Quality assurance in the European Statistical System

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Keywords: Quality framework, quality assurance, standardisation, statistical methods, administrative data

1. Introduction

Quality and trust are fundamental to official statistics. Increased complexity of the society and processes such as globalisation and European integration, have increased the need for more evidence-based policies, and thus the demand for official statistics in Europe. To deliver high quality statistics, in a situation where resources tend to be scarce, is a major challenge to statistical producers.

Thus, during the last decade, both international organisations and National Statistical Institutes (NSI) worldwide have focused on the importance of quality work. A systematic approach to quality has been adopted in many institutes. This has been based on some basic and common principles of quality management, even if the use of formal quality systems varies. Both on the international and national level quality work in statistics has gradually developed from assessing and reporting on output quality to a process-oriented approach following the whole statistical value chain. To this end various methods and tools have been employed, ranging from quality reports and self-assessments to formalised statistical audits. Several NSIs have embarked on standardisation programmes. Risk management has been given increased focus.

Important initiatives on the European level have been the set-up of the Working Group on Quality in Statistics, the formation of a Leadership Expert Group (LEG) on Quality and the adoption of the European Statistics Code of Practice (ESCoP) for the production and dissemination of European statistics in 2005 (Eurostat, 2005).

The Code of Practice addresses all statistical authorities producing and disseminating European statistics. It has been followed up by self assessments and by peer reviews during 2007 – 2008 of principles linked to the institutional environment and dissemination in all 31 NSIs in the European Statistical System (ESS). A Task Force on the Implementation of the Code of Practice completed its work in 2008 with a report giving an overview of these activities and recommendations for future work (Eurostat, 2009a).

The Code of Practice was firmly anchored in the new European Statistical Law that was decided in 2009 (Regulation 223/2009). This regulation also defined the new governance structure of ESS, with a new body – European Statistical Governance Advisory Board (ESGAB) - which has a separate mandate to review and follow up the implementation of Code of practice in Europe.
The European Statistical System Committee in May 2009 agreed that a Sponsorship on Quality should start its work under the co-chairmanship of Eurostat and Statistics Norway. The Sponsorship has participants from 11 European countries and started its work in September last year. It shall finish by 2011.

The objectives of the Sponsorship are:
- to promote a common view and understanding on the ESS quality management shared within the ESS and other important partners,
- to develop recommendations for possible modifications of the Code of Practice in the area of quality,
- to provide recommendations on how to proceed with quality work in ESS.

It is in the mandate of the Sponsorship on Quality to clarify and if appropriate harmonise quality work across international statistical organisations. The ECB and OECD will be involved in its work. There is also an interface to the UN work on National Quality Assurance Frameworks (NQAF), see UN (2009). In fact the NQAF proposed by Statistics Canada fits very well with the ESCoP.

The paper gives a brief overview of the work in the Sponsorship on Quality so far. Some important issues that are closely linked to quality assurance in statistics, will also be discussed. This comprises standardisation, the role of statistical methodology in quality work and quality elements related to the use of administrative data for statistics. These parts of the paper build on examples from Statistics Norway.

2. The work in the Sponsorship on Quality

The Sponsorship on Quality has organised its work in three main areas:
- Quality framework and the Code of Practice
- Implementation (of the quality framework)
- Communication with users and other stakeholders

The main challenge of quality work is how to proceed from theory in the form of frameworks and principles, to quality assurance in practice. Communication of quality to users and other stakeholders is an important issue, and is a central part of our work. However, general communication issues within the ESS will be considered by a (separate) Sponsorship on Communication.

A common understanding of quality concepts is a prerequisite for the work in the Sponsorship on Quality. The Sponsorship has therefore worked to clarify concepts and possibly modify frameworks. In addition, its work in the area of frameworks has included an investigation of the European Statistics Code of Practice and the Quality Declaration of the European Statistical System on possible updates. The status of this work is described below, while the work on quality frameworks and the implementation of quality assurance are considered in more detail in the next chapters.

When it comes to assuring quality of statistical products and processes the ESS Director of Methods and IT group (DIME) will be consulted. DIME can contribute with regard to domain specific standards and tools such as quality indicators. The Sponsorship on Quality will also be supported by an expert group on quality indicators.
Modification of the European Statistics Code of Practice

A stable quality framework has its own value, and changes in the ESCoP should be limited to allow its consolidation. However, the peer reviews on the ESCoP principles on institutional environment and dissemination carried out in 2007/2008 revealed some overlaps and room for different interpretations of the indicators underlying the principle “quality commitment”. This should not be confused with the actual quality of the statistical products with the components and Code of Practice indicators relevance, accuracy etc. Hence, this principle is a candidate for a modification of the ESCoP.

The task force on the implementation of ESCoP has also identified some possible modifications linked to the indicators defined for each principle. In particular, the Sponsorship has identified production of statistics based on administrative data as an area that might be better covered, see chapter 6.

ESS quality declaration

The ESS Quality Declaration was adopted in 2001, several years before the implementation of the ESCoP. It is quoted in Eurostat (2009b). To a large extent, the principles in this declaration have been integrated in the ESCoP. Others are covered in TQM. Therefore, rewriting of the Quality Declaration, to supplement the ESCoP and better address new challenges in statistics, is considered. However, a substantial revision is not foreseen. A possible solution is just to integrate the declaration as a preamble to the ESCoP.

2. Quality frameworks

In some sense Total Quality Management (TQM) that was developed in the last century is the mother of all quality management systems. Concepts and principles first developed here constitute a common content of all quality management systems developed later. This comprises Six Sigma, European Foundation for Quality Management (EFQM), Common Assessment Framework (CAF), ISO and Lean. These systems are based on a common set of principles (such as user and process orientation), but they differ with respect to their main focus and degree of formalisation. In EFQM and ISO emphasis is for example on rating and certification, whereas Six Sigma focuses on quality control. Some National Statistical Institutes (NSIs) apply several or parts of several of these systems for different purposes. Others have established their own systems adapted to their values and activities, but based on elements from the general quality systems.

A quality management system basically consists of:

- Definition of quality – in general and in the field of statistics
- Quality framework, containing principles and procedures for quality work
- Tools and more detailed guidelines
- Organisation and management processes

In the European Statistical System quality definitions are common, and most NSIs adhere to general principles from TQM. Most importantly, ESCoP represents a common framework with principles and indicators developed for official statistics. A set of handbooks and implementation tools has been developed in ESS cooperation projects (see chapter 3). However, the organisation of quality work, management system and the actual implementation of quality assurance vary between NSIs.

ESCoP emphasises that the core task of the European ESS is the production of statistics. There are many similarities between the production of statistics and production activities in private enterprises. Accordingly, there are similarities in quality control systems and tools as well. But there is
a major difference between the production of official statistics and private business. While private institutions compete, NSIs cooperate. Official statistics must be comparable across countries. This implies a need to coordinate activities and standardise products and processes. Obviously, this should also be reflected in the area of quality work.

The need to take both the nature of official statistics and national conditions into account makes it inconvenient to recommend a common general quality management system in the ESS. This has to be adapted to our role as statistics producers and to national requirements and systems. But all systems have a lot of common elements which should be followed.

This means that the European Statistics Code of Practice together with common definitions, principles and some tools de facto constitute common requirements to a quality management system within the ESS. The ESCoP itself constitutes the framework.

Figure 1 shows how ESCoP relates to a more general TQM system, as well as to a national quality assurance framework for statistics. For each principle in ESCoP there is a set of indicators guiding implementation of the framework.

Contrary to a general system such as TQM, the ESCoP and NQAF are confined to statistics. TQM focuses more on general management and support but does not cover conditions that are specific for NSIs, for example independence and confidentiality of data included on the institutional environment.

**Figure 1. Quality management frameworks and the European Statistics Code of Practice**

Defining ESCoP as a common quality framework in ESS is not inconsistent with an earlier Eurostat recommendation on using a general quality management system such as EFQM or a similar model (Eurostat, 2002). However, how the different ESS partners implement quality assurance can vary according to their own and national requirements.
3. Implementing quality assurance

Implementation of quality assurance is the main task of the Sponsorship on Quality. Quality assurance is traditionally defined as a systematic process of checking to see whether a product or service being developed meets specified requirements. Today's quality assurance emphasises catching defects before they get into the final product. Tools for quality assurance comprise a variety of simple tools such as mapping processes to more comprehensive tools including labelling and certification. Standardisation programs are important both for assuring quality and efficiency.

The basis for quality assurance in ESS is the ESCoP combined with tools and procedures, guidelines and organisational aspects.

The actual implementation will take place at two levels:

1) The European level
This means coordinated assessments or audits across countries and producers of statistics, including benchmarking. The Sponsorship will consider and propose new peer reviews or other international audits, in particular related to the institutional environment part of the ESCoP.

2) The national level
Although some indicators of product and process quality could be compared across countries as well, this will primarily be the task of each NSI. The Sponsorship will therefore seek to develop and define minimum standards for assuring product and process quality on a national level.

A meaningful assessment of product and process quality has to be done on domain or subject matter/statistics level.

The NSI of France, INSEE, has developed a website on quality which documents the status on implementation of ESCoP in France. This is a concrete example of monitoring and national follow up of the ESCoP compliance.


Specific requirements to the use of tools will constitute an important part of minimum standards for quality assurance. Methodology and tools have been described in several reports and handbooks. Two recent and relevant overview reports are the Eurostat ESS Handbook for Quality Reports (Eurostat, 2009b) and The UN Committee for Coordination of Statistical Activities and Eurostat Guidelines for the implementation of quality assurance frameworks for international and supranational organisations compiling statistics (CCSA 2009a). Some tools and procedures to assure quality are described in the Eurostat project on Data Quality Assessment Methods and Tools (DatQAM), see Eurostat (2007). This comprises:
- Quality reports and indicators
- Measurement of process variables
- User surveys
- Self-assessment and auditing
- Labelling
- Certification

Tools such as quality reports, labelling and certification are closely related to communication of quality in statistics.
Several tools for self-assessment of statistics have been developed, in particular the European DESAP (Eurostat, 2003a) and the International Statistical Processes Assessment Checklist (ISPAC, CCSA 2009b), which is built on DESAP.

The use of tools varies within the ESS. To some extent also, the use of tools has to be carried out in a certain order. It is for example not convenient to start labelling without audits, and audits should also build on self assessments. Therefore, the main recommendation in Eurostat (2007) is to build a quality assurance system step by step, both when it comes to the use of each tool and when implementing new tools or methods. Labelling and certification can be positioned at the end of this chain, however their inclusion in ESS standard quality assurance will require further reflections and discussions.

In recent years, many NSIs have embarked on standardisation programs, and standardisation and development and use of current best methods are other issues that might be considered when discussing minimum quality assurance standards. Examples of standardisation work are given in chapter 4. Other tools that are used in some countries, sometimes due to national requirements, comprise risk analyses and staff surveys.

Minimum standards for use of tools should be reflected in the quality guidelines of each NSI.

4. Quality and standardisation

Coordination across statistical organisations is a main feature of official statistics. International standardisation has traditionally been very much about common definitions and classification of statistical products, but standardisation of processes has also been focused recent years, in particular within the European Statistical System. Such standardisation facilitates benchmarking between NSIs. But also within each NSI standardisation is one of the most powerful ways to facilitate quality assurance. Traditionally, many institutions has been organised as “stovepipes”, with many parallel production lines and solutions resulting in vulnerability for changes in systems and staff. It also makes systematic quality control difficult and resource demanding. Standardisation will improve quality and efficiency, reduce risks and contribute to better coherence both in statistics production and output.

Business process model

Standardisation presupposes a common understanding of processes, i.e a process description for statistics production, see example in figure 2, from Statistics Norway (2008). The business process model has several levels beyond the first level shown in the figure.

All kinds of documentation should be linked to the various steps in the model, for example responsibilities, work and system descriptions, sometimes in the form of handbooks. Web technology provides a powerful tool for organising and linking this to other relevant information.

Many countries and international organisations have elaborated similar business process models, with some national variations. There is an international initiative to establish a common model, see UNECE (2009). The business process model provides support for standardisation and the use of quality assurance tools in statistics.
Standardisation in Statistics Norway

Like many other NSIs, Statistics Norway in recent years has been running a standardisation program. It has shown that some important preconditions must be in place in order to meet the objectives of creating a more coherent statistics production system. The business process model must be aligned with

- an information model defining data and metadata involved in all processes
- an IT system supporting the processes, based upon standard interfaces defined by the process and metadata models, modularised to be flexible to technological change and change in user needs

A coherent statistics production system is a prerequisite to be able to monitor and to compare processes quality across business domains. Quality self-assessment is well suited to give a snap-shot of the quality in different areas at a certain moment, which can be summarised to a general view of the statistical production. In a stove-piped production environment, systematic quality self-assessments are a tool that might be recommended as a part of a quality assurance system. It is more challenging to run quality audits. In a heterogeneous environment, a lot of resources will be spent in examining the different production systems themselves. There is a great risk of bias in the judgements to be made. Therefore, the prospects of implementation of quality assurance and standardisation of processes and systems are closely related.

Figure 3 expands the process labelled Support and Infrastructure in the general business process model (figure 2), by describing the main application areas supporting the collection, processing, analysing and dissemination processes. IT architecture principles should be agreed upon to ensure a flexible and effective set of IT services supporting the business processes. Moreover, a coherent metadata system is necessary to control the flow and storage of information at all stages of production.

The key factor in order to build a coherent system is that the modules must be followed by and driven by metadata. Statistics Norway developed a metadata strategy in 2005 (Sæbø, 2005). The metadata strategy shall ensure that different metadata systems can be linked together in a coherent system, to make metadata easily accessible for all users and updated in one place.

The main elements in the metadata strategy are linked to three areas:

- Common understanding through establishment of documentation and concepts linked to metadata.
- Clear roles and responsibilities.
- Stepwise development of content and functionality in master systems for metadata.

The standardisation of metadata secures the basis for interaction between the different sources, and a common interface for access to the metadata.
A coherent and modular statistics production system requires equal flexibility and capability of the supporting IT system. For the moment, the objectives of the Service Oriented Architecture (SOA) are driving the developments within IT. Statistical institutes, processing vast amounts of data, must implement SOA principles with particular attention to the specific needs of the business.

Statistics Norway has agreed upon the following principles for its IT architecture:

- IT-solutions must be built upon standard methods, a standard infrastructure and be in accordance with Statistics Norway’s business architecture
- IT-solutions must support Statistics Norway’s business processes i.e. IT-business alignment
- Statistics Norway shall use open standards in IT and information systems.
- Our IT-solutions must be platform independent and component based, shared components must be used wherever possible
- It must be possible to create new IT-solutions by integrating existing and new functionality
- Our services must have clearly defined, technology-independent interfaces
- Distinguish between user interface, business logic and data management (layered approach)
- End-user systems must have uniform user interfaces
- Store once, reuse many times (avoid double storage)
- Data and metadata must be uniquely identifiable across systems

The standardisation projects are now included in a portfolio management system described in Sæbø and Næs (2010), ensuring that projects contributing to standardisation are given priority. Examples of standardisation projects comprise development of an IT and information architecture, a new system for interview surveys, a framework system for data editing and estimation, an extensive redesign of our website and projects linked to micro data, metadata and development of a geodatabase for ground property maps. The integrated system for data editing will also be adapted to and applied for statistics based on administrative registers.

A quality assessment covering all statistical products and processes in Statistics Norway is described in Næs (2009). The standardisation programme has been described in more detail by Sæbø (2009) and Gløersen and Sæbø (2009).
5. Quality and methodology

Some of the pioneers in developing modern quality thinking were statisticians. Edward Deming was central in developing Total Quality Management (TQM), during his advisory work in Japan. His most important contribution was probably to emphasise the use of statistical methods in the production process to improve product quality. This was natural since TQM emerged on the basis of statistical process control, facilitated by wartime’s need for mass production. Both TQM and all later quality management systems have emphasised that decisions must be taken on a factual basis, i.e. data and indicators analysed by the use of statistical methods. However, in practise new quality management systems have emphasised management and often also communication (reflected in the TQM principle of participation by all). This might be at the expense of sufficient focus on statistical methodology. It is also a fact that in many NSIs, the role of more traditional statistical methodology in quality work has received little attention. Obviously systematic measurement and use of process variables are difficult, as considered in Sæbø (2007). Moreover, it must be taken into account that statistical skills are scarce in many institutions. But if anyone, methodologists working in statistical institutions should be in the front in the area of quality work.

The NSI units for statistical methodology have continued in recent years as before emphasising sample design, estimation of various kinds of errors and confidence interval estimation. These activities are almost only linked to the product quality component accuracy, and concentrated within process 2, 4 and 5 (design, collect and process) in the business process model in figure 2. Within these areas, the methodologist can claim that after many years of efforts, important results have been achieved. Within other areas of quality work, the situation is different. Just because of the shortage of statistical skills, it is of vital importance that the traditional methodologist extends her involvement in the analysis of process data linked to all quality components, and within all the statistical production processes.

As part of his introduction to systematic quality work, Deming introduced the PDCA wheel (figure 4). This is a convenient model when analysing process data, and can be linked to all steps in the production chain:

1. **Plan.** Plan a study of process variables, possibly in connection with a change or test. The aim should be to analyse the impact of various variables on the resulting output (product) quality, in order to introduce changes for improvement.
2. **Do.** Carry out the change and/or study.
3. **Check.** Use statistical methods in order to make sound conclusions from the study.
4. **Act.** Accept the present process or introduce changes. Repeat a similar study in the next round of the wheel.

![Figure 4. The PDCA wheel](image-url)
Whatever the results, a quality report should be produced from the study. This report may be a short and simple report including a few indicators, or a more detailed, technical report.

Studies have to be based on systematic measurements of process variables. If such measurements do not exist (some often do), methodologists should be in a good position to propose measurements. Measurements, process variables and indicators should be linked to each main process in the business process model.

It may be useful to give an example of the kind of statistical analysis of process data we have in mind. It clearly shows that introducing a few process variables into an analysis of non-response, can turn a more traditional non-response report into a useful quality report, as a basis for balancing several quality aspects.

In the Business Tendency Survey of Statistics Norway the aim is to estimate a Diffusion Index, which essentially measures the share of employees that are working in a unit expecting an increase in its activity as compared with the present quarter (each business is asked if it expects an increase or a decrease. Answers are weighted by the number of employees).

Figure 5 depicts the non-response rate on the left axis (in black) and the diffusion index with 95 percent confidence interval on the right axis (in red), as functions of days used for data collection. The non-response rate is naturally 100 percent at the beginning of this period, decreasing to less than 10 after 50 days with several reminders. The diffusion index with confidence interval has been calculated several times after the response rate passed 50 percent. The curves indicate that data collection might have been finished at an earlier stage; there is little improvement in accuracy at the end of the data collection period.

Figure 5. Non-response rate and Diffusion Index with 95 percent confidence interval.
The graph describes the continuous improvement in accuracy as a result of a reduction in non-response. But the graph also offers valuable information about the possibility of publishing the results at an earlier date with lower costs, or release flash estimates before the final publication. It can be used as a basis for balancing between different quality components and costs.

It is seen that the index shows a “jump” rather late in the collection period. The reason for this should be identified, and the methodology changed in order to avoid similar major changes in future surveys.

Sæbø (2007) who has considered the measurement of process variables within the framework of quality assessment, presents another example of analysis of variables.

6. Quality and administrative data

Utilisation of administrative registers for statistics production is a strategic issue for all statistical institutions. Utilisation of administrative data is cost effective, and it reduces response burden; thus contributing to compliance with main principles of the ESCoP. One of the indicators linked to the principle that appropriate statistical procedures must underpin quality statistics, refers explicitly to administrative registers: Where European statistics are based on administrative data, the definitions and concepts used for the administrative purpose must be a good approximation to those required for statistical purposes. Given the increasing emphasis on using administrative data for statistics, this may be regarded as a rather limited statement. Hence, the Sponsorship on Quality will consider a possible extension or specification of the ESCoP indicators in this area.

The requirements for process and product quality in the ESCoP are valid also for register based statistics. Nevertheless, there is a need for developing tools and better methods for handling the quality of statistics based on administrative registers. Such statistics often represent a compromise between cost efficiency and response burden versus product quality components such as relevance and accuracy. Eurostat (2003b) has made a list of quality components for registers that has to be taken into account. In addition to the normal quality components of the output statistics such as accuracy and timeliness this list comprises several indicators for the usefulness of registers for statistics production. Examples are administrative concepts, coverage and completeness of registers, record matching ability, compatibility between file formats and confidentiality issues.

As a part of Statistics Norway’s standardisation program a quality assessment was carried out for all of the approximately 200 statistics produced by Statistics Norway in 2008 using the DESAP tool (Eurostat, 2003a and Næs, 2009). One of the main findings was that knowledge of the quality of the registers used for statistics was poor. There are reasons to believe that this is an area of improvement for several statistical institutions.

It should be noted that the usefulness of registers for statistics often depends on a linkage of several registers. These registers may have different units that do not necessarily coincide with the relevant unit for producing statistics. This is illustrated in figure 6. The quality of the resulting statistical product can be insufficient for statistics even if each register has excellent quality for the administrative use it is meant for. There is a lack of statistical theories for assessing the quality of register based statistics. A key issue for using such theory is the conceptualisation and measurement of the statistical accuracy in register statistics. Moreover, data from administrative registers are frequently combined with data from surveys and other sources, and surveys can be based on different data
collection methodologies (multi mode data collection). This represents new possibilities but also a challenge for quality and methodology work.

Figure 6. Statistics based on administrative data

A current example from Statistics Norway is the register-based housing and population census to be carried out in 2011. The census will be based on several registers with different types of units, for example the Central Population Register of persons and families and a dwelling register with dwelling as unit. A main output will be statistics on households, whose unit identity has to be constructed by a linkage between persons and dwellings. Missing or wrong units in either register or linkage problems may result in insufficient quality in the resulting household estimates.

Li-Chun Zhang (2009) has developed a theory for unit errors for register-based household statistics. This is a modelling approach describing random variations in register data, so as to assess the potential systematic errors (i.e. bias) in the register-based statistics as well as the associated uncertainty (i.e. variance). The many-to-one mapping from existing administrative units (e.g. persons) to target statistical units (i.e. households) is represented by means of an allocation matrix. There will be errors in the register-based statistical units if the allocation matrices that correspond to the statistical (linked) register differ from the true allocation matrices. Information on the true allocation matrixes is collected based on an audit sample. This approach will be applied in the forthcoming census in Norway.

In order to build and maintain a sound basis for register based statistics, Statistics Norway has developed a program for management of statistical populations. Quality assurance is central in this program. It comprises adaptations and maintenance of registers for statistics based on variables linked to population, dwellings and properties, businesses and employment/employees.

It comprises adaptations and maintenance of copies of four registers that are vital for production of statistics:
- The Central Population Register
- The Central Register of Businesses and Enterprises
- The Cadastre – The National Register on ground Properties, addresses, buildings and dwellings, including digital property maps
- The Register of Employees

In addition, Statistics Norway has developed a geodatabase, where property maps from the Cadastre is combined with geographical information from other sources and made available for statistical use.
Management of statistical populations is based on comprehensive cooperation with the external register owners. This is essential to identify necessary changes and thus maintaining the registers up to date and of high quality.

The quality of the link (unique identification in all registers) between the different registers is very important. In addition to unique identifiers both for persons and enterprises, it also counts for the quality on numerical address information. This contributes to increase the quality of the registers by integrating data from different sources in a consistent statistical system.

7. Final remarks

High quality statistics is a central part of the infrastructure of a modern society, and a basis for decisions both by private agents and governments. In an accelerating information society, official statistics are faced with challenges in terms of responding to the increased demand for statistics, analyses and indicators, and at the same time taking necessary actions to secure quality in products and processes.

Quality work on a national basis can benefit from international work, through sharing of experiences and knowledge of best practices, but also by support from common frameworks, recommendations and measures taken by international statistical organisations. There is no doubt that the implementation of the European Statistics Code of Practice followed by self-assessments and peer reviews, has been an important milestone in the work on quality in statistical institutions.

By the Code of Practice, we have achieved a common framework for quality work in Europe. The goal of the ESS Sponsorship on Quality is to bring the work quality further, in particular regarding actual implementation of the quality framework in the various statistical institutes. In this paper we have reserved the term quality assurance to these efforts. We have underlined that national quality assurance will have to be adapted to differences in traditions and environments in various countries. Still, harmonisation and standardisation should be achieved, resulting in a set of minimum standards regarding quality assurance, e.g. on guidelines and the use of tools. Over time, such efforts will tend to strengthen trust, and support new improvements in the European NSIs, as well as contributing towards international harmonisation in this field.

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