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Pregledni znanstveni članak

Quality model based on total quality management in photogrammetry

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ABSTRACT. The global production of all kind spatial data is increasing, thus quality management has become a major concern. The main objective of this paper is the author's proposal of conceptual quality model for photogrammetric projects, consisted of managerial and technical aspects, that considers the principles of total quality management. Definition of term quality and principles of total quality management are given. International standards for geographic information as well as contribution of some professional associations to spatial data quality management are reviewed shortly. Proposal is given to distinguish two different types of photogrammetric products: basic and final. Application of total quality management in photogrammetric projects yields toward better final quality of collected data, better understanding and reliable interpretation of the quality parameters, and the long-term reduction of costs per data. Some recent results in Slovenian national projects prove this already.

Keywords: photogrammetry, total quality management, quality model, international standards.

1. Introduction

Technologies for data collection are becoming more and more advanced and widely used. Consequently, the production of spatial data of any kind is growing rapidly. The quality and reliability of data is thus becoming the most critical factor in the processes of decision-making. However, the changes in our profession are not only of a technical nature. Geoinformation is becoming a requested product in the global market and governmental organizations should start to behave like private enterprises.

The main objective of this paper is the author's proposal of conceptual quality model for photogrammetric projects that considers the principles of total quality

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management. Photogrammetry provides theory and methods for bulk spatial data acquisition. Working procedures are quite complex and it is important to plan carefully all individual phases, the timing and also the time frame for the quality control. Not only investigation of final quality is of concern, it is moreover necessary to manage quality in the whole process in order to optimize the cost to quality ratio of the products. Application of total quality management in photogrammetric projects yields toward better final quality of collected data, better understanding and reliable interpretation of the quality parameters, and a long-term reduction of costs per data (Kosmatin Fras 2002).

Managing spatial data quality is essentially not much different from managing quality in industry and manufacturing, although there are some specialties. The initial ISO 9000 series, that practically applied the concept of total quality management to all generic product categories, were published in 1987, while the international standards on geographic information are still in draft form. There is yet some uncertainty about procedures, quality parameters, sampling and statistical methods to be applied and the proposed international standards are not covering the complete scope of quality management.

2. Quality and Total Quality Management

Description and measurement of quality are complex operations as there are numerous definitions of quality itself. Quality always relates to something generally accepted, either being in written, exact measures like specifications and standards or being commonly accepted non-written criteria. We can speak of quality in different context, e.g. quality of products, quality of work, quality of life. In everyday life, the word quality is often used to mean expensive, luxurious or sophisticated. However, good quality does not have to mean high quality or high prices. Quality also means supplying the customers with what they want, to the standard and specification they want, with a predictable degree of reliability and uniformity, and at a price that suits their needs. International organization for standardization (ISO) defines the quality of a product or service as "*the totality of characteristics of an entity that bear on its ability to satisfy stated and implied need*" (ISO 1994). It is important to differentiate between the two basic meanings of quality: quality as luxury and quality as freedom from deficiencies. In this paper, the second meaning of quality is used.

Customer satisfaction is a key quality measure. Not only formal requirements on the project have to be met but also other customer needs have to be addressed to achieve a satisfied customer. In the field of geoinformation customer's satisfaction is difficult to measure. As geographic information can be used in a great number of different fields of application, it is almost impossible to produce maps or datasets fitting all existing user's needs. Therefore it is necessary to decide the relative importance of different customers and define the standard customers. Than, elements that contribute the most to customer's satisfaction should be identified. Geoinformation implies long and very expensive production processes. Knowing accurately customer's requirements about quality saves a lot of money and resources.

Total quality management (TQM) is a generic term that means the vast collection of philosophies, concepts, methods, and tools now being used throughout the world to manage quality (Juran and Godfrey 1999). It has been adopted by an increasing number of companies in the manufacturing and service industries over the past years. TQM is about ensuring that every task completed by every employee, from managing director downwards, is done right first time. However, we can find also other terms with practically the same meaning. TQM is probably the most frequently used term in United States, while total quality control (TQC) was until recently most often used in Japan.

There are *five basic elements of total quality management* (Turner 1993): attitude of mind, quality of the management processes, quality of the product, quality assurance and quality control (Figure 1). *Quality of the product* is the ultimate goal. It means meeting the customer's purpose, but achieving the quality of the facility that will produce the product is an essential stage towards that. *Quality of the management processes* is necessary condition for achieving a quality product. It is essential that the management processes are such as to ensure the quality of the product throughout each stage and between each stage. *Quality assurance* means steps taken in advance to increase the likelihood of obtaining a quality product. Ideally this likelihood should be hundred per cent. Prevention aims to stop defects happening. *Quality control* means steps taken to measure the quality of both product and the management processes, and to eliminate any variances from the desired standard. *The attitude of mind* is the commitment of everyone in the organization to achieve quality. This commitment must start at the top of the organization and it cannot be delegated.

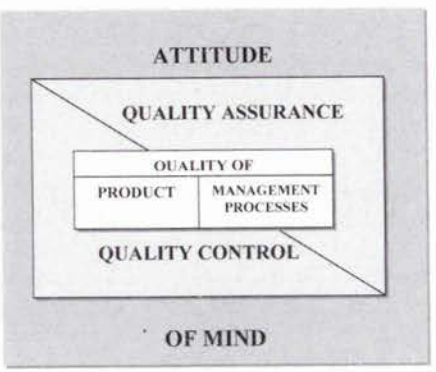

Figure 1. *Five elements of total quality management (Turner 1995).*

Managing for quality makes extensive use of three managerial processes: quality planning, quality control, and quality improvement, known as *the Juran trilogy* (Juran and Godfrey 1999). These processes are universal – they provide the basis for financial management as well, no matter what the type of enterprise is.

Quality management is mostly developed in construction and manufacturing industries. Many experts contributed to the success of the quality movement, mainly American and Japanese. We have to mention here some internationally acknow-

ledged names: W. E. Deming, J. M. Juran, P. B. Crosby, A.V. Feigenbaum, K. Ishikawa, and G. Taguchi. They introduced different fundamental doctrines on how to implement and improve quality. The common important issues of these concepts that have to be emphasized when implementing TQM are (Turner 1995):

- Organization needs to be committed to quality from the top down.
- The most critical quality problems must be identified, and management must provide to lead in resolving them.
- In every known process, it is necessary to identify the factors that indicate good quality, so that the process becomes measurable.
- Quality should be achieved through understanding and improving processes, and by prevention, not by inspection and correction.
- Organizations must develop a statistical understanding of processes, and use statistics to solve problems.

The results of TQM are almost universally accepted goals, i.e. lower costs, higher revenues, delighted customers, and empowered employees. Specific benefits to National Mapping Agencies can include (CERCO 2000) removal of non-conformance from topographic data, a faster registration of cadastral records, more efficient map production, complete and consistent land records and improved data. *Quality involves reducing all the costs of poor quality.*

3. The Role of International Standards in Spatial Data Quality Management

A lot of efforts in the professional society are given to adopt national and international standards on spatial data quality. However, it is not possible to implement quality management only by considering national and international standards. These standards should be taken into consideration, but the aims of quality management must be set higher.

There are several international standardization and mapping organizations and associations that are working on spatial data quality issues. There are two relevant *international standardization organizations*, dealing with, among many other topics, Geographic Information: International Organization for Standardization (ISO) and European Committee for Standardisation – Comité Européen de Normalisation (CEN). The most famous and relevant for quality management are the *ISO 9000 family standards*, produced and maintained by Technical Committee 176 of ISO. The first meeting of ISO/ TC 176 was held in 1980, and *the initial ISO 9000 series* were published *in 1987.* The ISO 9000 standards were introduced principally *to facilitate international trade* (Marquardt 1999). Since 1987, additional standards have been published. The ISO 9000 family now contains a variety of standards supplementary to the original series. Revision of the basic ISO 9000 series were published in 1994 (ISO 9000 : 1994), and the most recently in 2000 (ISO 9000 : 2000).

The *ISO/TC 211* is devoted to geographic information / geomatics (URL 1). From many topics of the TC 211 program, two are directly addressing quality: Geographic Information – Quality Principles (ISO/DIS 19113) and Geographic Information – Quality Evaluation Procedures (ISO/DIS 19114). The *CEN TC 287* is de-

voted to geographic information. A prestandard, ENV 12656: "Geographic Information – Data Description – Quality", is available at present. Indirectly connected with data quality on informative level is the prestandard ENV 12657: Geographic Information – Data Description – Metadata. The Agreement on Technical Cooperation between ISO and CEN (Vienna Agreement) was formally approved in 1991 in Vienna.

In addition to the standardization organizations, some *professional associations* more or less intensively work on spatial data quality issues. *Eurogeographics* (on 1st January 2001, CERCO and MEGRIN became Eurogeographics) created several working groups (URL 2). In 1997, the CERCO *Working Group on Quality* was established. This working group consists of three sub-groups: *Quality Management and ISO 9000*, *Data Quality*, and *Standards*. The sub-working groups on data quality aims to share experiences in methods used to write dataset specifications, measure quality, assess user requirements and evaluate fitness for use (Jakobsson and Vauglin 2001). The WG on quality is very active. It prepares and distributes questionnaires on specified subjects and reports on analysis of the results in meetings and seminars. Two very useful documents were published by the members of the CERCO SWGA (sub-working group A): *Good Reasons for Implementing a Quality Management System* (in 1999) and *Handbook for Implementing a Quality Management System* was published (in 2000), both available also from the Web (URL 2).

International Cartographic Association (URL 3) has the *Commission on Spatial Data Standards*. This commission is very fruitful and since 1991 published several editions of book on all national and international spatial data transfer standards. The commission is also active in making scientific contributions to ISO/TC211.

OEEPE, the European Organization for Experimental Photogrammetric Research (URL 4), in 1999 set up a *working group on Spatial Data Quality Management* to lead a project "Developing a Spatial Data Quality Management System" (Altan and Tastan 2002). The real start of the project was an OEEPE/ISPRS TC IV joint workshop, organized in March 2002 in Istanbul, with many contributions covering both theoretical and practical aspects of the spatial data quality management.

International Society for Photogrammetry and Remote Sensing, in the inter-congress period 2000-2004, does not have any technical commission or working group specifically devoted to spatial data quality. However, the technical commission IV – Spatial Information Systems and Digital Mapping has in its research and application areas implicitly involved some spatial data quality aspects. This resulted in the mentioned above joint workshop with OEEPE working group on spatial data quality management. In addition to this, the Technical Commission II – Systems for Data Processing, Analysis and Representation has in its Terms of Reference the task "standardization of data transfer formats and processes" (URL 5).

International Federation of Surveyors – FIG (URL 6) has in the period 2002-2006 two working groups dealing with quality issue; under Commission 1: Professional Standards and Practice, Working group 1.1: FIG Standards Network, and under Commission 5: Positioning and Measurement, Working Group 5.1: Standards, Quality Assurance and Calibration. The both working groups participate in the relevant technical committees (TCs) of the ISO and other appropriate bodies.

In general, the mentioned above ISO and CEN standards define the basic spatial data quality components. We further need exact measures and evaluation methods to assess data quality. None of the standards gives yet the comprehensive and exact measures and evaluation methods for all spatial data quality components (there are some in ISO, but rather as examples). Sampling methods for spatial datasets should be considered with more attention. Further on, there is no standard, how to prepare specifications which are the reference for data quality evaluation. Projects in geoinformation field are very complex and some inquiries show (e.g. Jakobsson and Vauglin 2001) that not all national mapping agencies have well defined specifications. We should actually start with good specifications having all needed elements. If data are described in such a way that the customers exactly know what they buy or get, this will be the major product enhancement. This also lowers the risk of misunderstanding. The "story" of spatial data quality standard is thus far from being completed. There are still a lot of challenges for research work and international cooperation in this field.

Some European National Mapping Agencies and other surveying organizations (e.g. from Denmark, Norway, Great Britain, Germany) have already started with implementation of ISO 19100 spatial data quality standards (19113, 19114 and optionally 19115) in the practice. In the OEEPE/ISPRS joint workshop on Spatial Data Quality Management in Istanbul (Altan and Tastan 2002), some authors reported of many problems in implementing these standards into practice and they advise a team work of different experts.

4. The Proposed General Concept of Quality Model in Photogrammetry

From the presented principles of TQM it is obvious that we need to develop a spatial data quality model that considers not only technical issues but also managerial. The proposed model is thus consisted of two aspects: *managerial and technical*. They are both mutually connected, but different in approaches and practical performance as the staff is usually different (managers and technicians).

We already stated that final inspection of the results at the end of production line is not the optimal choice. With the final control it can be find out if data are not of the requested quality, but it is very difficult to find out the causes. Corrections could be very costly and time consuming, especially in photogrammetry.

Further on, in photogrammetry we can use the same sources (photos or images and it's orientation parameters) to produce very different results in different projects (e.g. to produce a digital orthophoto map or to collect data for topographical database). The quality of each phase of photogrammetric production line directly influences the quality of the next phase.

The main idea is that quality evaluation is accomplished after every phase with methodology that is well defined in advance. Due to limitation of funds, quality control could not be accomplished in the complete intermediate-product, thus we use sampling methods. If the intermediate result passes the evaluation procedure, the process is continued in the next phase. Now we come to the point, that the next phase can be assumed as the continuation of the quality evaluation procedure. Namely, if there is still some nonconformity in intermediate data, it is great proba-

bility that this will come out through the subsequent phase. Thus we have a process that is able to "control itself". This general concept is graphically represented in the Figure 2.

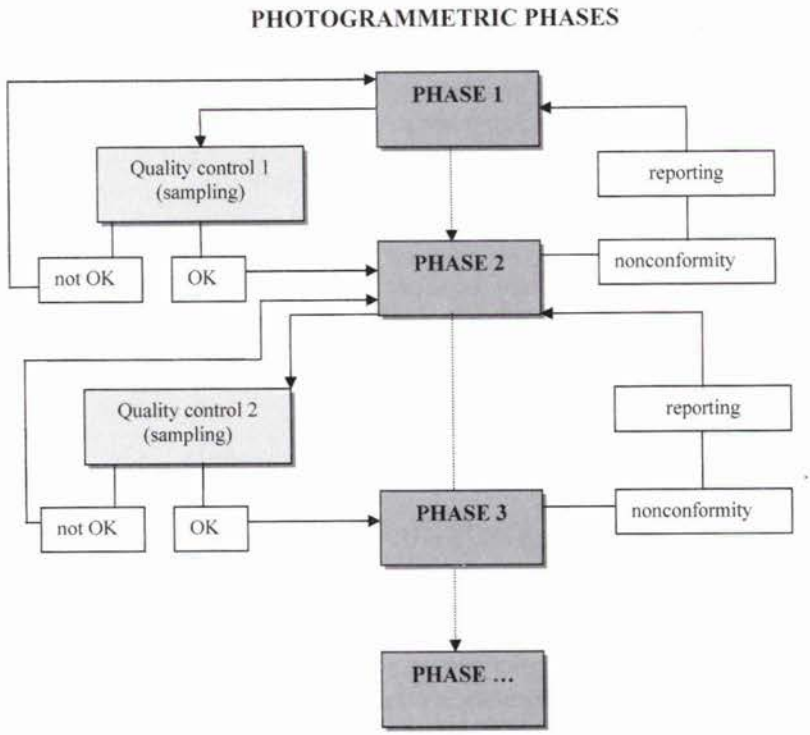

Figure 2. *General concept of quality control in photogrammetric projects.*

4.1 Managerial Aspect of the Proposed Quality Model

Decisions are no better than data on which they are based. Data quality program can help ensure that data are of the highest possible quality. The two of the five elements of TQM are directly connected with managerial aspect: attitude of mind and quality of the management processes.

Considering the attitude of mind, the most important recognition is that for successful implementation of TQM, it is necessary that decision is made at the very top management first. On the national level, this means, that a national strategic decision should be made for giving the quality very important place.

Considering the quality of the management processes, it is the most important that the top management supports TQM and assures resources for its implementation and than its continuous and gradual use in the practice. All employees should be involved in a quality process and should strive for improvements. Suitable training should be prepared for different working structures.

On the other hand, not only national or company level is of concern. Internationalization and globalization caused that spatial data are not produced only by national firms and institutions. We need to exchange data (near borders, to produce e.g. European map, for navigation, etc.). In the branches where the data quality and accuracy is of vital importance (e.g. hydrology maps, aerial navigation maps, etc.), there are already highly demanding quality standards (each data must be 100 % accurate and reliable).

It should be stressed that not only technical knowledge is needed for successful data quality management. Due to complex issues, a team work of different experts is advisable when developing and implementing spatial data quality concepts and models, being either on international, national or company level. Total quality management forms a solid and well-conceived framework for managing geographic information. However, its implementation will be in long-term assured also through implementation of international standards in the practice (e.g. through ISO 9000 family standards).

Additional training of the employees is of great importance, but more systematic approach would be *to introduce lectures of TQM already in formal education system* (e.g. at least at the university level).

To produce low-quality spatial data is costly in long-term. If users are not satisfied, they are searching for other better sources. It is very important to realize, that quality is a very important issue, especially because consumer (users) are more and more demanding and *quality products could be a strategic advantage* also in geoinformatics. It is important to assure the feedback information from data users. From my experience in Slovenia, this is often overlooked, since it is not really necessary to get the feedback from the users as data collection is financed mainly from the national budget. If the investor would be from private firm, there would be definitely more interest for good quality products.

The following *recommendations* are given from the managerial aspect of the proposed concept, I found to be the crucial for the implementation of TQM:

- willful decision for quality and introduction of TQM concepts and tools in all levels of the society, and in particular in National Mapping Agency,
- more emphasis on quality issue in national education programs ,
- harmonization of national standards with international standards; production of standards or technical specification for topics that there are not yet or not enough well presented.

4.2 Technical Aspect of the Proposed Quality Model

The three of the five elements of TQM are connected with technical aspect: quality of the product, quality assurance and quality control. The most important is the following statement of TQM: *"Quality should be achieved through understanding and improving processes, and by prevention, not by inspection and correction."*

Quality of the product is the final result of the successful working process. A general concept has already been introduced of the proposed quality model for photogrammetric projects. Quality assurance is assured with the implementation

of the concept and quality control should be performed in all phases of the complete process.

The author of this paper proposes to distinguish two different types of photogrammetric products: *basic products and final products*. An aerial photo or image with the corresponding elements of orientation is already a result of some photogrammetric phases – it could be assumed as a basic product. It is not necessary to accomplish all the phases in photogrammetric process in one production line, so these data could be stored in a database for further use. The quality of basic products is of very great importance as there is a direct influence on the final quality of spatial data acquired from this basic source. In the quality evaluation procedures, the type of data should be taken into account.

Basic products of photogrammetry are:

- photographs and/or digital images,
- orientation parameters.

Final products of photogrammetry are:

- topographic data (in maps or databases),
- digital elevation model / digital terrain model,
- digital orthophoto maps,
- 3D models, etc.

The following working phases are necessary to get the basic products:

- aerial survey (for photographs or images),
- field survey (for control and check points),
- scanning (if analog photos were taken),
- aerial triangulation (the results are orientation parameters).

After all these phases are accomplished and controlled, the basic products could be stored in a database (Figure 3). The production of final products starts from getting the basic products from the database. Quality basic products are the necessary condition that the final products could achieve the specified or requested quality. Thus, from the same sources, different firms can produce different products and there could not be overlaps of work. This approach is suitable for the national or regional level, where the basic products could be centrally collected and controlled. Of course, it could be implemented also on a company level.

Implementation of the presented model in Slovenia (Bric et al. 1999) followed three further sub-concepts: concept of phases, concept of quality control, and concept of basic photogrammetric products database.

A concept of phases:

- control points (CP) are permanent and targeted, measured only once and then only maintained,
- the working unit for aerial survey is photogrammetric block, division on block is standard, connected to CP targeting, a copy of film is produced for security reasons,

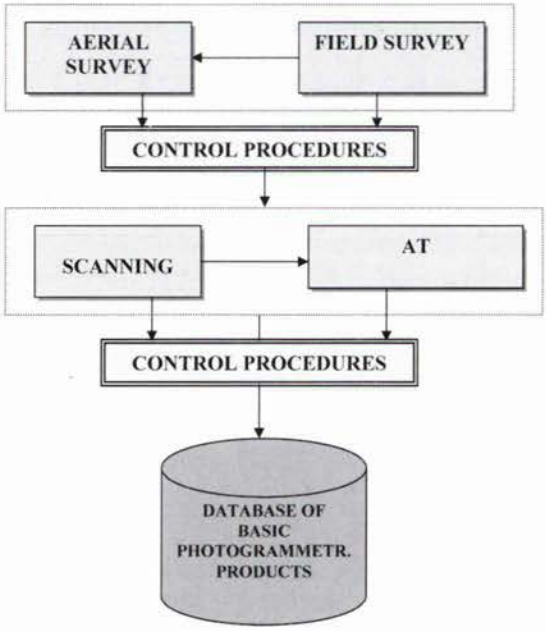

Figure 3. *Production phases of basic photogrammetric products.*

- all photos are scanned with precise photogrammetric scanner from original film,
- the working unit for aerial triangulation is photogrammetric block, only block adjustment is used, data acquisition on analytical instruments or digital photogrammetric workstations.

A concept of quality control:

- quality control is performed by national authority in cooperation with an authorized institution,
- for each phase technical specifications should be produced,
- phases are controlled in a framework of one contract,
- a positive evaluation of quality is necessary for starting with the subsequent phase.

A concept of database of basic photogrammetric products:

- database of basic photogrammetric products and databases of projects are separated,
- database of basic photogrammetric products include measurements, technical reports and results in analogue and digital form,
- operational projects get basic photogrammetric data only from the database of basic photogrammetric products,
- metadata from the database of photogrammetric data and databases of projects are available from the Web.

This approach is especially suitable for Slovenia. The photogrammetric projects are mostly financed by the Ministry of Environment – Surveying and Mapping Authority of the Republic of Slovenia, this means from the national budget. There is only one private company for aerial survey who provides aerial photos. As well, only a few firms are able to perform precise photogrammetric scanning and aerial triangulation. But there are quite many private firms for data collection. If basic products are assured at the national level, then it is easier to plan operational projects and to control the final products.

Some parts of the presented above concepts have already been implemented in Slovenia, in project of Cyclic Aerial Survey (CAS), targeting permanent control points, a database of basic photogrammetric products. Different options of targeting permanent control points in fixed photogrammetric blocks were analyzed and studied in a project (Gvozdanović et al. 2001). As photogrammetric blocks have been fixed in advance (photogrammetric block is one trigonometric section) it was possible to make a plan of permanent control points for aerial triangulation. This would simplify a surveying planning, reduce costs for aerial triangulation, yield to better reliability of aerial triangulation results due to more homogeneous disposition of control points, etc. The database of basic photogrammetric products has been established (Gvozdanović et al. 2000). Orientation parameters of photos computed in aerial triangulation are entered in the database, together with some other data (references to aerial survey project). Images (scanned photos) are stored separately as a file-database. Further on, a regular quality control of CAS photos, aerial triangulation and digital orthophoto maps started in 1999/2000 and is being accomplished by Geodetic Institute of Slovenia (Kosmatin Fras 2002). Detailed description of the technical procedures would exceed the scope of this paper.

The advantages of the proposed concept are transparency of phases, more simple and better planning, use of the same data in many projects, well defined standards for procedures, systematic quality control. However, technical specifications are not completely prepared, as well as measures and evaluation procedures using sound statistical methods are not sufficiently implemented in all projects.

5. Quality Assessment of Spatial Data

Many people equate accuracy of spatial data with quality of spatial data but in fact accuracy is just one component of quality. The basic spatial data quality components defined in the current international standards (ISO DIS 19113, CEN ENV 12656), are completeness, logical consistency, positional accuracy, temporal accuracy and thematic (or semantic – in CEN) accuracy. Additional general information includes lineage, usage, and purpose (in ISO) or homogeneity (in CEN). The terminology in both standards is different, but there is no real difference in the context. The Figure 4 gives these elements "at a glance". It is often difficult to refer a specific quality problem to specific quality component, as they are many relationships between these components.

A data quality evaluation procedure is accomplished through the application of one or more data quality evaluation methods. Data quality evaluation methods are divided into two main classes, direct and indirect. Direct methods determine data

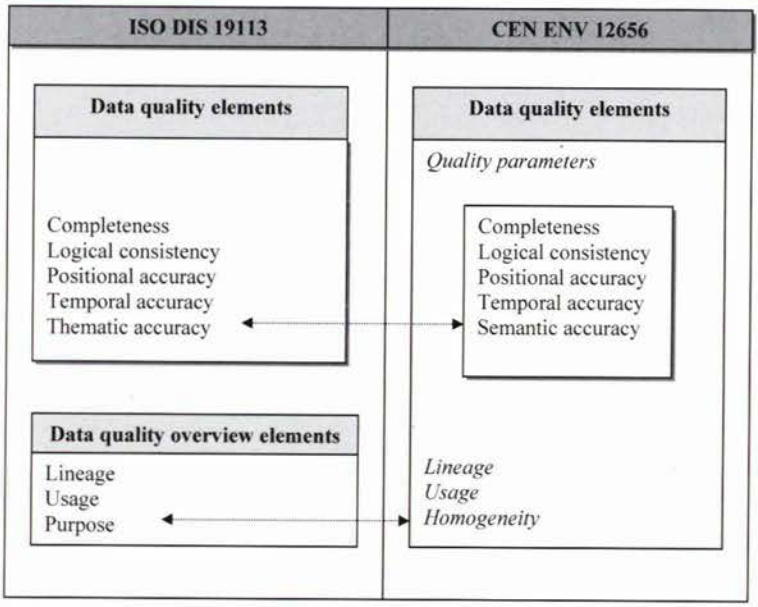

Figure 4. *Comparison of data quality components by ISO and CEN.*

quality through the comparison of the data with internal and/or external reference information. Indirect methods infer or estimate data quality using information on the data such as lineage.

To be able to implement the quality concept in the practice, there are two very important issues to be known and distinguished: *product specification* and *user requirements*. For a data producer, a product specification describes the application

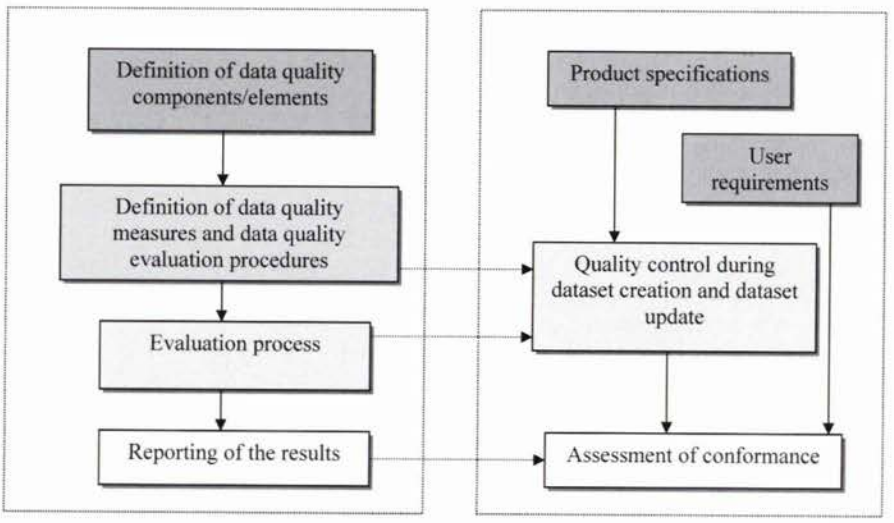

Figure 5. *The main phases of spatial data quality concept (ISO 19114).*

model and contains the parameters for constructing a dataset. For a data user, user requirements describe another application model, which may or may not match the dataset's application model. *The true quality of a dataset is how well it represents the application model based on product specification.*

Product specifications should be *set forth the production* of a dataset. User requirements should be defined before evaluating if a dataset satisfy the requirements for the particular application. When developing a product specification or user requirement, quality evaluation procedures may be used to assist in establishing conformance quality levels that should be met by the final product. A product specification or user requirement should include conformance quality levels for the dataset and quality evaluation procedures to be applied during production and updating.

6. Conclusions

It is important to realize that quality does not happen just by itself. Quality requires a conscious society and devotion that starts from the very top structures and ends at the last worker. There are still some research problems in spatial data quality management that should be solved in the future. Sampling methods for spatial datasets have to be more investigated, tested and ready prepared for the practice. There are certainly different approaches suitable for topographical map, cadastral map or sea chart, for example. Evaluation methods should be precisely defined for each quality parameter. To my opinion, simple and robust statistical methods should be more widely used in the practice for spatial data quality control, so that even not highly educated personnel involved in a quality system is able to understand and use them. More advanced methods could be implemented in special tasks and research works by highly educated teams. Good specifications must be prepared in advance of the data collection. Of course, specifications are ideals that are not possible to reach in total, thus tolerances and acceptable quality levels must be defined in advance as well. A great problem in the practice occurs when specifications are changing due to different reasons in the course of the project.

The situation in Slovenia has been improved much in the last few years regarding the controlling the spatial data production. Introduction of quality control procedures in some photogrammetric projects (e.g. aerial survey, aerial triangulation, digital orthophoto maps, DTM) yields significantly to better data quality, thus we are encouraged to continue and to further develop a general spatial data quality model. Currently, a research project was supported from the Surveying and Mapping Authority and the Ministry of education, science and sport, to develop a quality control system for national spatial data.

The prospects for international community are certainly to further develop and harmonize international standards. They should become more user-friendly and intelligible. On the Slovenian national level, national standards should be further developed and harmonized with international standards. Statistical methods should be more used in quality evaluation processes. A reasonable amount of financial means must be assigned for quality management. However, this should be re-

turned from reduced costs due to bad work and from better data quality. It would be a good idea to establish a "customer service" on the national level that will follow and receive the user's needs and complaints and forward them in a concise way back to the researcher and developer. Last but not least, a great challenge of the future is 3D visualization of spatial data that gives ruthlessly evidence of errors in any inconsistencies in datasets.

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Model kvalitete u fotogrametriji utemeljen na potpunoj kontroli kvalitete

SAŽETAK. Globalna proizvodnja svih vrsta prostornih podataka se povećava, pa je i kontrola kvalitete postala jedno od glavnih pitanja. Osnovni cilj ovog rada je autoričin prijedlog idejnog modela kvalitete za fotogrametrijske projekte koji se sastoji od kontrolnih i tehničkih aspekata i uzima u obzir načela potpune kontrole kvalitete. Navedene su definicije pojmova kvalitete i načela potpune kontrole kvalitete. Dan je kratki pregled međunarodnih normi za zemljopisne podatke kao i doprinosa pojedinih stručnih udruga kontroli kvalitete prostornih podataka. Predlaže se da se razluče dvije različite vrste fotogrametrijskih proizvoda: osnovni i konačni. Primjena potpune kontrole kvalitete u fotogrametrijskim projektima vodi prema boljoj konačnoj kvaliteti sakupljenih podataka, boljem razumijevanju i pouzdanoj interpretaciji parametara kvalitete, te dugoročnom smanjenju troškova po podatku. Neki nedavno dobiveni rezultati u slovenskim nacionalnim projektima to već dokazuju.

Ključne riječi: fotogrametrija, potpuno kontrola kvalitete, model kvalitete, međunarodne norme.

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