriate methods are used for weighting sample data, developing estimates from the data, and providing variance estimates.
D2 Providing Model-Based Estimates	The purpose of this standard is to ensure that model-based estimates use sound statistical practices.
D3 Providing Estimates of Nonsampling Error	The purpose of this standard is to ensure that indicators and measures of nonsampling error are computed, documented, and used to inform improvements to the program.
E. Analyzing Data and Disseminating Products	
E1 Analyzing Data	The purpose of this standard is to ensure that appropriate statistical methodologies are used in data analyses.
E2 Reporting Results	The purpose of this standard is to ensure that reports and other products meet statistical requirements; provide understandable, neutral presentations of results and conclusions; and that conclusions are supported by the data.
E3 Reviewing Data Products	The purpose of this standard is to ensure that all data products are of high quality by undergoing four types of reviews: subject matter; supervisory; statistical and methodological; and policy.
E4 Releasing Data Products	The purpose of this standard is to establish quality criteria for releasing data products; specify procedures for releasing data products that do not meet these criteria; ensure equivalent and timely access to data products released to sponsors and the public; and ensure procedures are in place to correct errors or misrepresentations.
E5 Providing Metadata To Accompany Data Products	The purpose of this standard is to specify the metadata that must accompany data products released to the public.

Table 1. Framework of Census Bureau Data Quality Standards	
ucts	
E6 Correcting Information that Does Not Comply with Census Bureau Section 515 Information Quality Guidelines	The purpose of this standard is to specify the procedures that must be followed when a party outside the Census Bureau seeks correction of information that does not comply with the Census Bureau's Information Quality Guidelines.
S. Supporting Standards	
S1 Protecting Confidentiality	The purpose of this standard is to protect the confidentiality of information provided by individuals and organizations.
S2 Managing Data and Documents	The purpose of this standard is to ensure that data and documentation are produced and retained to allow replication, analysis, and evaluation of data products.
S3 Testing	The purpose of this standard is to ensure that all systems, methods, and procedures function as intended prior to implementation.
S4 Ensuring Quality	The purpose of this standard is to ensure that programs institute controls that promote good management of the program and compliance with all applicable policies, standards, procedures and requirements.
S5 Applying for a Waiver	The purpose of this standard is to establish a standard mechanism to excuse a program from compliance with a Quality Standard when the circumstances warrant it. This standard also ensures that appropriate documentation of exceptions to the standards is generated and maintained.