POSSIBILITIES OF IMPLEMENTING THE QUALITY STANDARDS FOR SPATIAL DATA INTO CADASTRAL WORKS

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***Abstract**: The institute of cadastre, as well as GIS systems, consider the data at their disposal to be perfect. These data are used without taking into account the contained errors, and this can lead to inaccurate results, confusing information, erroneous decisions and high costs. After a short presentation of the standards in this domain, we will try to reason the necessity of evaluating the quality of spatial data, as well as assuring it, at the level of cadastral authorities.*

***Keywords:** data quality, cadastre, quality standards*

1. Introduction

Despite the arguments in favor of explicit treatment of spatial data quality, the institution of cadastre and GIS usually consider these data as being perfect. These data are used without taking into account the contained errors, and this can lead to inaccurate results, confusing information, erroneous decisions and high costs. These data represent real-world entities that are generalized according to the product specifications, which are characterized by spatial and thematic aspects, as well as consistency in time.

The dataset is not generally produced for a specific application, but rather for a set of supposed applications. The quality of the dataset can be evaluated in case we know the data quality elements and the data quality check elements.

Data quality elements evaluate the difference between the produced dataset and the generalization of the physical reality (the dataset is perfect if it corresponds with the product specification). Data quality concepts provide an important frame for data producers and data users. Data producers can control how well the dataset fulfill the criteria set at the product specification. Data users have means to evaluate the dataset, which is derived from an identified universe of discourse, in case that it is in unison with the application requirements. Data users can evaluate quality in order to convince themselves if the dataset can satisfy the requirements of some applications.

Quality control is based on internal standards, defined processes and procedures for quality control and monitoring.

The *promise of quality* is based on external standards; it follows the review of the activities and the process quality control in order to assure that the final products fulfill the preset quality standards.

2. Quality standards

A group of experts have investigated the regulations concerning quality, the methods and software used to assure quality in the structure of cadastral data administrators across

Europe. There have been abundant specifications everywhere of spatial positioning quality, in many cases thematic accuracy and completeness was specified, and only in a few cases elements concerning the actuality of the data and logical consistency is mentioned.

Generally, quality management was considered as a cost, a surplus expenditure, and not a force which leads to a change. Quality management is considered to be important, but its strategic potential is not as highly rated as it should be.

Based on this investigation, we can state that there is a clear necessity to develop procedures for assuring quality.

3. The motivation behind introducing quality standards

The National Agency for Cadastre and Land Registration (A.N.C.P.I.) has an important contribution in the build-up and development of the National Infrastructure of Spatial Data, which is defined as the totality of technologies, standards, protocols, system accesses and policies necessary to harmonize the geospatial databases and assuring the access to spatial information.

The data acquired, taken and stored by the A.N.C.P.I. can become reference data for other structures of spatial data, mostly because any information in G.I.S. is positioned in space. Knowing the quality of these data is vital.

The European Committee initiated the development of the European Infrastructure for Spatial Data by issuing the INSPIRE directive. This directive creates a legal and a technical frame for the foundation and activity for a spatial data infrastructure in Europe. The INSPIRE politics also extends the system in other sectors, like transportation, industry, agriculture, energy domain. It is also intended to be extended for environmental problems.

The directive establishes the requirements for metadata and acknowledgement of spatial data quality as being one of the key criteria in the administration and usage of spatial data.

Because of that, structures of cadastral data administration should have information about quality reported in the form of metadata.

It is important that information concerning quality to be sure and data acquisition methods to be known to the smallest detail. By using quality standards, the administrational structures of cadastral data can assure these conditions.

4. Interpretation of the reference dataset quality concept

Quality can have multiple interpretations based on the work phase, based on the data lifecycle, in the usage phase. ISO19100 quality standards can be used in this process for defining and reporting the quality of data

Table 1. Model of data requirements [according to Antti Jakobsson]

Phase	Documents of quality	Objectives of quality	Quality verification methods	Level at which verification occurs
Before production	Data requirement model is defined	Quality requirements are defined	Investigation of user requirements	Classification of the characteristic feature of the level

During production	Database – creation process history	Knowing the specifications Introducing anticipated data qualities in the database	Inspection (verification)	Verification of elements (expl. positioning precision)
After production	Metadata – Reporting the test	Conformity is compared with quality requirements	Evaluation Reports	At the dataset level

The quality management principle should be applied in the production process. It is recommended to introduce the data production management procedure, as well as the ISO9000 principles. This standard is not the standard for one product, but a general standard of the quality assuring system, and has three domains of regulation:

- projecting the production or the service
- process control
- documenting the activity

Organizations can certify the quality of processes.

5. Implementing the quality standards at the level of National Agencies of Cadastre and Land Registry

First of all, the needs should be identified – and also we can already note that applying these standards is a long process; also, some organizations normally have some existing elements; in this way, they can integrate in this project, and a pilot project is recommended for clarifying the omissions.

The implementation of standards starts with necessities, more precisely from the identification of needs/necessities. The most important aspect, for which we attend for when applying the quality standards, is the requirements of the clients (users). There are many points of view, we must take into account:

- the quality requirements (declared or imaginary) as levels of quality conformity
- the cost to evaluate the quality
- reporting quality
- legal basis (legal requirements)

Different spatial date infrastructures are taken into account when analyzing data quality. For this, based on the requirements of the clients, quality elements and sub-elements are created, according to ISO19113. These standards can change in time, and can be used together with other standards from that family, for example.

Applying the standards should be made at the level of project management on internal level.

Table 2. Directing lines of standard implementation [according to Antti Jakobsson]

Phase	Scope	ISO Standard	Guidance
Data specification	Quality model	ISO19131	General guidance from ISO19131, ISO19114 explains the means to set the quality conformity level
Production	Logical consistency test	ISO19114	Completely automatic control, software independent instruments for testing the logical coherence

	Metadata production	ISO19115 ISO19113	Must be incorporated in the production process and also in the software
	Database quality measure	ISO19113 ISO19138	These are usually based on the quality model
Quality evaluation	Quality test	ISO19114 ISO2859-4	ISO2859 is taken into account for revealing the samples. ISO2859-4 is useful for evaluation purposes. For positional accuracy, there are standards which could be used
Metadata	Reported quality	ISO19115	Must be reported in conformity with the requirements. Numerical results can be useful in a variety of different applications
Metadata exchange	Metadata catalogue, metadata to clients	ISO19139	

Assuring the quality in the process of creating cadastral maps

The elaboration process of the cadastral maps has always been a very well defined operation, carried out by specialists, with respect to the good intentions about their quality.

In different times, correct elaboration was obstructed by conditions created by society, the political environment and finances. In our days, there is a necessity to anew the process of creating cadastral maps, and with this, the assuring of quality on new basis. Some reasons to sustain these affirmations:

- the economical and social conjuncture has changed
- society, based on private property, created a new real estate market, which expects an authentic land registry. The safety of the property and the real estates became a social necessity
- the private sector became an important part in the elaboration of the final products (maps)
- consolidation of the available services is necessary, as there's an increase in demands for quality products and services
- European integration imposes the necessity to align the services, the product elaboration methods and the regulations, to international normatives
- IT solutions make possible to switch from analogue maps to digital ones, making possible to link these products with land registry

Transforming the methodology to create maps supposes the re-evaluation of quality assurance because:

- the expectations and requirements of the beneficiaries (in our case citizens, organizations, society) are very well defined regarding the maps and the inventories/registries based on them
- the financer expects high quality products
- the interests of the governmental organizations, which represent the financer (OCPI, ANCPI) is that the job quality should be high
- the financial interest of the executor is to elaborate quality works

Assurance of quality when creating maps is realized on 3 levels:

1. – project coordination level

   The project needs a central regulation and it is realized by integrating the financial, political and professional interests at a high level.

   - Objective: main regulation at the level of the whole country
   - Participants: organizations with national responsibilities

2. – production process level
   Here belong all institutional procedures, of management, execution and control, in al processes of the elaboration.
   - Objective: regulations for all operations in order to elaborate the product
   - Participants: executioner and beneficiary

3. – technological level
   Contains all the quality control procedures and associated methods of certification for the technology used.
   - Objective: professional revision of measuring techniques
   - Participants: executioner (executioner of the work and certified, independent internal and external control personnel)

A possible system to evaluate the quality general cadastre works (jobs)

Verifying the geometry – the objective has a wrong geometry if any point that describes it is erroneously positioned, or the dimension of an object has a deviation after control measurements, which exceed the permissible limits of dimension or positioning. The objective of verifying the geometry consists of accomplishing basic positional conditions: perpendicularity at constructions, parallelism at linear elements, etc. Any deviation regarding to positioning, dimensions or achieving basic geometric conditions constitutes an error.

Verifying the existence of the objectives – the existence of objectives is important when determining the reality. It is considered a mistake if the objective is missing totally or partially, or if it's added to the physical reality.

Verifying the topological links/relations – At topologic verifications, any selection will be tested regarding the topological links, the extension, of the element. It is considered a missing topological element if:

- the element exists in reality, but has no topological links, or the links are bad
- the topological link refers to a non-existing objective
- the topologic link exists, but the objective has no correspondent in the database

Based on these tests, the errors can be categorized by the frequency of their appearance. If the above errors are identified in the case of more groups, then it frames to the hierarchically superior group, as follows:

1. error in objective existence
2. geometrical error
3. topological link error
4. attribute-type value determination error

6. Strategies to implement the standards

Standards, by definition, have a general applicability. An organism from this structure has no need, and cannot produce all types of data, some of them being useless for the organization. A standard consists of generalizing the profile before application. An organism cannot elaborate a standard by itself, the provided information has standard mandatory fields, to which a distinct profile cannot resign. Conditional fields are mandatory under some logical conditions, optional fields can be given up. The organism can add another string of data,

based on proper requirements, which do not counter with general requirements of the standard. The profile is constructed based on these decisions, and naturally comes along with the necessary explanations and documents. From the manager's point of view, more strategies can be elaborated in order to satisfy the needs of the beneficiaries.

The organization can specify the same standard for all products, which must be used in a single document for the whole organization. The advantages are the easier development and maintenance of the applications, the standardized dataflow and the coherence in product structure. The disadvantages would be the creation of bulky reference documents and the slow actualization rate.

A *data quality model* has two purposes:

- follows the application of the elements and sub-elements of quality in an organization, as well as what measures of quality evaluation is applied on the dataset
- establishes quality requirements for these datasets. There are already existing elements, but at the current time there are not unambiguously defined, there is no general direction (Finland, Sweden)

7. Conclusions

In order to evaluate data quality in terrestrial measurements and cadastre, we begin with the definition of certain specifications for each product (creating the network of fundamental points, introduction of general cadastre, creating topographical base maps, creating digital maps from analogue ones or from photogrammetric images).

The next step is the definition of objective classes and groups, respectively the definition of characteristic attributes for each group of objectives.

The more difficult part is to establish the conformance level (confidence, exactness) for each type of job, and moreover, for each group of objectives in these jobs.

Defining all these elements should be the objective of some standards, which would assure the regularity of topographical and cadastral data in the whole country. Only after we have these premises can we evaluate the quality of the jobs.

The vast majority of geometrical data quality evaluation can also be done at the current phase, with the help of statistics and theory of errors. The lack of clear regulations regarding uniform identification and representation of map objectives makes this operation difficult.

There is no type of regulation available to evaluate the quality of the other types of data, used in the cadastral domain.

The standardization of quality evaluation has beneficial effects on spatial data users. User complaints are reduced, confidence in these data are rising, and costs caused by decisions made based on these erroneous data are cut. But a dataset can never be without errors. In order to achieve a high quality level we need a big effort, time and money.

The value of costs in an application, based on erroneous data, can be estimated. This sum of money should be invested in quality management. The effect can be expressed in the level of conformance of the quality.

The last conclusion is that, if there were two key points to perfect the data quality, they would be prevention and correctness. Prevention of the errors is considered to be superior to error detection, because detection is usually costly, and does not guarantee a 100% success. The best way to prevent errors is to follow the regulations regarding the specifications, structure, dataset, and procedures of implementation and evaluation.

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