Interoperability of Standards and Models in Official Statistics

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Abstract. *In Croatian Central Bureau of Statistics (CBS) an Integrated Statistical Information System (ISIS) is built using in its core Croatian Statistical Metadata Repository (CROMETA). ISIS is a multilingual platform intended for generic approach to various statistical surveys using standardized processes for producing standardized statistical outputs.*

An analysis of the development designs, tools and underlying standards used in projects for development of ISIS will be presented. Also, authors will present the current state of usage of ISIS and analyze the possibility of aligning CBS' ISIS with currently emerging standards in official statistics.

Keywords. Statistical Metadata, Generic Systems, Official Statistics' Standards and Models, Interoperability

1 Introduction

Increasing requirements to be met by official statistics and resources that have been shrinking for years require new ways of producing statistics. The statistical offices have therefore set themselves the goal of standardizing and optimizing sub-processes of statistics production and of creating (IT) tools which can be applied across various sets of statistics [14].

Numerous projects concerning metadata issues, standards and concepts in official statistics have been undertaken in previous decades. Some of the examples are *A network of excellence for harmonizing and synthesizing the development of statistical metadata, MetaNet project* [1], *Statistical Metadata, METIS project* [13], *Management of Statistical Information Systems, MSIS project* [10] and in Croatia *CBS-ISIS project* [8]. These projects developed a valuable knowledge base for the development of Integrated Statistical Information Systems, based on metadata repositories using metadata driven approach in their implementations. A Common Metadata Framework (CMF) [16] is an online brochure developed and available under the METIS project. It is divided into four parts, each of which concentrates on different practical and theoretical aspects of statistical metadata systems, and provides vital knowledge for anyone working with statistical metadata. Especially important for the development of official statistics are the constantly evolving models and standards aimed at standardizing information models and processes among all the National Statistical Offices (NSOs), like the Generic Statistical Information Model (GSIM) [6] and the Generic Statistical Business Process Model (GSBPM) [18].

The CBS' Metadata Strategy, aimed at implementing the metadata methodology in the development of CBS' Information Systems (ISs), was prepared in 2001 and in 2002 a framework agreement was signed between Division for Western Balkans and Swedish International Development Cooperation Agency (SIDA) by which Swedish Statistical Office (SCB) provided support for the creation of the public macro database and a central metadata repository in CBS. In its final phases (2006-2007) the project was extended to support the development of the ISIS [7].

There were three principal reasons to implement metadata in the development of CBS' ISIS:

- to standardize definitions across all statistical activities
- to move the production of statistics closer to the subject-matter experts in order to speed up the statistical survey life cycle
- to present statistics on the internet along with its context in order to make statistics understandable and available to users of all types, i.e. to extend the use of statistics beyond the usual statistical publications [7].

In Germany process standardization started in 2003 when a relevant decision was taken as part of the Master Plan for the Reform of Official Statistics. To co-ordinate the plan across the network of

statistical offices, the SteP Working Group was then set up. Members are representatives of IT and specialized departments of the statistical offices of the Federation and the Länder. Since the end of 2009, each statistical office has had a SteP officer. SteP comprises two major tasks:

1. Describing and implementing standardized processes in statistics production
2. Developing relevant standard (IT) tools and interfaces [14].

Involving the SteP officers of the Federation and the Länder in the development of IT projects is required by the Vorgehensmodell der Amtlichen Statistik (VMAS – Procedural Guidelines for Official Statistics) as amended in 2011. In this way, the standard tools presented are successively implemented in the statistical processes [14].

Development of ISIS is still an on-going effort as it is a system constantly evolving to support as many of statistical surveys as needed in a standardized manner.

This paper is aimed at explaining the complex steps and cycles used in the development of ISIS, involving the use of relevant standards and methodologies in official statistics, which could be used as an example for building similar complex ISs in official statistics, or other implementation areas.

2 Central Metadata Repository

CROMETA is derived from MetaNet project Reference Model concepts within Eurostat (2000-2003) [9].

The aim of the Neuchâtel group was to clarify some basic concepts and to arrive at a common terminology for classification systems and database objects, i.e. metadata terminology model used across various statistical surveys. The Neuchâtel terminology model: Classification database object types and their attributes, version 2.0, was released in 2002. It was essential for the Neuchâtel group that the terminology should be flexible and independent of the IT software and platforms. This resulted in different classification database implementations, attuned to the specific needs and policies, for the participating NSOs. It was always an important premise for the group that the work should be public and available to anyone free of charge. Many countries have at least partially implemented the model. These include Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Germany, Greece, Ireland, Norway, Portugal, Slovak Republic, Slovenia, Sweden, Switzerland and the Netherlands [3].

The CROMETA model contains Neuchâtel Reference Model concepts extended and customized for CBS' needs as well as specifics of a previous CBS metadata model and specifics needed to run PC-Axis as the main dissemination tool. Now the metadata database is stable, with high tolerance for occasional changes that occur along with development of specific solutions for particular stages of the statistical life cycle [7].

CROMETA has nine groups or sections of metadata:

1. Organizational structure,
2. Variables and measurements,
3. Studies and questionnaires,
4. Classifications,
5. Publications,
6. Processing and validation rules,
7. General,
8. Access and authorization rules,
9. History and version handling [7].

Metadata objects in each section are closely related, but there are relationships between metadata from different sections [7].

The central metadata repository (CROMETA) is the essential part, the core of the ISIS. In other words, ISIS is developed upon CROMETA [7].

A central database was the preferred solution because it realized several important principles of metadata – document and update once (centrally), and reuse wherever it is relevant [3].

3 Integrated Statistical IS

Integrated ISs, based on metadata repositories, are ISs consisting of different interconnected subsystems which use the same base, i.e. central repositories. Repositories are often bilingual or multilingual. Afore mentioned ISs cooperate and exchange data and metadata and also, in some cases, create new data and metadata.

The metadata repository must contain all the necessary information to be used as parameters for a general "program" that produces specific operating procedures for particular surveys [7].

ISIS is, therefore, a metadata-driven, more or less automatic statistical information system, built upon a comprehensive metadata management system [7].

There are several customized tools developed in CBS that support different aspects of **ISIS**: metadata maintenance tool **Metadata Manager**, survey processing tool **Survey Processor** and a tool for data tabulation/aggregation **Warehouse Browser** [8].

CROMETA Metadata Manager features a Windows-like interface. This is the tool which provides a memorable, graphical, user-friendly interface for adding, browsing, editing and generally maintaining metadata. Basically everything that could be done to metadata could be achieved here, given you have the appropriate privileges to the metadata you are aiming for [7].

Survey processor application is the most important consumer of metadata in CBS. This is a metadata-driven application for automatic survey processing. Survey processor is not only a consumer but also a producer of metadata. Metadata is captured

during survey processing because it is the natural place where processing metadata is created. This metadata is immediately stored in the central repository. When a survey is processed, then the following metadata are created: populations, questionnaires, questions, context variables, matrix variables, matrices, registers, cubes, tables, etc. This metadata can be easily used in the metadata management tool to create new versions for next processing periods [7].

Warehouse Browser is used to create cubes or ready-to-use tables and customize reports in various formats for printing or on-line publishing [8].

Table 1 presents a summary of various technical implementations, i.e. applications used to support the development of different parts of ISIS and to support the overall managing of the project.

3.2 ISIS' Standardized Business Processes

One of the main reasons for the decision to develop a generic system for statistical survey processing at CBS was because the majority of surveys have similar processing stages (data entry, validation, correction, tabulation, dissemination) and therefore the majority of corresponding data processing jobs has similar structure which could be incorporated in a generalized solution [7].

Table 1. ISIS Technical Implementations

ISIS		Sybase Power Designer 9.5	Microsoft SQL Server	Microsoft VB .NET	Microsoft Visual Source Safe	SharePoint Portal Server	Microsoft Project
CROMETA	Conceptual Data Model	■					
	Physical Data Model	■	■				
Metadata Manager				■	■		
Survey Processor				■	■		
IT Development Management						■	■
Project Management							■

3.1 Layered Architecture of ISIS

In developing integrated ISs the complexity of the development itself, as well as the overall demand on reusability of features, suggests the need for the layered development approach – the approach which is based on the principle of dividing the system in subsystems, i.e. layers. As in [5] multi-layer architecture is concerned with the logical and physical partitioning of data (and metadata) and code into packages which support reuse. In this way an easier to maintain and more scalable system is achieved as output of the development efforts.

Layered architecture development approach has been introduced from the start of the development of ISIS in Croatia and it has proven to be very successful, enabling large and diversified team members' contribution. For facilitating access and handling of different versions the collaborative software was used. Collaborative software, as defined in [15], enables multiple users to jointly work on a project, enabling online sharing, processing and management of files, documents and other data types.

It is useful to have a description of the production process that encompasses all types of surveys and statistical products – the generic statistical production process. This description covers, for instance, data collection from all sources and with all modes, including mixtures (administrative data, direct data collection by telephone, web etc.). The centralization has several reasons, for instance to facilitate process orientation and new competence, also to avoid the former decentralized situation for IT and methodology with small department groups and many single persons in subject matter units [2].

The current strategic approach of Statistics Estonia has been to develop only generic office-wide software, but whenever possible to use commercial statistical software (SAS, SPSS, etc.) or software developed by other members of the international statistical community [12].

Generic Statistical Business Process Model (GSBPM) [18] is a model that identifies the steps in the statistical business process and the inter-dependencies between them. It is a part of the CMF which is aimed at introducing standards in metadata implementation and development of metadata driven

systems for producing and disseminating official statistics. In regards to introducing and implementing changes in statistical processes and statistical survey's organization and implementations, a new version of GSBPM (v. 5.0) was released in December 2013.

In Croatia a business process model used for official statistics' production systems (and development of ISs) is very similar to that of GSBPM. The majority of CBS's statistical surveys are processed in 9 steps presented in Table 2 [7].

CBS designed and developed a software that could produce (generate) programs needed, based on the on-line input of parameters. The statistician would enter basic data on the survey (owner, periodicity, basic descriptions etc.) while programmers enter other data (record definitions, processing order of particular steps etc.). On the basis of all these data some programs are automatically produced and some programs still need to be done tailor-made. Once the necessary software had been produced, the programs are run either by the statistician(s) or by the IT expert in charge. For large surveys, steps 4 - 6 are carried out by a special data editing unit [7].

By process standardization, the following goals should be achieved:

- reducing the variety and complexity of statistics production
- reducing the burden on respondents through online reporting procedures
- reducing the burden on the specialized units by process automization
- earlier provision of procedures by using standards
- providing standard tools and interfaces in the network of statistical offices that can be applied to various sets of statistics
- improving quality and transparency in statistics production [14].

Table 2. CBS' statistical survey processing steps

	CBS statistical survey steps
1	Planning all activities
2	Survey design and description
3	Data capture and file transfer
4	Validity checking against pre-set rules and producing error-list to be presented to the statistician in charge
5	Online correction
6	Tabulation, i.e. producing statistics for statisticians' supervision
7	Publishing, i.e. producing first releases and other statistics
8	Archiving
9	Monitoring

Table 3. ISIS Classification of the GSBPM phases and allocation of user groups

	Users				GSBPM phase									IT tools
	Specialised unit	IT organisers	IT developers	External / other users	1. Specify needs	2. Design	3. Build	4. Collect	5. Process	6. Analyse	7. Disseminate	8. Archive	9. Evaluate	Monitoring	
Documentation			■		■										Methodology explained in text editor documents
Survey Database - CROMETA	■	■				■									SQL DBs with metadata information using MDDA Metadata Manager
SP Module: Population			■			■									SQL tables containing list of response units using MDDA
SP Module: Survey Design			■			■	■								MDDA using CROMETA DB
SP Module: Module: Data import			■					■							SQL bulk data import / flat file import using MDDA
SP Module:Validation	■								■						SQL scripts using MDDA representation of results
SP Module: Data cleaning			■							■					MDDA
SP Module: Tabulation	■			■							■				SQL scripts, PC Axis, Excel reports, SAS reports, PDF publications
Archiving	■			■								■			Manual or automatic backups
SP Module: Monitoring	■	■	■											■	MDDA using CROMETA

SP – Survey Processor; MDDA – Metadata Driven Application ■ - specify/develop ■ -use output

3.3 ISIS as a Multilingual Platform

Bilingual (or multilingual) software application, as [11] must allow for data to be entered, processed, stored and presented bilingually (or multilingually), and these applications should support equal treatment of all languages. Users should have the freedom to

change the preferred language of the interface at any time in interaction with the system.

CROMETA Metadata Manager supports an indefinite number of languages. Furthermore, also the interface itself supports several languages. Hence it could be customized for any language [7].

For building user interfaces four structuring approaches are introduced in Welsh Language Board's Bilingual Software Guidelines and Standards Brochure [19]. In order of sophistication and capability these are:

(1) Parallel/Mixed text – one version of the application is produced containing equivalent English and Welsh displayed,

(2) Parallel Mirroring – two versions of application are produced with the ability to switch between them,

(3) Switchable Embedded Content – one version of the application is produced, text for the two languages are embedded within the application, usually at the user interface layer,

(4) Resource-Based – one version of the application is produced with the text for each language stored in a data store outside the application.

ISIS is built according to the Resource-Based principle, the 4th approach in [19], enabling easy reuse of objects stored in the metadata repository and other databases.

4 Development of ISIS in Steps

According to the research on development of ISIS it can be concluded that the logical cycle of development and usage of integrated ISs, developed using multilingual metadata repositories in the core of the system, usually implies a complex list of steps to be taken. These steps are graphically presented in Fig. 1.

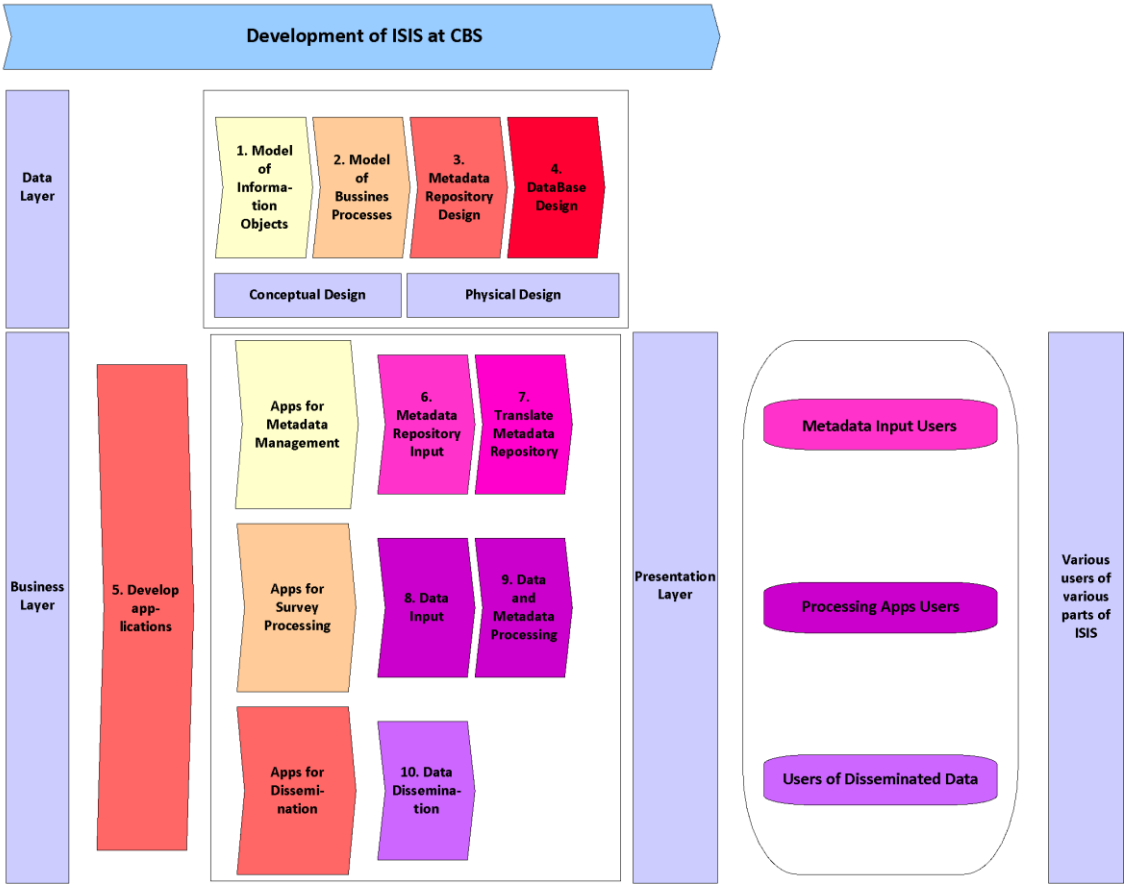

Figure 1. Steps in development of CBS' ISIS

The steps in the development of ISIS included the following:

(1) Designing / obtaining a model of information objects, i.e. list of entities (i.e. persons, organizations) and their attributes and relationships between the entities, i.e. developing conceptual metadata database model,

(2) Designing / obtaining the model of business processes, i.e. the list of business processes in CBS' statistical surveys processing,

(3) Designing the metadata repository (metadata database), i.e. developing a physical metadata database,

(4) Designing a relational database of entities and relationships in the system, i.e. developing physical data database,

(5) Developing / implementing multilingual metadata driven applications and services for data input, processing and dissemination,

(6) Developing / implementing a metadata repository specific for the statistical survey,

(7) Translating metadata repository into English language,

(8) Developing / using metadata repositories and metadata driven applications and services to manage data input,

(9) Developing / using metadata repositories and metadata driven applications and services to manage metadata and statistical survey processing,

(10) Developing / using metadata repositories and metadata driven applications and services to manage dissemination of statistical outputs.

Reusing already developed repositories and functionalities and extending the possibilities of the integrated IS is possible, according to the new requirements and users' needs, thanks to the clever design of the system and the use of very sophisticated methodology based on grounds of very stable and solid models and standards in official statistics.

The presented development methodology, and the complex development cycles involved, could be an illustrative example to someone facing with similar needs of development of complex system for management of their business processes, regardless of the area of work.

5 ISIS' Current Use

ISIS handles the architecture of data and metadata repositories, design of surveys, process oriented approach to statistical production, standardization of datasets and processes, implementation of standard tools and solutions, and facilitates and provides convenient documentation for users of the system.

All assessments proclaimed the project as very successful and the work done was considered as a model for other countries in the region [7].

While developing multilingual ISs, language should certainly be considered as a key part of the software right from the start of the development. Adding support for other languages later in the development cycle is not a wise approach because it could result with a lot of additional repercussions and, possibly, with an unstable and demanding system maintenance-vice. In the development of ISIS language was considered as a key part of the software right from the start and this is one more reason for the success of the project.

The conclusions about the results of implementation of the generic IS in Estonian NSI could be applied to Croatian case. In [12] an office-wide generic software could be developed, but hardly implemented, if there is no central department acting as the owner and main user of that software More statistical domains have benefitted, even though at the same time great efforts have been made for the standardization of methods and working routines. But at the same time, the software itself is not enough – usually, organizational changes are also needed.

Currently ISIS is being more and more exploited as many of statistical surveys are being migrated from older IT platforms used in CBS to the ISIS platform.

CROMETA has added functionality as well as quality to the system for producing official statistics in Croatia through at least four aspects:

1. well-described and uniformed metadata, i.e. all information on statistical surveys and statistics in one place,
2. using same classifications, registers and address lists (nowadays, they are different for each survey and not maintained centrally),
3. speed up all the processes in the statistical survey life cycle and bring down the time needed to establish a new survey,
4. better control over statistical surveys in general and data processing in particular [7].

A multilingual metadata repository contains stored metadata translated into English. The underlying logic of the business layer in ISIS is using the knowledge of the preferable language and producing the desired outputs by pulling metadata in the desired language from the database. In this way ISIS expands the possibilities and the role of databases. Databases become, in a way, specialized communication systems for knowledge deposition as well as knowledge reuse. ISIS' repositories enable a simple way of adding new language translations of metadata to support new extensions of the system. Use of generic approach in ISIS does not require tailor-made programming for the new extensions of the ISs. Furthermore ISIS enables direct usage by experts from the area and provides a possibility for the expert to design new functionalities for the IS's subsystems. These kind of generic ISs are also acknowledged for fostering a better cooperation in the organization as well as between other organizations in the same area of expertise. ISIS enables recording of knowledge from the experts in the area to the IS repository and in that sense is valuable in saving the previously gained knowledge of the organization for the future.

6 Interoperability of Standards and Models in Official Statistics

Another standard in statistical information modeling is the Generic Statistical Information Model (GSIM). GSIM is a reference framework of information

objects enabling generic descriptions of data and metadata throughout the statistical process. The first version of GSIM had been released in December 2012. A new version of GSIM was released in January 2014. The model is conceptual, intended to provide a framework through which statistical offices can describe their designs, processes, artefacts, and data, i.e. statistical objects. This includes statistical classifications, categories sets, and code sets – the subject of the Neuchâtel Classification Model (NCM). So, one obvious question is whether the GSIM and NCM describe classifications, category sets, and code sets in a compatible way [4].

High-level Group for the Modernization of Statistical Production and Services and the projects that have been spawned by it, for example the development of the GSIM, draws heavily from the Neuchâtel Terminology Model for the information objects in the GSIM Concepts Group. At the 2011 METIS Workshop, participants discussed the need to revise the Neuchâtel Classification Model. It was agreed that the revision of NCM should take into consideration the mapping of Neuchâtel terminology into that of GSIM, DDI and SDMX [3].

The SDMX (Statistical Data and Metadata eXchange) standards do not provide a model for statistical business processes in the same sense as the GSBPM. However they do provide standard terminology for statistical data and metadata, as well as technical standards and content-oriented guidelines for data and metadata transfer, which could be applied between sub-processes within a statistical organization [17].

The DDI 3 Combined Life Cycle Model has been developed within the Data Documentation Initiative (DDI), an international effort to establish a standard for technical documentation describing social science data. The DDI Alliance comprises mainly academic and research institutions, hence the scope of the model is rather different to the GSBPM, which specifically applies to official statistical organizations. Despite this, the statistical business process appears to be quite similar between official and non-official statistics producers, as is clear from the high level of consistency between the models [17].

There is growing interest in official statistics in using DDI 3 for microdata in combination with SDMX (Statistical Data and Metadata eXchange) standards as more appropriate for macrodata [17].

7 Conclusion

One of the major drivers behind the development of GSIM is the idea of standardizing statistical production. This means the standards, models, and other specifications used to describe the work of statistical offices need to be mapped to show, within their scopes, the same kinds of statistical objects are described in translatable ways. If descriptions are not translatable, then there are fundamental incompatibilities among them. This might mean the entire metadata and modeling question must be revisited, this time on the level of models (e.g. GSIM and NCM) themselves, rather than on the level of statistical objects the models describe [4].

From the results of the study concerned with the possibility of mapping the NCM classification model to GSIM terminology model [4] it can be concluded that NCM is translatable to GSIM and this is very important for the future of ISIS, because it opens the possibility for extending the system to support the implementation of currently emerging standards aimed at harmonizing official statistics metadata, data processing and dissemination, involved documentation and processes across all the European NSOs.

ISIS, as a multilingual platform based on use of solid standards and standardized methodologies, could be implemented in an international context for official statistics' data processing and dissemination, as well as for handling data documentation. However, in that case, it would be necessary to provide proper technical support in implementation and tuning of the system.

Finally, since ISIS was developed in a cooperation project between two EU member states, Croatia and Sweden, a question of copyright should be taken into account as well.

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