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Assessing Quality through the Collection and Analysis of Standard Quality Indicators: The ISTAT Experience

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1. Introduction

This paper describes the approach followed by Istat for assessing the quality of statistical processes based on the collection and analysis of standard quality indicators (SQIs). The SQIs are calculated for all Istat surveys and are stored into a centralised information system, named SIDI, which permits analyses and comparisons over time and among different surveys.
The calculation of SQIs started 4 years ago on a voluntary basis. Since 2005, Istat started a new strategy for a compulsory even if gradual implementation of the SQIs. So far the degree of implementation of SQIs can be considered quite satisfactory and constitutes a basis for quality analyses that can be tailored to satisfy the needs of different typologies of internal users such as Istat top management, the centralised quality managers and finally the survey managers.
This paper reports an update on the SQIs that will be shortly implemented in the SIDI system. It also provides some examples on the variety of the reports that can be produced for different users and examples of the different standard and *ad hoc* analyses that can be performed on the already implemented SQIs.

2. SIDI quality indicators: an update

One of the main feature of the SIDI system is the possibility to store and offer to the users a set of SQIs for the analyses of the quality of a survey supported by the relevant metadata that influence their levels.
Initially, the SQIs were basically process indicators, referred to the main phases of the statistical production process (quality of the frame, data collection, editing and imputation) or relative to the entire process (timeliness and punctuality) and representing the resources' constraints (costs). These indicators have been described previously (Brancato *et al*, 2004).

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Under the impulse of Eurostat (Eurostat, 2005) and in response to Istat internal requirements, new indicators, more oriented to the product quality, have been added and some old indicators have been improved. These new sets will be implemented in the course of 2006.
In general, the old indicators included in the system reflected the overall process quality and were not referred to single variables. Now, the interest shifts towards product indicators, able to better reflect Eurostat quality dimensions (Eurostat, 2005).

Indicator on Coding phase
The coding phase consists in the assignment of codes to: open-ended responses, geographical areas, economical activity, education level, etc. The new indicator defined in the system is a process indicator. For a given variable, it is represented by the *Recall Rate*, and is calculated as the ratio between the number of values automatically coded and the total number of values submitted to coding.

Indicators on Editing and Imputation for variable
Indicators on Editing and Imputation (E&I) had already been defined in the SIDI system. They were based on the comparison between the data before and after the E&I phase and were related to the overall set of variables submitted to check. In order to have measures of the quality of single questions, these indicators have been extended. Therefore, for the most relevant variables of the survey, the Imputation Rate, and the Non Imputation Rate with their components have been added. Their computation formula is here summarised:

Indicators on Editing an Imputation for variable

Total records	
Imputation rate	no. of modified values / total no. of records
Modification rate	no. of value-to-value modifications / total no. of records
Net Imputation rate	no. of blank-to-value modifications / total no. of records
Cancellation rate	no. of value-to-blank modifications / total no. of records
Non Imputation rate	no. of unmodified values / total no. of records
Blank unmodified values rate	no. of blank unmodified values / total no. of records
Nonblank unmodified values rate	no. of nonblank unmodified values / total no. of records

As usual in the system, for each of the two indicators, percentages of the components are also computed. The indicators can be unweighted and weighted. It is worth noticing that the net imputation rate is a proxy measure of Eurostat item non-response rate.

Indicators on Coherence
With respect to the past version of the SIDI system, in which a coherence indicator on the comparison of the survey estimates with estimates from other sources was available, an additional indicator has been defined, i.e. the coherence between provisional and final estimates derived from the same survey.
In general, the coherence indicator has the following form: $C_h = \frac{Y_f - Y_p}{Y_f} \bullet 100$
Where the subscripts *f* and *p* represent the final and provisional estimates (or the survey and the alternative source estimates), respectively.

Indicators on Comparability over time
With respect to the comparability, indicators reflecting the length of comparable time series have been defined. For each relevant variable or statistical indicator of the survey, the initial and final dates of availability of comparable estimates are provided. If a break in time series occurs, the indicator will indicate such interruption. Differently from Eurostat, the indicators are simply represented by the range of dates of the series, and no computations are performed to obtain the number of years of the homogeneous time-series.

Indicators on revisions
They are indicators of accuracy. They are especially relevant for short term business statistics that adopt an established revision policy. For a given variable or statistical indicator, the quality indicators on the revisions reflect the proximity of the estimates after each revision to the final estimate. For *k* revisions, the following indicators have been defined in the system:

Size of the first revision: $I_1 = \left| \frac{Y_1 - Y_2}{Y_2} \right| \bullet 100$

Average size of revisions[2]: $I_2 = \left[\frac{1}{k-1} \sum_{i=1}^{k-1} \left| \frac{Y_i - Y_k}{Y_k} \right| \right] \bullet 100$

$$I_3 = \left[\frac{1}{k-1} \sum_{i=1}^{k-1} \left| \frac{Y_i - Y_{i+1}}{Y_{i+1}} \right| \right] \bullet 100$$

Indicators on timeliness and punctuality
This group of indicators has been enriched to comprise also indicators on timeliness and punctuality with reference to delivery of data to Eurostat or Istat National Accounts sector.

3. A quality tool for different users

The SIDI system is based on an integrated management of SQIs and metadata related to the survey content (e.g. analysis units, phenomena,...) and to the production process (e.g. survey design, operations such as data collection mode, quality control actions for preventing, reducing and estimating non sampling errors,…). The metadata play a multi-faceted role: they provide a description of all the important features of a survey, notably those ones that might affect quality; they guide the users in better analysing the SQIs and in comparing the quality of different surveys by taking into account the survey design and context; and finally, they support the users in retrieving qualitative and quantitative information managed into the system (Brancato *et al*., 2004).

[2] Equivalent to Eurostat Mean Absolute Percentage Error (MAPE) indicator

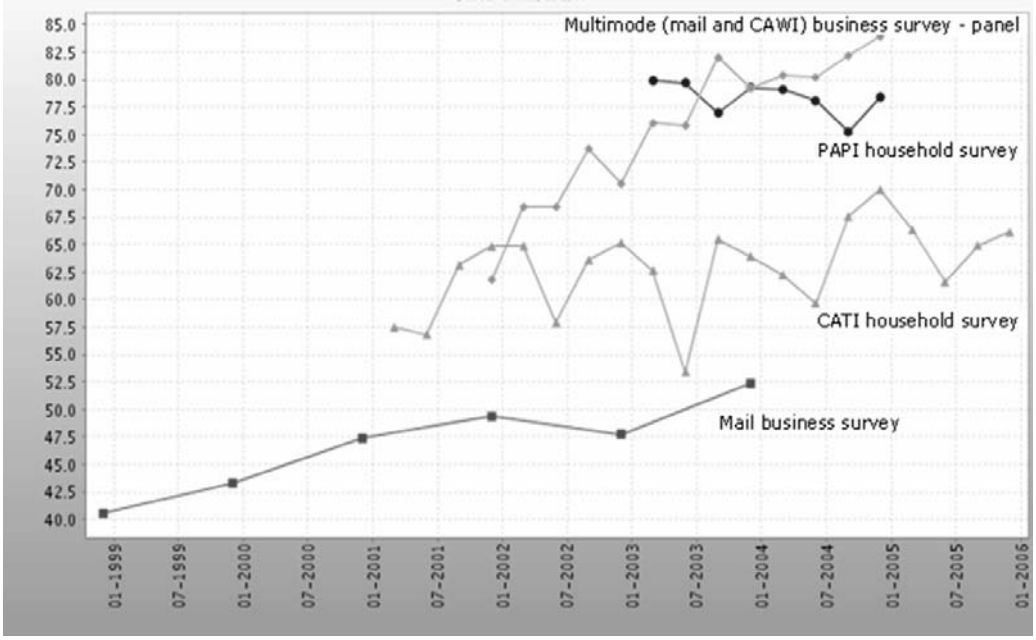
Such an approach makes the SIDI system a useful quality tool that can satisfy the needs of different users' typologies, namely: the survey managers, Istat centralised quality managers and top management, Eurostat and other international organisations, external users.
Indeed, the SQIs have been defined in order to allow the survey manager to monitor the quality of the main phases of the production process as well as to assess the product quality. Furthermore, the system is equipped with a rich set of functionalities for analysing the indicators over time and comparing them with mean values or with indicators from other surveys (see next paragraph).
At a centralised level, the SIDI system is primarily used for assessing the quality of Istat surveys and monitoring it over time. To this purpose, reports from the system are periodically submitted to Istat top management as described in paragraph 5. In addition, SIDI is a tool for analysing the trends of homogeneous classes of surveys, for evaluating the effects of process improvements on data quality as well as the effectiveness of quality policies. To this aim, besides standard enquiry functions, the information content can be exploited through *ad hoc* analyses for meeting the specific needs of quality managers and the top management. Examples are presented in paragraph 6 with regard to some sets of SQIs implemented in the previous release of the system. Thus, the system supports the decision process underneath quality improvements.
Other users, though indirect, are Eurostat and other international organisations. For instance, the information stored in SIDI has been helpful in compiling the 2005 Eurostat questionnaire for self-assessment against the principles of the European Statistics Code of Practice.
The SIDI metadata repository constitutes the main information source from which relevant metadata can be extracted and provided to external users in appropriate formats and through different dissemination channels. Examples are: i) the standard methodological notes of the ISTAT Yearbook, which can be derived by means of the ASIMET subsystem, and ii) the information system, named SIQual, which has been recently released on Istat website in order to provide final users with metadata on statistical processes and to improve transparency.

4. Standard quality analyses

The SIDI system provides the users, particularly survey managers, with some valuable standard functions for investigating the quality indicators (Brancato *et al*., 2004).
Figure 1 shows an example of the mentioned standard quality analyses. In particular, the trend of the response rate for four different surveys is represented. The data confirm what expected: mail business surveys have lower levels of response rate respect to PAPI household surveys. Comparing the single mode mail business survey and the multimode (mail and web) survey, the advantages of using mixed modes come out: even in the worst performance (the first survey occasion), the multimode survey presents a value of about 10 percent points higher than the single mode survey. The increasing trend of the multimode survey is mainly due to the continuous update of the

sample information made possible by the fact that it is a panel survey, and changes in demographic dynamic of sample units are suddenly recorded.

Figure 1. Trend of Response rate for four different surveys



5. Standard reports for Istat managers

SIDI has been planned as a supporting tool for the quality control of the statistical productive processes and, as such, it allows to provide the users of the Institute with periodic information about the quality of Istat surveys.
A function implemented in the system permits to print reports showing metadata and SQIs available at the moment of the enquiry, for a single process or for many of them. This functionality is aimed at satisfying the needs of survey managers or the directors of productive Divisions.
In addition, it has been considered opportune to inform the top management of the Institute twice a year with performance reports, extracted from the system, concerning the state of updating of the system itself with reference to the main information classes: metadata and quality indicators of the surveys (direct surveys and surveys based on administrative data) and metadata of the secondary studies (e.g. National Accounts). The attention is oriented towards giving information about the current updating and the quality of the content of the system. The periodic reports for the management of the Institute highlight the changes occurred with regard to the previous situations. In addition to a general report, a specific report has been arranged for each productive Division with detailed information on its own surveys. Such a reporting activity supports the motivation to complete the SIDI updating and to improve the quality of the managed information.
In 2005 the documentation of all surveys has been completed and for all the surveys, which disseminate data, the indicators on "timeliness and punctuality" have been

calculated. Given the necessity of bringing up the information concerning the informative content, the productive process and the quality indicators of the surveys as well as the changes in the documentation, we have realised a procedure which memorizes all the requested information in appropriate tables in the system database and this therefore allows to realise some dynamic reports that show the increases in the items documented in the system.
Two examples of tables realised for a typical report are reported. In table 1, the enhancement in the calculation of SQIs after the 2005 mandatory Directive are represented.

Table 1 – Numbers of occasions of quality indicators calculated for each group before and after the 2005 Directive

	No. of occasions	
Groups of quality indicators	**06/05/2005**	**19/12/2005**
Frame	81	143
Data Collection	81	143
Editing and Imputation	34	98
Timeless and Punctuality	49	775
Costs	19	34

General improvements in the updating of the system for metadata are shown in table 2.

Table 2 – Numbers of different metadata before and after the 2005 Directive

	Numbers of items in the system by type					
Date of system recovery	**Analysis units**	**Observed phenomena**	**Survey design**	**Operations**	**Control actions**	**Questionnaires**
06/05/2005	655	823	147	4033	2027	53
19/12/2005	714	851	172	4536	2216	127

6. Exploiting quality indicators

Besides the standard quality analyses and reports provided by the system, the qualitative and quantitative information stored in SIDI can be further processed in order to analyse specific quality issues and support quality improvements. Such analyses are mainly addressed to Istat top management for supporting the decision process and for verifying the implementation of quality policies. Obviously, this kind of analyses will be more powerful with the increase of the amount of data available. Considering the degree of implementation reached so far, the data available at the moment allow some cross-sectional analyses but only limited over time evaluations.

6.1 Timeliness

In this section some examples of analyses are shown concerning the indicator on timeliness. The timeliness indicator in SIDI is defined as:

Timeliness=(actual date of first release of final data) - (date of reference for the data)

The calculation of the timeliness indicator became mandatory for all Istat surveys in 2005 with reference to the most recent data released. Furthermore, past time-series of indicators could be provided on a voluntary basis. As a consequence, not the same amount of data is available for each year.
In table 3 the mean of timeliness by year of reference for the data and by survey periodicity is reported. For annual surveys, the value of the indicator from 2002 to 2004 is constantly decreasing, but it must be underlined that 2003 and 2004 surveys with worst timeliness have not released final data till 2005, and consequently the indicator means underestimate the true values. However, the overall mean value of 593 days suggests that there is room for improvement.

Table 3. Mean of timeliness by year and survey periodicity (days)

	Monthly	Quarterly	Yearly
1995	-	80 (1)	-
1996	-	78 (1)	516 (1)
1997	-	637 (2)	396 (1)
1998	-	783 (4)	486 (1)
1999	-	591 (4)	822 (2)
2000	-	572 (4)	796 (17)
2001	62 (4)	424 (5)	727 (32)
2002	64 (4)	431 (6)	611 (35)
2003	160 (8)	434 (8)	484 (49)
2004	152 (18)	234(12)	308 (11)
2005	85 (17)	158 (7)	-
Overall mean	124 (22)	407 (16)	593 (65)
Overall	346 (137)		

number of surveys is reported in parenthesis

Clearly, quarterly and monthly surveys show better timeliness, although the average values for both periodicities might seem quite high (407 and 124 days respectively) for groups that should include timelier surveys. Nevertheless, it should be noticed that a great impact on timeliness is due to the survey typology, and the metadata available in SIDI allow us to explore this hypothesis. For example, in table 4, the means of timeliness for different typologies of monthly surveys are reported. In particular, two different kinds of surveys with substantially different levels of timeliness can be found: i) the demographic surveys based on administrative registers and some structural business surveys, generally slower, varying between 158 and 212 days (around 6 months) and ii) the short term business statistics faster, often constrained by regulations, ranging from 31 to 76 days of annual average timeliness. Finally, it should be mentioned that the indicator refers to final data release, whereas monthly and quarterly surveys commonly provide also preliminary data in a shorter time.

Table 4. Monthly surveys: Mean of timeliness by year and survey typology (days)

	Administrative or structural	Short term	Monthly
2001	181 (3)	32 (1)	62 (4)
2002	181 (3)	32 (1)	64 (4)
2003	212 (7)	31 (1)	160 (8)
2004	197 (10)	76 (8)	152 (18)
2005	158 (8)	42 (9)	85 (17)

number of surveys is reported in parenthesis

As already mentioned, caution should be used in drawing conclusions on the temporal trend of Istat surveys timeliness on the basis of the data available at the moment, basically because mean values relative to different years can be based on different surveys. Nevertheless a way to analyse the trend is given by the:

Absolute timeliness difference (v_j)= [timeliness at survey occasion j] – [timeliness at survey occasion (j-1)]. j=2,…,k

Starting from a set of k occasions of the same survey, k-1 absolute timeliness differences and their annual averages are computed. In this way each survey is compared with itself and the annual averages represent indicators of the global gain (or loss) in timeliness occasion by occasion expressed in days. In table 5 the mean of absolute timeliness difference by year and survey periodicity is reported with reference to the two most recent and complete years.

Table 5. Mean of absolute timeliness difference by year and survey periodicity (days)

	Monthly	Quarterly	Yearly
2003	-4,1 (8)	-6,4 (7)	-86,6 (28)
2004	-0,3 (16)	-7,4 (12)	-64,2 (9)

number of surveys is reported in parenthesis

The fact that all the cells in table 5 are negative reflects a general improvement in timeliness. Obviously, the different levels of the improvements for different periodicities depend on the way the indicator is defined: being it an average on survey occasions, the difference is attributable to a single occasion. For example, on average, each of the 2004 quarterly surveys saved 7.4 days *for each quarter* of the year, that means 7.4*4(quarters)=29.6 days globally for the year.

6.2 Frame and data collection

The calculation of SIDI indicators on frame and data collection is quite demanding for survey managers at least the first time they have to perform it. For this reason in 2005 it was mandatory to calculate them only for those surveys that had already done it in the past years. In practice, the time-series of indicators should be updated with the most recent survey occasions. Consequently, such indicators are available for about 30 surveys with 5 occasions each on average. Despite the amount of indicators collected is not large, some examples of analyses are described in this section in order to highlight the potentiality of the system. In particular, some analyses performed on the frame errors rate and on the response rate are reported. The frame errors rate is defined as follows:

Frame Errors Rate=(out of scope units + no contacts due to frame errors) / resolved units),

whereas the response rate is calculated in the following conservative way, as asked by Eurostat (Eurostat, 2005):

Response Rate= respondent units / (in scope units + unresolved units).

In table 6 the mean of frame errors rate by year and data collection mode is presented. As can be easily observed, mail surveys show a high level of frame errors. This is due to the fact that the majority of mail surveys are business surveys, and the demographic dynamic of businesses in Italy is very fast, and make it more difficult to keep up-to-date business registers. On the contrary, administrative sources (e.g. local authorities) are very stable, consequently the level of frame errors rate for administrative surveys is close to 0.

Table 6. Mean of frame errors rate by year and data collection mode (%)

	Administrative survey	At least CATI survey	At least Face to face survey	At least mail survey	Overall mean
1997	-	-	0,78 (1)	-	0,78 (1)
1998	-	-	-	14,91 (2)	14,91 (2)
1999	-	-	-	15,19 (2)	15,19 (2)
2000	-	-	-	11,48 (6)	11,48 (6)
2001	-	22,14 (4)	0,88 (1)	9,83 (6)	13,49 (11)
2002	-	2,68 (3)	1,02 (1)	9,02 (7)	6,56 (11)
2003	0 (3)	2,92 (2)	3,74 (2)	6,90 (7)	4,40 (14)
2004	0,82 (3)	9,37 (4)	7,13 (1)	6,50 (7)	6,17 (15)
2005	-	1,35 (1)	-	9,62 (5)	8,24 (6)
Overall mean	0,62 (4)	13,11 (6)	2,85 (3)	8,56 (19)	7,88 (32)

number of surveys is reported in parenthesis

In table 6 a high level of the rate for CATI surveys can also be noticed, in particular in 2001 and, though less evident, also in 2004. This is due to the fact that in those two years respectively 3 and 2 surveys that contribute to the average used a particular type of frame. These surveys aim at studying changes in lifestyles after a specific period (3 years) following a significant life event (e.g.: birth, educational degree…). To this purpose, *ad hoc* frames were built from particular administrative sources, where the events had been recorded. The contact information at the time of the data collection resulted not to be fully updated, not surprising considering that a significant change in life was happened, and, actually, this raised the fraction of the frame errors rate that is related to "no contacts due to frame errors". Indeed, more then 90% of frame errors rate is attributable to errors in the contact information in each of the mentioned surveys. However, the notable improvement obtained in 2004 compared to 2001 should also be underlined.

With regard to the response rate, table 7 reports the mean of the indicator by year and use of single or multimode of data collection. The use of multimode is constantly increasing in recent years at Istat: at the moment about one third of all Istat surveys use mixed modes. A broadly used approach is the combination of traditional mail with web for business surveys, exploiting the opportunities offered by information technology advancements. Observing table 7, referred to about 30 surveys, the multimode approach seems to produce very good results: the response rate averages result always better for multimode surveys than for single mode ones, thus encouraging the promotion of a wider implementation of the multimode approach across the Institution.

Table 7. Mean of response rate by year and mode (%)

	Single mode	Multimode
1997	96,43 (1)	-
1998	40,54 (1)	50,16 (1)
1999	43,28 (1)	51,37 (1)
2000	62,33 (5)	92,48 (1)
2001	63,45 (9)	83,27 (2)
2002	65,08 (8)	86,54 (3)
2003	75,46 (9)	79,73 (5)
2004	76,36 (6)	87,02 (9)
2005	64,77 (1)	83 (5)
Overall mean	69,67 (18)	81,69 (14)

number of surveys is reported in parenthesis

7. Conclusions

This work has highlighted that, besides the functions already available in the SIDI system to monitor and evaluate the SQIs, additional meaningful explorative and confirmatory analyses on quality can be produced, even with a limited set of data. The usefulness of such analyses strengthens as the completeness of the documentation for metadata and SQIs increases.

Istat choice of centrally collecting and storing SQIs for quality assessment has significant advantages which are accompanied by some drawbacks. These last ones are: i) the work load for survey managers for calculating the SQIs for each survey occasion and for revising or adapting some procedures; ii) the survey managers' need of more detailed SQIs for deeper process/product quality analyses; iii) the cost of developing, implementing and keeping up-to-date the system. Furthermore, a certain initial degree of reluctance from survey managers has been faced.

Nevertheless, we can not argue that the efforts made were worthless. Indeed, the advantages are becoming gradually but steadily evident as the amount of SQIs and metadata in the system grows up. Survey managers are increasingly appreciating the support offered by SIDI, for example in producing quality reports (e.g. for Eurostat or for external users), and Istat top management is regularly informed on quality issues. Finally, the added value related to the storage of quality indicators has to be underlined and it will be more and more precious in the future.

In so far, the SIDI system has contributed to increase the quality culture in Istat and represents a starting point for communicating quality to final users. However, documentation systems require a constant awareness of the obstacles and the difficulties that might be encountered. From our perspective of centralised quality managers, future efforts will be addressed to increase the series of SQIs and to exploit the quality information in SIDI in a more systematic way.

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