Quality and the Product Development Cycle

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ABSTRACT[1]

As a new statistical agency, the Bureau of Transportation Statistics' initial efforts in the data quality area were conventional ones: statistical standards development and data quality reviews. These activities are typical components of a statistical agency's quality program. However, in the four years since the data quality efforts began, we have learned much about what is truly needed for an effective quality program. This article presents what we wish we had known back when we started, and outlines the key elements of the program we now have. The crucial insight is that we need to address data and information quality from a broader perspective than just a statistical one. Data quality depends both on the obvious statistical components – statistical standards and data quality assessments – and on the existence of a procedural infrastructure to support the statistical components. Our current system is centered on the product development cycle, integrating product management and statistical quality elements.

KEY WORDS: data quality; product development; quality management; statistical standards

Introduction

As a new statistical agency, the Bureau of Transportation Statistics' initial efforts in the data quality area were conventional ones: data quality reviews and statistical standards development. These activities are typical components mentioned in discussions of statistical agencies' quality programs.

The data quality reviews were designed to assess the current state of data quality, and to make recommendations and suggestions for quality improvements (Burns et al. 2002). The statistical standards were developed to specify the ideal state of data quality (BTS 2005, USDOT 2002).

Both the data quality reviews and the statistical standards were organized around the statistical product development cycle (Figure 1). The cycle starts with planning and design, continuing with the implementation of the design and through to dissemination and the end-of-cycle post-mortem. This type of organization, which follows a traditional survey development cycle, is used to organize statistical standards by other statistical organizations as well (e.g., ICSP 2002, NCES 2002, OMB 2005, Statistics Canada 1998).

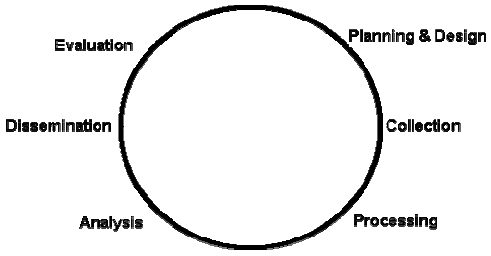

Figure 1. The Statistical Product Development Cycle

While the statistical product development cycle may appear complete, it is not self-contained. Data quality does not improve automatically once the data quality reviews have been completed and the statistical standards have been written. The BTS goal was to see the reviews and standards actually used to improve product quality, and not to be filed and forgotten.

Beyond Statistical Quality

Other, non-statistical, activities occur within the statistical organizations, and the statistical product development cycle needs links to non-statistical processes within the organization for action to take place.

Statistical training and experience largely focuses on the development of statistical methods for applications. However, statisticians in statis-

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tical organizations also need to learn how to implement recommendations from data quality reviews, and how to put statistical standards into practice throughout an organization, not just in their own work. Actions to make changes within a large complex organization are not part of statistical training or experience!

The crucial insight is that statisticians need to address data and information quality from a broader perspective than just a statistical one. Data quality depends both on the obvious statistical components – statistical standards and data quality assessments – and on the existence of a procedural infrastructure to support the statistical components.

The mission of a government statistical agency is complex, involving the interplay of employees in a variety of roles. Regardless of the discipline, some concept of "quality" is likely to be part of training and practice. For this reason, a person's view of quality rightly depends on the person's position and responsibilities within the organization.

It is not necessary, or even desirable, to wed the approaches into a single consistent set of goals. Instead, each function can have discipline-appropriate goals, since the principles from all domains need to guide practice for an agency to be successful. If quality is not encouraged to expand into discipline-appropriate forms, the concept will remain abstract and divorced from day-to-day work situations.

As appropriate, organizational units may be guided by statistical concepts of quality (Karr and Sanil 2003), computer science concepts of quality (Huang et al. 1999), or perhaps from the discipline of quality control itself (Gryna 2001). Dippo (1997) advocates combining the approaches of survey statistics and quality control. Quality control procedures, initially developed for manufacturing, are applicable to high-volume processing operations (Conklin 2002; Reichert and Piegari 2002).

While quality control procedures focus on particular processes, quality management is an overall management function dealing with the development and implementation of quality policy. Quality management can well serve as an overarching approach for the various disciplinary quality approaches. It has the conceptual tools needed as to elaborate quality goals down through the layers of the agency to the smallest project.

Quality management is also suitable as an overall approach because, at an agency-wide level, maintaining and advancing quality at a Federal statistical agency is fundamentally a management issue. The agency needs to coordinate activities, obtain and allocate resources, promote its products in the policy arena, and respond to the demands of Congress, interest groups, the private sector, and a myriad of other data users. Management needs to vigorously promote and fund data quality efforts in all organizational units. Management of quality is vital to ensuring agency credibility and survival.

Implementation, whether of review recommendations or statistical standards, is clearly a quality management issue, as well as a statistical issue. Over the years, quality managers have accrued a considerable amount of experience in applying quality management principles to quality improvement problems, especially in manufacturing applications, but also in other areas. The title of the 2005 Deming Lecture, "Statistics, Quality, and Organizational Excellence" (Godfrey 2005) captures the relationship that needs to develop.

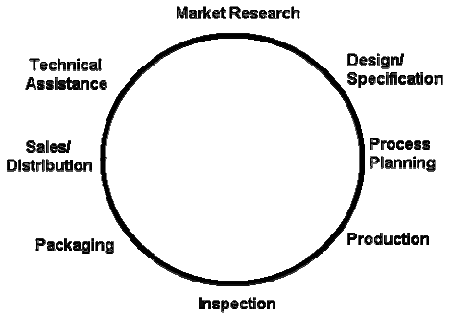

Figure 2. Manufacturing Product Development Cycle

A product development cycle from manufacturing (Figure 2) does not look terribly different from the statistical product development cycle shown previously. It describes a similar process, only for manufactured products rather than statistical products. However, quality managers in manufacturing settings have had more time, and more opportunity to work through the processes. Under the leadership of people such as Deming, the result has been the development of tools to "institutionalize" product development (and improvement) within the organization.

Institutional Quality

By focusing on the statistical product development cycle to guide the development of statistical standards, BTS initially assumed the existence of an organizational infrastructure, with defined responsibilities, policies, procedures, and resources. This organization infrastructure would both implement the statistical standards and act on the recommendations of the data quality assessment reports. However, quality improvements do not take place unless the product development cycle is strongly linked within the larger organization.

The goal of institutionalization is to embed statistical quality activities within the larger organization, recognizing that not everyone in a statistical organization focuses on the product development cycle. Institutionalization explicitly recognizes that an organization has multiple product and service loops, e.g., statistical, computing, financial, of which the statistical product cycle is only one of several, and needs to be integrated within the system of loops to be effective.

The statistical product development cycle can be embedded within the institution through:

- Links with the institution's project management and other standard operating procedures,
- Measures of information quality that can be used for management, and
- Adopting a more formal approach to quality improvement projects

The current BTS statistical quality system is centered on the statistical product development cycle, but integrating both product management and statistical quality elements. The system consists of measures, controls, and planning.

Links and Controls. There are natural points in the overall agency operation that provide an opportunity to establish a link with the statistical product development cycle.

The statistical standards contain explicit cross-references with agency standard operating procedures for project and product planning and for the predissemination review and release of products. These are both activities that require coordination across different organizational units and levels. The statistical standards also promote quality controls within processes. A special effort was made in developing the statistical standards to be explicit about the need for quality control within processes such as data collection and processing.

Data quality evaluation has become a vehicle for the implementation of statistical standards through self-assessments and independent data quality reviews. The statistical standards require product managers to assess the quality and performance of their products and processes on an annual basis and to submit a summary report to the BTS Director. Independent data quality review teams, established by the Director, provide more comprehensive reviews of compliance with the statistical standards and with the design specifications. The team prepares a report for the Director, while the office responsible for the products and processes prepares a quality improvement plan.

For a particular product, a linking opportunity arises when the product is first proposed. An Information Product Scoping Paper (BTS 2004) has been developed for product planning. In addition to providing schedules and resource needs, the Information Product Scoping Paper provides product managers with a place to summarize their research into the potential users and uses of the product, to designate reviewers, and to summarize the focus and approach. The information provided in the Information Product Scoping Paper enables BTS management and staff to give the author comments and suggestions at the planning and design stage of product development, thereby leading to better quality at dissemination. The statistical standards reinforce the requirement to plan fully for products to be disseminated to the public.

Another opportunity to link the statistical product development to other different levels and components of the organization arises during final product review and clearance. The Information Product Scoping Paper should help ensure that the review and clearance proceed smoothly. Checklists keyed to the statistical standards aid in the review. Other reviews include reviews for confidentiality protection, style, and compliance with information access regulations.

Measures. Management of the statistical product development cycle requires measures of quality and performance of the cycle and its links to other organizational processes. Measures are easy to talk about in general terms but it is harder

to develop ones that are meaningful (i.e. valid) and reliable. Applying low quality measures of quality and performance could be harmful to both attributes of the statistical product development cycle.

Developing a comprehensive set of measures takes time. As BTS begins to implement its recently adopted statistical standards (BTS 2005), it is beginning to examine and organize the measures it already has. Ultimately, BTS is aiming at a balanced representation (Godfrey 1997, 1999) of organizational interests, and include performance-related, technical (based on statistical standards), and user-derived measures.

Performance measures mainly concern the management of time and resources (personnel and funds). Although data users are interested in the timeliness of the final product, performance measures are mainly of interest to managers, who need to meet time and resource constraints.

Technical measures, such as the components of total survey error, are the ones that statistical staff members traditionally have focused on. The statistical standards are an obvious starting point for measures of technical adequacy. For data collection systems, additional measures can be derived from diagnostics and measures that are generated during data collection and processing.

Measures from data users are much harder to develop than technical measures. Data users are as critical for the government statistical organization as customers are for the private sector. However, the two sectors differ in the nature of the bottom line.

In the private sector, a product is sold or not depending on how well the product pleases customers who pay for products, thereby providing a direct benefit to the organization. Thus, financial performance becomes the most important measure.

A statistical agency gives its products away as public goods. Funding is provided by Congress rather than being directly provided by data users. Filtered through a political process, customer support remains important, but is not as easy to quantify and use to justify quality improvement projects.

For statistical agencies, the key indicator becomes stakeholder satisfaction, which eventually can translate into support for the organization. Deming wrote (1986, 6) that a government agency should deliver economically its services, and aim for distinction in service. Through continual improvement, it could hope to earn the support of the public and private industry, and gain funding.

The ideal rating would encompass all available information--quantitative where available, qualitative where not. Indeed, management often has to work in absence of hard data. Since decisions have to be made, regardless of data availability, it is better to have a tool based on systematic consideration of data systems.

An example of a rating tools designed to assist managers in decision-making is OMB's Program Assessment Rating Tool (OMB 2002). The tool is structured to allow rating of those aspects of programs that OMB management deems critical, not necessarily those for which data are available. A considerable amount of judgment is involved, but the judgments are structured and consistent across programs. The results of the ratings are comprehensible, and can be related to program decisions. The OMB tool is not necessarily exemplary, but tools like it are common in the world of management.

Quality and Performance Improvements. Measures describe the current state of affairs and can track its progress, but more is needed if quality and performance are to be significantly improved. On a continuous basis, agencies need to improve current processes and designs, and also need to design and introduce new products and services. Data quality needs to be part of, not separate from, products and processes. Performance also is usually more a function of design and management than of execution. Therefore, the planning stage is critical for quality and performance improvement.

Not all desirable improvements can be made in an environment of resource constraints. In establishing priorities, both the data users and agency technical staff have important roles. Since the information products are produced to meet user requirements, it seems reasonable to allow the users themselves to evaluate fitness for use. Users can indicate what they consider important, and what standards they use to judge fitness. With customer studies, the focus shifts from the

process to user assessments of fitness for use. In a world of limited resources, such data user opinion can be quite valuable in helping to prioritize decisions on data improvement projects.

However, data users may only observe certain aspects of quality, and may take basic needs for granted. For example, being unable to observe processing activities, data users may simply assume that the data collection and processing operations of a Federal statistical agency are carefully planned and conducted, and focus instead on timeliness and relevance. In this case, professionalism in the collection and processing of data is fulfilling a basic need of data users; lack of it will cause considerable dissatisfaction. Since the users do not have the data collection expertise that the data producers (hopefully) have, and should not be expected to develop feasible solutions to problems. In addition, data producers see their products differently from the way data users do, and may perceive different problems.

Summary

BTS started its data quality program by concentrating on the statistical product development cycle, the traditional focus of statistical training and experience. However, other cycles are operating in a statistical organization, and the statistical product development cycle needs to explicitly link with these other cycles. Measures are needed for the management of the statistical product development cycle and its links to other cycles and to data users.

Returning to the statistical product development cycle (Figure 1),

- Budgeting and initial product approval link to the planning and design portion of the cycles,
- Quality control standards primarily effect the collection and processing portions,
- Product review and release procedures are part of the dissemination portion, and
- Data users are consumers of disseminated products and partners in planning.

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