Chain management in statistics: Best practices

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Explanation of symbols

.	= data not available
*	= provisional figure
x	= publication prohibited (confidential figure)
–	= nil or less than half of unit concerned
–	= (between two figures) inclusive
0 (0,0)	= less than half of unit concerned
blank	= not applicable
2007–2008	= 2007 to 2008 inclusive
2007/2008	= average of 2007 up to and including 2008
2007/'08	= crop year, financial year, school year etc. beginning in 2007 and ending in 2008
2005/'06–2007/'08	= crop year, financial year, etc. 2005/'06 to 2007/'08 inclusive

Due to rounding, some totals may not correspond with the sum of the separate figures.

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Chain management in statistics: Best practices

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Summary: Statistics like the national accounts are compiled using various data sources. Most statistical institutes compile the underlying data using so called stovepipes. A stovepipe means that a statistic is produced as a "stand alone process". Stovepipes, however, are inappropriate for producing integrated and coherent information and cause administrative burden. A solution is to integrate all stages of the production process as part of a chain of statistical products, using chain management. So far, chain management is hardly applied in statistical institutes. The present chapter describes the main components of chain management and how it is organized. It turns out that chain management is not easy to implement; it must be introduced step by step, and it is not something that once "organised" will continue to work ever after.

Keywords: Statistics, chain management, interdependencies, process design, Deming-cycle

1. Introduction

There are many good reasons to consider the compilation of for example short-term statistics, annual source statistics and national accounts not as different processes, but rather as a chain of (related) statistical processes. Currently, however, many statistical offices do not use such an integrated system but instead compile the underlying data using stovepipes (COM, 2009). A stovepipe means that a statistic is produced as a "stand alone process". One disadvantage of the stovepipe approach is that it affects the quality of the output. Quality covers different areas of attention such as accuracy, comparability within time and domains, consistency between statistics, timeliness etc. Quality may be improved by coordination across statistics of definitions, of populations, of classifications, of methodology and the definition of a general revision strategy. If the primary production process is focused on the quality requirements from the whole chain instead of the local process itself, the quality of the results of the chain will improve.

Another disadvantage of stovepipes is the lack of re-use of data resulting in much administrative burden. There is (political) pressure to reduce the administrative burden and therefore to increase re-use of data and increase the use of (fiscal) administrative sources. The re-use of data and use of administrative data may require a redesign of the whole chain, treating it as an integrated system sharing the same business register with a central linkage of administrative units to the statistical units. Another problem with stovepipes is that is more difficult to ensure that

methodological issues and discontinuities of, for example, a change in the mode of data collection are dealt with in the same way by all statistical processes in the chain.

Lastly, the increasing pressure to combine the various sources as efficiently as possible and still release statistics on time makes the system more vulnerable for delays and missing sources, and thus increases the need for chain management. Such vulnerability, however, not only comes from within the national statistical institute, but also results from external data suppliers, for example in the case of administrative data. Chain management must therefore include good account management with respect to external sources.

To compile statistics using an integrated system, however, is quite demanding: the whole chain of statistics, including all interdependencies, should be transparent, and for each of the relevant statistical products it must be known which population they describe, how the data are compiled, which statistical concepts they describe, and how the various statistical products are used in the chain. Furthermore, it must be known at what point in time various inputs are needed for other products, how much time the various processes take, and how the various outputs can be combined. Given this knowledge, methodologists could design the process, and managers could oversee the compilation of statistics. However, no such ideal situation exists. Not only do external requirements change all the time, but there is also external pressure to reduce administrative burden, to improve quality and efficiency and to increase timeliness.

In order to achieve an integrated system, the various statistical processes must be coordinated to some degree. This coordination - or chain management - must focus on processing and designing the various statistical products from the perspective of the whole chain. From this point of view, chain management is the whole set of management activities aimed at improving the cooperation of all parties in the chain so that the result of the joint effort is optimal and transparent for all users. It concerns the whole process from observation to publication of statistics, but is limited to steering on those issues with dependencies between statistical processes and consecutive processing steps.

Chain management addresses two types of chains. The first is the primary production process: the statistical data, the metadata and the required methodologies. This chain includes input, half-products and output and all necessary intermediate processes. The second chain consists of the actors who steer these processes and the points of transfer between them. The actors of the chain may all have a different agenda, but they still have to communicate with each other and have to agree on the products and quality to be achieved.

So far, only few statistical institutes (e.g. Bergdahl, 2008; Renssen and Van Delden, 2009; Savage, 2008) have taken the first steps in moving from the stovepipe approach towards an integrated system. In order to achieve integration through all processing stages of a chain, chain management is necessary. The objective of this chapter is to describe how to implement and organize chain management.

On the basis of our experience, we distinguish two phases in the implementation. Phase 1 focuses on quick wins, such as improvements of the day-to-day production process, of bilateral communication and of the regular bilateral data deliveries. In phase 2, there is room for more comprehensive improvements: coordination across the whole chain and multilateral agreements and also addressing operational and strategic levels. Phase 1 lays the basis within the organisation for confidence in chain management and gives quick wins. When that is achieved, there may be room for the further improvements.

This paper is organised as follows. Section 2 describes the domains and time horizons for chain management. Next, section 3 describes phase 1 and section 4 phase 2. Section 5 concludes with the lessons learned and the way forward. Sections 3 and 4 each discuss the following three topics: (a) description of the statistical processes, (b) determination of the chain management objectives, and (c) organisation of chain management. Topic (a) is part of the chain of statistical production, topic (c) deals with managing the chain of actors and topic (b) deals with both.

2. Domains and time horizons for chain management

2.1 Domains and time horizons

To describe the full perspective of chain management we distinguish between four domains and three time horizons. The domains involve a *policy* domain, and the three business domains *design*, *production* and *management* (see also Renssen and Van Delden, 2009). In brief, *policy* of a statistical institute sets constraints to the design of the production process. For example the policy may be to use administrative data for the statistical process unless they are not available or not suitable. The policy may also involve budget cuts which may lead to a reducing the output of a statistical process or to improvement of the efficiency of the process. *Design* involves the conceptual and quality metadata of statistical datasets as well as the (methodological) process metadata and the corresponding processes. *Production* concerns the compilation of statistical datasets, and *management* involves planning and monitoring the production processes as well as validating the produced statistical data.

Besides these four domains, there are also different time horizons to be considered: the operational level (O) of the daily production, the tactical level of whole production cycles (T), and the strategic level (S) dealing with the objectives to be achieved. The domains and time horizons are related. Policy usually deals with strategic or more tactical decisions. For example, a policy decision could be a change in the data collection strategy of the organisation. Design may either involve the strategic or the tactical level. At the strategic level, design deals with large redesign projects, such as achieving coordination of population, variables and methodology across different statistics with a chain of production processes. At the

tactical level, design deals with adjustments to the methodology of a production process, such as changing a weighting model. The production domain involves the operational level. Finally management, may be done at operational level (process management) but also at tactical or even at strategic level.

2.2 Relation with chain management

Chain management is needed for both the design stage and the production stage. In the design stage, it is necessary to coordinate statistics that:

- share the same data sources;
- use combinations of data sources;
- are derived from other statistics;
- are related.

This coordination may involve using the same general business register (GBR), or harmonising populations, variable definitions, classifications and methodology. In addition it involves defining standards for the quality and timeliness of the output. Standards may be set for all of the different quality aspects of a statistic. Examples of standards are a maximum confidence interval for an estimate (accuracy), and an ultimate date of delivery of a product (timeliness).

In the production stage, chain management deals with:

- steering processes by comparing the realised quality with the standard as defined in the design stage;
- dealing with problems in the production process;
- communication across actors of the production chain.

Especially chain management in the production stage should lead to a step by step improvement, e.g. by finding and improving the weakest link. To manage the chain successfully, the actors of the chain must be organised so that they work together.

3. Phase 1: optimising individual statistical processes

3.1 Process description

To secure the quality of the output with respect to accuracy, completeness and punctuality in phase 1, a process description is made for each statistical product. It distinguishes main and supplementary processes, input and output of the various processes, suppliers and users of specified datasets, agreements made, process owners, tasks to be fulfilled, responsibilities and decision authority, information systems used, and relations with other processes. The process description should also consist of a risk analysis, proposals to cover these risks, and a dependency and vulnerability analysis. A dependency analysis determines to what degree business processes supported by information systems depend on the reliability of these

systems, and determines what potential damage can occur if these systems fail. A vulnerability analysis determines the impact of threats on the functioning of an information system or an area of responsibility.

3.2 Objectives

The objective of phase 1 is to optimise the quality and guarantee the timeliness of the individual statistical product, not to focus on the whole chain. In this respect it is advisable to draw up a Service Level Agreement (SLA). The purpose of such a written agreement is having a means to handle an ordinary customer-supplier relationship. Core of this agreement is that the supplier is responsible for delivering his product on time and for achieving the requested quality; the user should not interfere in the way the supplier realises the agreed statistical product, as long as the present standards are met. More specifically, the SLA describes the product to be supplied, as well as the rights and obligations of supplier and user about the agreed quality level. Furthermore it specifies what is to be delivered, and the quality of the delivered products. Lastly, the SLA presents communication guidelines, describes the responsibilities of the supplier and user, and presents a change management procedure. This change management procedure determines how changes in the SLA can be enforced in that way that both parties agree with proposed changes. If the supplier and the users work in different departments within the same organisation, these agreements clarify what dataset is to be received or produced. If the supplier and users work in different organisations, the need for this kind of agreements is even stronger. Special attention needs to be paid to external data suppliers, such as the tax authorities and national banks. In these cases formal agreements or even laws may be needed to describe data delivery to the statistical office.

3.3 Organisation

In phase 1 the compilation of statistics is focused on the tactical and operational level. The production cycle is a regular Deming cycle, consisting of four stages: Plan, Do, Check and Act, see Figure 1. In order to improve the quality of statistical products and the learning ability systematically, it is important to note that all four stages of the cycle must be passed through.

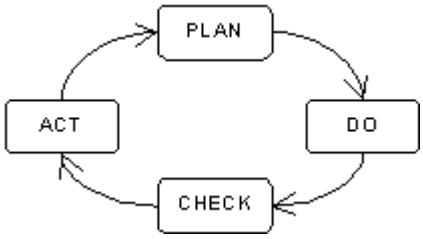

Figure 1: Deming cycle

The four steps of the Deming cycle are applied to each relevant aspect of quality (see table 1) and timeliness of the output.

Plan Supplier and users make agreements on the quality and dates of delivery of both data and metadata. If possible, the agreements are made explicit in the form of quality indicators. These quality indicators must be measurable and defined beforehand in an instruction. For each quality indicator a value is given that defines the minimum quality to be achieved for the outcome to be acceptable. These values are also referred to as the "standards" to be met. The result is laid down in a Service Level Agreement.

Do The various actions of the production process are carried out and the data are processed and delivered. Furthermore, quality reports are made at the end of the process and supplied to the users. The quality reports contain the realised outcomes of the predefined quality indicators.

Check The outcomes for the quality indicators and the dates of delivery are compared with the preset standards. If the standards are not met, check what went wrong and how the problems can be dealt with in the immediate and in the longer term. Expert groups can help in this respect, as they can advise how the results of the processes can be improved and whether a redesign is necessary. In addition to the quality check, other parts of the Service Level Agreement should also be evaluated.

Act Given the detected problems, research is carried out to improve the process, solutions are implemented, the process description and the Service Level Agreement are updated and adjusted if necessary. By specifying various fallback options in the Service Level Agreement, it is possible to steer on quality versus budget, time and other priorities in the case of incidents.

4. Phase 2: optimising the chain as a whole

4.1 Process description

The process description of phase 1 described bilateral dependencies: what (meta)data are delivered to the next processing step and what data are received from the preceding step. Each statistical process is characterised by a set of statistical datasets as input, a set of statistical datasets as output, and (methodological) process

metadata that convert the input to the output. For bilateral dependencies, the points of (meta)data transfer for the output of one process to the input of the subsequent process in particular need to be described.

In practice the dependencies within the chain of economic statistics may be more complicated than a linear transfer from one actor to the next: the output of one process may deliver to two or more statistical processes. Also, besides the main input, a statistical process may use auxiliary information somewhere during one of the stages in the production process. Furthermore, the necessary quality requirements are determined by the various users of a specific dataset.

To describe these more complicated dependencies systematically, we recommend the concept of steady states. Steady states are datasets in a well-defined state of processing (see Renssen and Van Delden, 2009). Steady states may be the starting point, the end point or half-products of the production process. For each steady state the dataset and its quality must be defined by means of quality indicators. Characterising the steady states and the processing stage between two steady states provides a transparent means for an overview of the processes. These steady states are stored in a central data warehouse in order to make data available for re-use in other processes and to control data editing.

Alongside these steady states, we advise to draw flow charts of the various processes. These flow charts show which processes result in which steady state, and which input is required. Figure 2 gives an *example* for the compilation of the short-term statistics and the structural business statistics. One or more processing steps (rectangle) result in a steady state (diamond) that is stored in the data warehouse. The steady state A4, for example, is the output of the short-term statistics (STS) process “estimating stratum totals” and is used as input by the structural business statistics (SBS) processing step “reweigh to STS turnover totals”. Each steady state must satisfy predefined quality requirements. The further towards the end of the process, the more demanding these quality requirments are. Box 1 presents an example of the quality requirements for steady state A3.

It is also wise to construct a coordinated chain time schedule to ensure that the various statistics can be published on time. This time schedule can be used as a basis to coordinate Service Level Agreements of the various processes. This time schedule is a main instrument of chain management. It can be used to see what the consequences will be if specific input is delayed and what measures should be taken; it can also be used to determine which parts of the chain must be redesigned if quality is below standard or specific products are systematically too late.

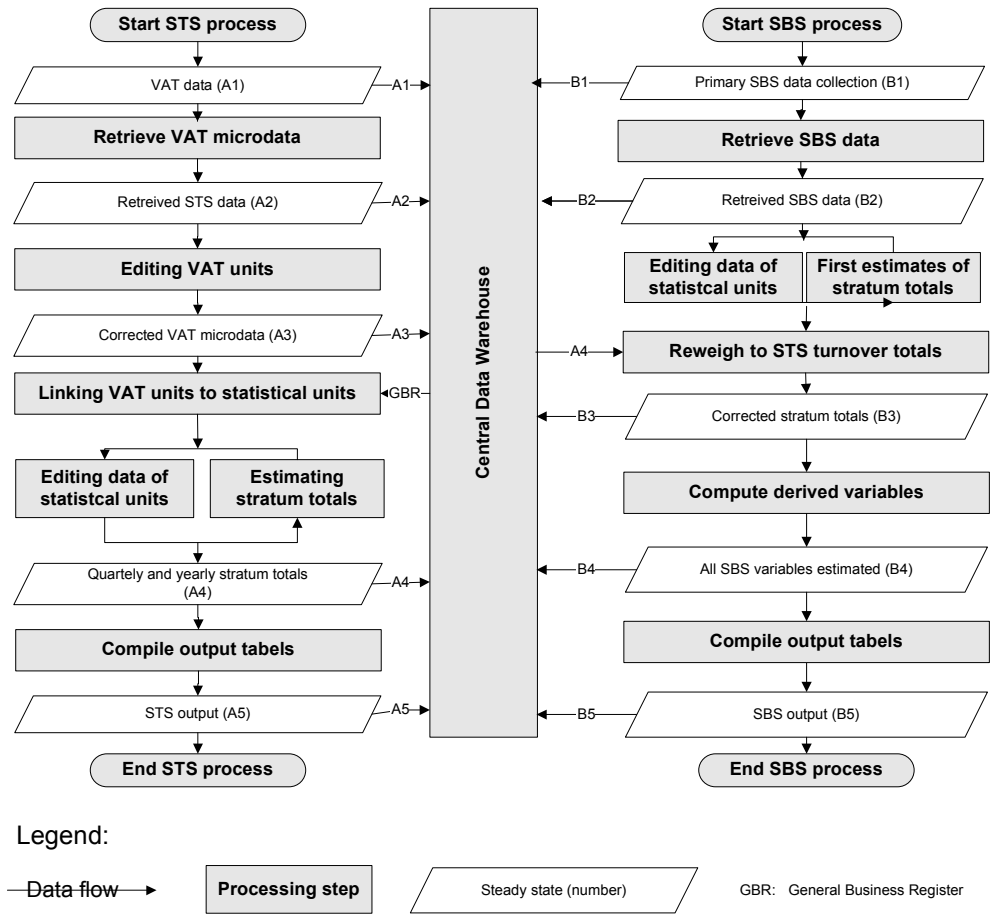

Figure 2. Example of a possible process description for the short-term statistics (STS) and for the annual structural business statistics (SBS).

Box 1. Quality requirements for steady state A3

The steady state ´corrected VAT microdata (A3)' guarantees that:

- systematic error patterns in the values of source units are detected and corrected;
- data are available in terms of the original source unit types, the original classification and the original variables.

4.2 Objectives

Where for phase 1 it is sufficient to formulate the objectives of each separate statistical product, for phase 2 a common objective must be defined for the whole chain. Often a single statistical product may coincide with one institute or the part of an institute responsible for making it. The objectives of the different institutes, or parts of institutes, may not be the same. To get all the parties to work together effectively, the actors of the chain should define a common objective based on a major chain problem they are trying to solve in the coming year(s) to ensure that all actors are working with the same objective in mind.

Examples of such main problems are given in Table 1. A predominant chain problem may be related to the statistical output, the statistical production process or to the interaction between the actors involved in running the production process. An example of a predominant chain problem is that the statistical products are systematically delivered too late; in that case the parties need to work together in order to reduce the delivery time in the near future. Another example is that the differences between the GDP releases are too large, due to quality issues with regards to the outcomes of the underlying processes.

A clear objective provides an aim for the cooperation of the actors within the chain, and for the measures to be taken when production processes are not performing "optimally". To succeed, the production staff must support and agree upon the objective to be achieved.

The objective is the first step; the next step is a thorough analysis of the causes underlying the main problem. If lack of consistency between outcomes of different statistics is caused by the use of different population frames or the use of different classifications, a redesign of the processes may be needed. However, if outcomes are inconsistent because quarterly figures are not numerically adjusted to the yearly ones, adding a weighing step may suffice. To improve a sub-optimal situation, the weakest spots of the chain must be identified and strengthened.

Some issues, such as lack of harmonisation of populations, output inflexibility or an inefficient production process, are more likely to be solved in the design than in the production stage. When the production process is carried out, there are only limited possibilities to increase efficiency because of organisational obstacles and the transfer of knowledge and experience. Given a certain capacity, a punctual delivery of the various statistical products is much more important, as not publishing data on time will damage the reputation of a reliable statistical institute.

Fulfilling the complete set of quality (and timeliness) requirements can be seen as an optimisation issue. First the set of requirements that always need to be fulfilled should be known: the limiting constraints. Examples are: delivering output on time, and numerical consistency of quarterly and yearly estimates. Given this set of constraints, the statistical office can optimise other aspects, such as quality aspects or reduction of production costs.

Table 1. Examples of problems in the chain of economic statistics

No	Areas of attention	Example of a main problem
		Statistical Output
1	Relevance	Output has not enough detail
2	Accuracy	Large differences between releases
3	Coherence of variables within one series of statistics	Use of different variable definitions, use of different methods
4	Comparability over time and between domains	No harmonisation of the classifications
5	Consistency between statistics	Uncoordinated corrections in structures of businesses
6	Timeliness	Processing time is too long
7	Punctuality	No production time schedule
8	Clarity	No information metadata is given to the users of the output
9	Completeness	Input sources are not reliable
10	Confidentiality	No coordinated confidentiality policy
		Process
11	Efficiency	Too many steps are done manually
12	Complexity	Actors cannot judge the output because they don't understand the methodology
13	Flexibility	Changes in input sources lead to a full redesign of the processing steps
14	Transparency	Changes in one statistical series have unexpected effects for other series
		Actors within the Chain
15	Openness	Mistakes are reported too late

4.3 Organisation

4.3.1 Managing the different levels and time horizons

Where phase 1 focuses on the production domain at operational level, chain management in phase 2 deals with the three business domains: design, management and production. Phase 2 also has a broader time horizon, and deals with the operational, tactical and strategic time horizon. To deal with these domains and time horizons, two levels of management are foreseen, each with a specific area of responsibility, see Figure 3:

- A chain director, to deal with the more strategic levels, the management and design domains;
- A chain manager, to deal with the more tactical/operational level and the design and production domain.

The chain director is responsible for the results of the chain processes at a strategic level. Given this responsibility, the chain director should perform a number of tasks such as determining the common policy for the design of the chain and the focus for the production process, translating the policy into specific objectives for the coming year, organising the management of the production process and work on improving the cooperation of the different partners within the chain. Another task is relation management with external suppliers. Finally, the chain director should approve changes in the metadata.

The chain manager is responsible for the results of the production process at the more tactical level. In the planning phase he/she is responsible for having a coordinated and consistent chain time schedule, for coordinated populations, variables and classifications, and for coordination of desired quality standards. During production the chain manager monitors whether this designed coordination is realised. Furthermore, the chain manager ensures that the chain actors report their results and verifies whether the quality standards in the agreements and orders are met. In cases that the designed coordination is not realised or quality is below standards, the chain manager decides what's the best way to proceed.

Note that the descriptions of the tasks of the chain director and the chain manager are meant to describe two *roles*. One person may have different roles within the chain, and one role can be fulfilled by more than one person. Furthermore, it may be desirable to partially rearrange responsibilities between the chain director and the chain manager.

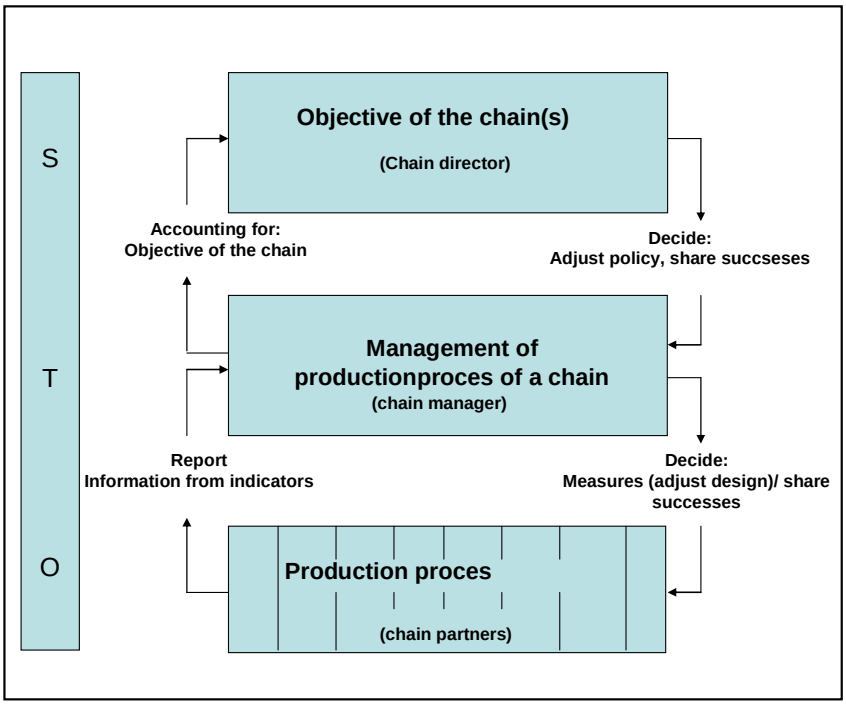

Figure 3: The levels of chain management (Steketee, 2007)

As in phase 1, special attention should be paid to external suppliers of administrative data. Obviously, administrative data are collected for other purposes than to make official statistics. The content of administrative data, or the frequency of their collection may change, and this can have important implications for statistical offices that depend on them. It is very important that statistical offices are kept informed of all plans to change administrative data well before these changes are implemented, so they can try to adjust the plans, or have enough time to adjust their statistical processes. Formally, the long term aspects of account management are the responsibility of the chain director, but it may be more practical to appoint a separate person for the day to day contacts with the external data suppliers.

4.3.2 Managing the actual production process: tactical/operational level

For chain management of the actual production process at tactical/operational level, agreements are made for the points of transfer of (meta)data from one partner to the next one in the chain. The delivery of each separate steady state could be laid down in an order describing the timeliness and quality of the data. An agreement on a point of transfer may contain the delivery of one or more steady states, as laid down in orders. More specifically, an order is an agreement between a user and a general business service that will deliver a part of a production process, for example a data collection service.

If problems occur in one of the processes, the production manager of the local process is primarily responsible for finding a solution within that process. If that is not possible, the local production manager passes on the issue to the chain manager. The chain manager discusses the issue with the other partners in the chain. If there is a conflict between the partners, the chain manager should have the authorisation to decide on tactical/operational issues. For a chain manager to be effective, it is important that he has an ability to persist, i.e. he can take decisions about what is best for the chain as a whole in situations with conflicting interests. Persistence is also needed when a supplier consistently does not comply with agreements that have been made beforehand.

Likewise to phase 1, chain management of the actual production process follows the steps of the Deming cycle for each relevant aspect of quality and for the timeliness of delivery. In phase 2, however, the Deming cycle is more complex than in phase 1:

Plan. The production process receives orders to produce steady states from chain management. The order describes the steady state to be produced, the standards for its quality characteristics and the time of delivery from the chain time planning.

Do Quality reports are generated *during* the production process and where possible they are generated automatically. Furthermore, the local production managers inform the chain manager if they cannot fulfil the agreements, if quality or timeliness is below standard, or if there is friction between the various partners in the chain. In the case of incidents, the chain manager can pass them on to the chain director.

Check The quality reports with the outcomes of the steady states and of the quality indicators are compared with the agreed standards in the SLA. If the quality does not meet the preset standards, action is needed. What went wrong? And how can the problems be solved for the moment and in the future? Expert groups can help as well here. Other parts of the order should also be evaluated. Lastly, quality can also be checked by making Gross National Income (GNI) process tables, see box 2.

Act Solutions are sought for specific problems, research to improve the process is initiated, and the process description and the Service Level Agreement are updated. The reasons for updating the various process descriptions and the Service Level Agreements may originate in other parts of the chain, for example a quality improvement necessary for certain products. Furthermore, measures can be taken *during* the production process itself, e.g. partially re-allocating resources for editing from one branch to another. It is also possible that estimates are continually of poor quality and that the estimation method needs to be revised. In that case a redesign is necessary. Such a redesign in phase 2 must be carried out from the viewpoint of the chain.

Box 2. Gross National Income (GNI)-process tables

In the GNI-process tables, three stages of integrating annual production statistics to final estimates in national accounts are distinguished for output, intermediate consumption and value added. The first step consists of adjustments to correct for mistakes and exhaustiveness, the second of adjustments to national accounts definitions, and the third of balancing items (corrections to remove inconsistencies between sources).

Process tables can be used in various ways. First, they show how important the various sources like surveys and censuses, administrative sources, combined data and other data are for the final estimate of the gross domestic product (GDP). Secondly, process tables can be used to improve estimates as they make it easier to explain the adjustments in the source data. Thirdly, process tables can be used to analyse differences in the series of consecutive estimates in order to reduce them. For example, if there is a large adjustment in the turnover level in a specific branch of industry, it is wise to check whether there are systematic causes that can be taken into account in the regular production process.

5. Lessons learned and the way forward

To our knowledge, there is not much experience with chain management in statistical institutes and implementing and sustaining it is not easy. Therefore it is good to know what the pitfalls are and which parts are easier to achieve. Below we mention some points of attention. Although most of them are common sense, it is still useful to be aware of them.

In a statistical institute, chain management must be introduced step by step. A logical order is to start with management at the tactical/operational production level and aim for phase 1 of chain management. That is the level where the actual problems are perceived that need immediate attention. Only once the day to day management is running smoothly and the bilateral expectations are well managed, should the institute shift its attention to higher levels of control: more complicated multilateral contacts and longer time horizons (phase 2).

Chain management is not something that once organised will continue to work ever after. Like the production process itself, the organisation of chain management needs to be evaluated regularly and adjusted if necessary. Natural moments of evaluation may be when external circumstances change, when user requirements change or when the availability of data sources changes. Furthermore, interdependencies are often more complex than anticipated. In most cases it is not possible to carry out phase 2 for all interdependent statistics at once. Therefore is it wise to start on a small scale and introduce chain management for the main chain. At a later stage, additional processes/chains can be integrated within chain management. As a result, the chain may become a network of statistics to be managed.

It is important that chain management is seen as a means for gradual improvement of the chain of production processes. There is a risk that production assistants think they are performing well if they ensure their results stay between given boundaries of the quality indicators. On the contrary, observations outside the boundaries should prompt them to check whether the results are correct and whether an improvement in the statistical process is perhaps necessary. Also, process descriptions should not be made just because they have to be made, but because they give an insight into the interaction of the various statistical processes and processing steps. Finally, these process descriptions and the various Service Level Agreements must be periodically updated and the updating should be integrated in the regular workflow.

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