# Ensuring process and product quality

## Training course on Quality Management of Official Statistics

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## Content

- ✓ Product and process quality, accuracy, type of the errors
- ✓ Sources of nonsampling errors
- ✓ The Quality Control System of a statistical production process

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# PRODUCT AND PROCESS QUALITY, ACCURACY, TYPE OF ERRORS

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## Statistics quality

### Eurostat Quality dimensions

- Relevance
- Accuracy *(and reliability)*
- Timeliness and punctuality
- Comparability and Coherence
- Accessibility and clarity

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## Process quality

- Refers to the quality of the **phases/sub-processes** and **tools** used in the data production process
- How statistical information is produced affects the quality of the statistics produced
- To monitor and improve the statistical production process is a way to improve the quality of the final results
- Focus is on process activities and what to do in order to have better quality statistics

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## Accuracy

«Accuracy is the closeness between the **estimate** and the **true parameter value**»

It reflects the “closeness” between the estimate and the true (unknown) value of a parameter of the population under study.

An estimate will rarely be equal to the true unknown parameter due to a series of errors.

These errors can arise in any phases of the survey.

| SAMPLING | NONSAMPLING |
| --- | --- |
| due to selecting a sample instead of the entire population | due to mistakes or system deficiencies |

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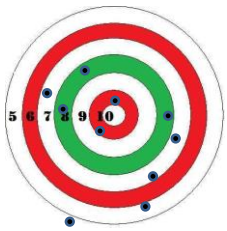
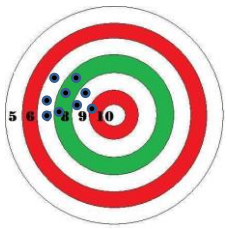
## Type of the errors: systematic and random

For example in measurement error

- systematic: *in an hypothetical high number of repetitions of the same operation the errors are always in the same direction*
- random: *in an hypothetical high number of repetitions of the same operation, these errors sum up to zero*




Large variance and small bias




Large bias and small variance

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## General impact of errors on estimates

**REDUCTION OF ACCURACY**

**INCREASE OF VARIABILITY**

**INTRODUCTION OF BIAS**

**WORK ON PROCESS CHARACTERISTICS TO LIMIT THE IMPACT OF THE ERRORS**

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## MAIN SOURCES OF NONSAMPLING ERROR

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## Errors in statistical production processes

| ERRORS | PHASES/SUB-PROCESSES |
|---|---|
| SAMPLING | Sampling design |
| NONSAMPLING | |
| Specification errors | Questionnaire design, improper use of administrative data |
| Frame errors (coverage and other errors) | Creation of the sampling frame Administrative data |
| Unit Nonresponse/ Nonobservation | Data collection (survey data) Acquisition of administrative data |
| Measurement errors and item nonresponse | Respondent+interviewer+data collection mode+questionnaire, Variables not relevant for the administrative purposes |
| Processing errors | Data treatment: coding, editing and imputation, data integration, …. |

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## Specification errors

- Target concepts are not sufficiently identified before the statistical process is planned
- Surveys → lack of comprehension between the survey commissioners and the questionnaire designers
- Administrative data → errors occur if the administrative concepts do not correctly reflect the target statistical concepts

**Main impact is on RELEVANCE**

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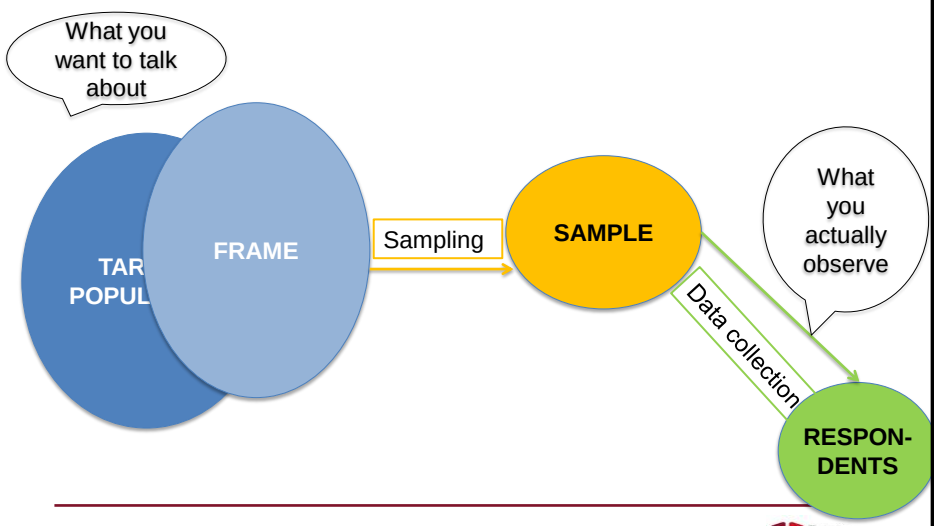
## Population, frame, sample and respondents

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## Frame errors

- The frame should contain **all and only the units** of the target population (**eligible units or in-scope**) and, for each unit the **auxiliary information** necessary to locate/contact it and for sampling design (e.g. stratification by geographical area, business size) and estimation (ratio or regression estimation).

Frame errors arise from discrepancies between the target population and the population listed in the frame

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## Frame errors

- Main types of frame imperfections:

  **Under-coverage**: some units belonging to the target population are not included in the frame

  **Over-coverage**: the frame includes units that do not belong to the target population

  **Misclassifications**: there are errors in the auxiliary information

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## Coverage errors in administrative sources

- Some **sub-populations may not be represented** in the administrative sources (e.g. Ministry of Education does not own data on private universities)
- Some **populations can be included** in the source and they are not of interest because of conceptual differences in the definitions between statistical and administrative population.
- Sometimes, the population is **not directly represented** in the administrative sources and is derived (e.g. in data from the National Social Security Institute the statistical unit 'worker' is obtained by aggregating various 'contribution profiles')

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## Frame errors: impact on final estimates

- Over-coverage can slightly **increase variance** because of the reduction of the actual sample size
- Under-coverage can cause **bias** when un-covered units differ from covered units with respect to the characteristics of interest
- Misclassification can **increase variance** because it can worsen the performance of the sampling design or cause unit non response

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## Nonresponse errors

- Nonresponse is a **non-observation** error
- It represents an unsuccessful attempt to obtain the desired information from an eligible unit selected in the survey
- Two types of nonresponse:
  - **Unit nonresponse** is a **complete failure** to obtain data from a sample unit.
  - **Item nonresponse** occurs when a respondent provides some, but **not all**, of the requested information, or if the reported information is not usable.
  - The distinction between unit and item nonresponse is often made based on survey rules

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## Nonresponse and nonobservation errors

- Reasons for nonresponse in surveys:
  - **Unit nonresponse**: Refusal, no-contact, inability to participate…
  - **Item nonresponse**: interview interruption, refusal, skip of due question, "don't know"
- In administrative data
  - A nonobservation **at unit level** corresponds to under-coverage
  - **Variables** not of interest for the administrative function may not be collected (or collected without accuracy)

Why is it important to collect information on them?
To address **improvement efforts**

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## Nonresponse errors: impact on final estimates

- Slight **increase of variance** because of the reduction of the sample size
- Possible **bias** if the nonrespondents/nonobservations are different from the respondents with respect to the characteristics of interest
- The presence of item nonresponse can also cause problems when estimating the relationship among variables

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## Measurement errors

Deviations between **the value of a variable** observed on a unit and the **true value of that variable** on that unit

In **administrative data**, the administrative concept reflects the statistical one, but the data do not correspond to the true values.

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## Measurement errors

Sources of measurement errors **in surveys**:

- Questionnaire (wording, length, instructions, coding system, …)
- Respondent (understanding questions, remembering events, willingness to cooperate, …)
- Data collection mode
- Interviewer (contact, administration of the questions, probing of answers, recording answers, cheating interviews, …)

**In administrative sources**

- Variables not of interest for the administrative function may be collected without accuracy
- The same variable can be present in more sources (and differ)

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## Measurement errors: impact on final estimates

- **Bias** in the final estimates, due to a **systematic** pattern or direction in the differences between the observed and the true data (e.g. interviewers may ask the question as to lead always to a under-/over-estimation of the true answer)

- **Increase of the variance** associated to the estimates due to:
  - Respondents (e.g. respondents may interpret differently a question)
  - Lack of standardisation in the interviewers' work (e.g. interviewers may ask the question leading sometimes to over-estimation sometimes to under-estimation of the true answer)

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## Processing errors

They refer to errors that are introduced in the data once they have been collected, during the steps of coding, data entry, editing and imputation, etc... before the final estimates are produced

Main sources of processing errors:

- Typing errors (data entry and data coding)
- Errors due to misinterpretation (data coding)
- Errors in the localisation (editing) and correction of errors
- Errors in the data integration: false links and false nonlinks

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## Processing errors: impact on final estimates

- Possible **bias** and **variability** due to systematic and random errors associated to the human factor (coders, reviewers, …)
- Possible **bias** due to systematic errors associated to the use of software and IT procedures

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## THE QUALITY CONTROL SYSTEM OF A STATISTICAL PRODUCTION PROCESS

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## The Quality Control System

Quality control actions

- ✓ Planned, also in terms of budget
- ✓ Integrated to the statistical production process
- ✓ Tailored for the type of process (survey vs administrative sources - based)
- ✓ Oriented to prevent, monitor, correct and evaluate the errors

The set of quality control actions represents the **quality control system** of a process

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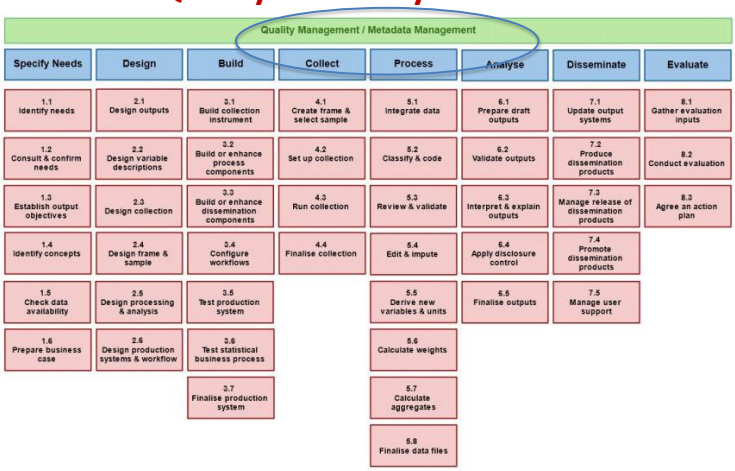
## Quality control system




The GSBPM overarching process Quality Mgm represents the quality control system implemented across the process

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## Types of quality control actions

- **Preventing:** are planned and implemented to avoid that errors occur, they act on the sources of errors
- **During the process:** actions to **monitor** and **correct** the errors during the execution of the production process; tools that are aimed at identifying the errors when they occur and intervene promptly as to limit their effect on the final estimates
- **Evaluating**: actions aimed at direct measurement (estimate of variance and bias on the final results due to the errors)

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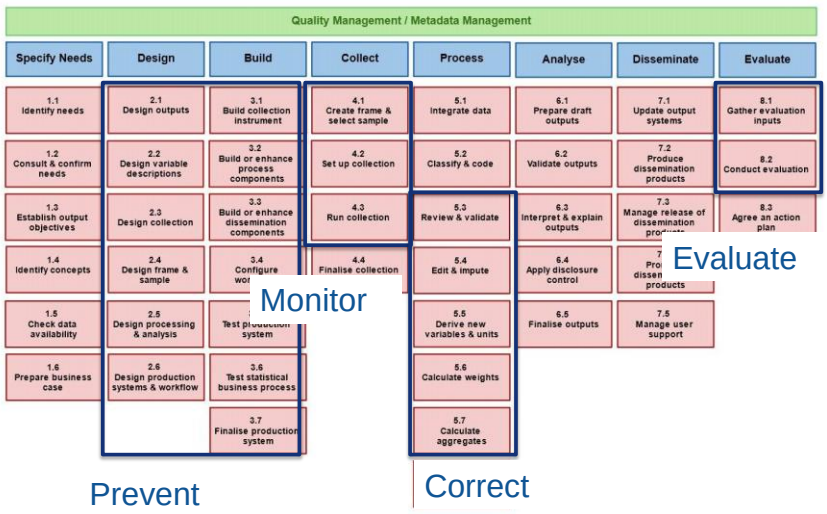
## Quality control system

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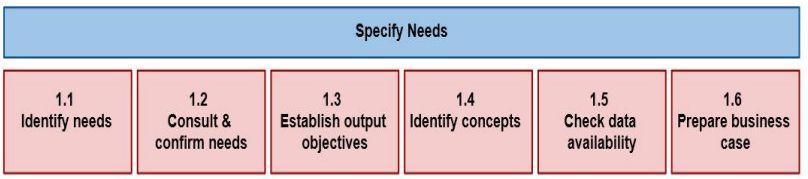
## Defining information needs




- Dialogue with the users and identification of information needs, Regulations
- Check for the availability of data useful for the intended scopes

Preventing the specification error.
Impact on **relevance**

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## Preventing and evaluating specification errors

- Methodologies for the design and testing of the questionnaire
- Analyses of administrative concepts

- Assessment of RELEVANCE by means of analysis of users' feedbacks, consultations or satisfaction surveys

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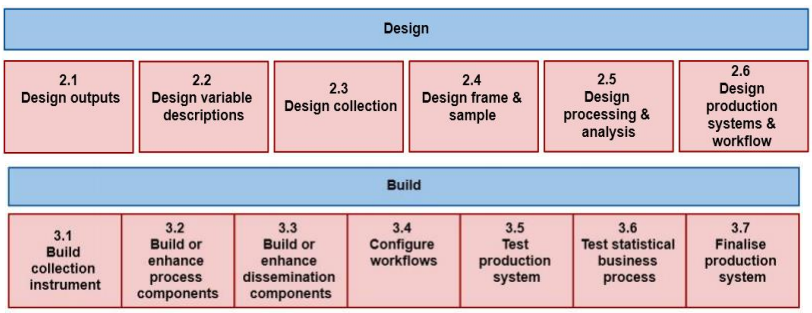
## Planning, development and test of the tools




- Design, development and test of methods and tools

- Set **sampling error**
- Preventing **all types of error**

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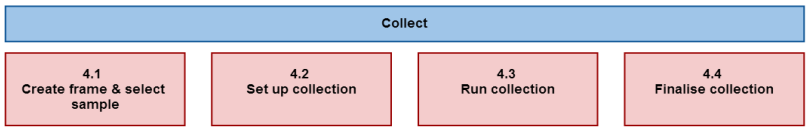
## Data collection




- Includes the creation and update of the frame
- Includes the acquisition of administrative data providers
- Includes data entry

**Errors of:**
- **Frame**
- **Unit Nonresponse**
- **Measurement (and item nonresponse)**
- **Processing (data entry)**

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## Preventing, monitoring, correcting and evaluating frame errors

- **Integration among lists, update and improvement of the quality of the list**
- **Monitoring of over-coverage quality indicators and indicators on errors in the auxiliary variables**
- **Weighting adjustment methods like post-stratification**
- **Estimation of the under-coverage rate by means of comparison with external sources or by means of Post-Enumeration Surveys**

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## Preventing, monitoring, correcting and evaluating unit nonresponse errors

- Advance letter to sampled units, follow up to non respondents, guarantee on privacy, tool free number, …
- Relationships and agreement with the providers of administrative data

- Monitoring of nonresponse quality indicators and reasons of nonresponse
- Weighting adjustment (calibration)

- Estimation of the bias in the final estimate by means of a survey on a subsample of nonrespondents or other experimental approaches

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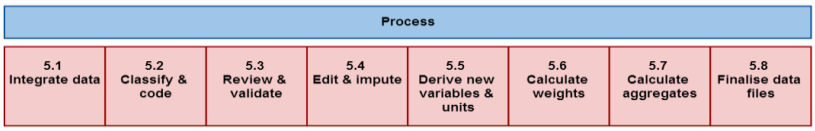
## Preventing, monitoring and evaluating measurement and item nonresponse errors

- Test of the questionnaire, training of the interviewers, choice of the data collection mode, instructions …
- Integrate quality checks in Computer Assisted questionnaire or in data entry software
- Criteria to select a variable when available from different (administrative) sources
- Application of editing and imputation procedures
- Monitoring answers' distributions, item nonresponse, "don't know" answers
- Supervising and monitoring interviewers
- Estimation of variance and bias due to measurement error by means of re-interview studies; Estimation of variance and bias due to the interviewers by means of interpenetrating samples or randomised experiments

## Processing




- Sub-processes involving staff and software or IT procedures
- Weights are adjusted for the errors of previous phases (frame and nonresponse)

Errors of:
- Coverage & measurement (False link/false nonlink)
- Processing errors: systematic and variable

Impact on:
**Accuracy, coherence**

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## Preventing, monitoring, correcting and evaluating processing errors

- **Use of trustable linkage key in data integration**
- **Staff training, instructions**
- **Test of the instruments (software for coding, editing and imputation, …)**
- **Use of software implementing solid methodologies**
- **Monitoring and supervision of the staff**
- **Monitoring of editing and imputation quality indicators**
- **Calibration estimation to assure coherence with known totals**

- **Estimate variability (by repeating the operation under the same conditions) and bias (by repeating the operation under more accurate conditions)**

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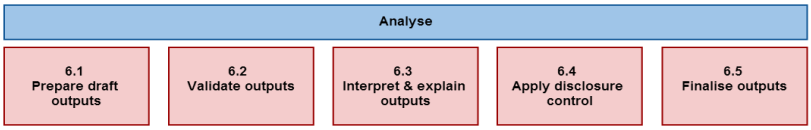
## Analyse




- Production of indexes, trends and seasonally adjusted series
- Control of the estimates with data from other sources or with data from previous editions of the process

Impact on:
- **Coherence and comparability**
- **Accessibility and Clarity**

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## Preventing, monitoring and evaluating processing errors (in the analyse phase)

- **Use of standard concepts, classifications, methods, …**
- **Prevention of risk of disclosure**

- **Monitoring of the legislative changes over time of administrative data**
- **Monitoring of coherence and comparability indicators**
- **Revision back of the time series**

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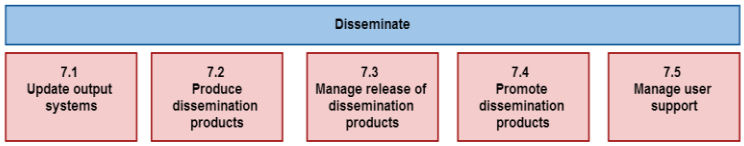
## Dissemination




- Statistics are released to the users according to the publication standards and the dissemination calendar

Impact on
- **Accessibility and Clarity**
- **Timeliness and Punctuality**

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## Preventing, monitoring and evaluating errors in the dissemination

- **Commitment with the users on modalities for dissemination**
- **Have a release calendar**
- **Have metadata to support understanding and further use**
- **Efficiency of the process to guarantee timeliness and punctuality**

- **Monitoring of the accesses to the data disseminated**
- **Monitor of the feedbacks from the users**

- **Analysis of quality indicators on timeliness and punctuality**
- **Assessment of the quality of the Dissemination service by means of users' feedbacks, consultations, satisfaction surveys**

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## Conclusions

- **Which are the relevant phases & sub-processes of my statistical process?**
- **Which activities should I plan in advance to avoid the occurrence of errors later on during the field operations?**
- **Are the data collection mode and questionnaire the best choice for the statistical objectives?**
- **Is there staff involved that needs to be trained?**
- **How can I assure that the staff works in a standardised way?**
- **Which indicators can help me to monitor quality during the statistical process execution?**
- **How can I correct the main nonsampling errors, i.e. the undercoverage and unit nonresponse and item nonresponse?**
- **Are there other statistics I should be coherent with?**
- **Is comparabiliy over time and over space assured?**

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