Process Analysis of Environmental Reporting

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Abstract: Paper outlines current trends in environmental information management in the Czech Republic specifically in the field of environmental reporting systems. The paper also presents selected results of two research projects "Analysis and Design of Environmental Data Models and External Czech Environmental Information System Interfaces Compatible with the EU" and "Proposal of Communication Framework with International Environmental Information Systems". The paper furthermore discusses the developed web based information system Central Data Model which facilitates the management and monitoring of the reporting activities that the Czech Republic demands. During the development of environmental reporting (on national and international levels) system the Unified Modelling Language was used for process modelling and for the design. Results are applicable not only in the area of public administration but also in the field of business environmental communication and environmental and sustainability corporate reporting. The global central data model for environmental information exchange and reporting purposes has been designed to perform systematic attributing, thereby providing a basis for a central output data warehouse to meet reporting obligations.

Keywords: Process Analysis, Environmental Information Systems, Information Management, Environmental Reporting, Unified Modelling Language, Select Perspective Methodology.

1.   INTRODUCTION

Within the framework of the Corporate Environmental Information System (CEIS), the Ministry of the Environment (ME) of the Czech Republic (CR) and The Czech Environmental Information Agency (CENIA) systematically collect primary environmental data through monitoring, statistical research and recording. An example of significant data source is monitoring network of Czech Hydrometeorological Institute and Czech water research Institute. After consolidation, primary environmental data are stored in the CEIS as validated data and the chosen environmental information and indicators are processed by the Reporting Information System (RIS) and published. Reporting [Directive, 1999] (i.e. providing in-formation to the European Commission (EC) on a regular basis) is defined as the preparation of reports on the implementation of certain directives and a regular submission of these reports to the EC, or to the European Environment Agency (EEA) using the European Environmental Information and Observation Network (EIONET), see [Hrebícek, Pitner, Rácek, 2004, 2005]. The EIONET includes many offices, institutes and organisations of member states of the European Union (EU) and its affiliated countries. The EEA coordinate environmental data exchange with national repositories of member states of EU by means of the REPORTNET system, see Figure 1.

Figure 1. REPORNET system (source: the EEA)

Currently, it is not possible to make any direct reporting from the Czech Corporate Environmental Information System into the RIS and then through Czech national repositories into REPORTNET and European repositories due to different attributing, technology and methodology, [Hrebícek, Pitner, Rácek, 2004, 2005].

2. INTERNATIONAL ENVIRONMENTAL REPORTING OF THE CZECH REPUBLIC

The project "Analysis and Design of Environmental Data Models and External Czech Environmental Information System Interfaces Compatible with the EU" funded by the ME has been solved at Masaryk University (MU) in Brno from October 2003 to February 2006 [Hrebícek et al., 2005]. The research team followed ideas of Denzer [2005], where the question, how different environmental information systems can be integrated in a generic way, is discussed. The second project "Proposal of Communication Framework with International Environmental Information Systems" [Hrebícek et al., 2005a] started in January 2005. The common objectives of both projects (mostly of the first) are:

- Perform a complete analysis of the current requirements for environmental reporting and for environmental data models and external interfaces, from both national and international viewpoints;

- Perform analyses of significant data sources from the point of view of attributing and methodologies;

- Design and implement an exchangeable national central data model (CDM);

- Prepare the conversion of the existing information sources of the CEIS into the CDM;

- Integrate the CDM into the existing structures of the CEIS and the REPORNET to create Czech national repository for the efficient exchange of environmental data and information at both the national and international level.

A common output of these projects is the web information system CDM (http://www.cba.muni.cz/cdm) for the management of national and international environmental reporting, which is implemented in the CENIA. The CDM is described further in this paper together with the methodology of the solution. Its analysis consists of two basic parts:

- Analysis of the reporting obligation and processes given by legislation;

- Analysis of significant national data sources.

The aim of the first part was to identify the reporting processes included in the national and European legislation, to specify data structures of the relevant reports and then to make a comparison of the identified processes and data structures. When analysing reporting obligations, investigators Hrebícek, Pitner, Rácek, [2004, 2004a, 2005] have chosen the simple procedure:

$$Regulation \rightarrow Process \rightarrow Data$$

This procedure respects the basic structure of the components of the web information system of the EEA, and involves the following three steps [EEA, 2004]:

- Finding the relevant legislative regulations,

- Identification of the reporting processes implied by these regulations,

- Specification of data produced in these processes.

The second part of the analysis has been oriented to the Czech national data sources which are used for environmental reporting. This entails the identification of significant environmental data sources (information systems of the CEIS) in the CR, analysing and describing their internal data formats, finding their relation with reporting processes and designing data interfaces between data sources and the reporting management system.

3. PROPOSAL OF GLOBAL ARCHITECTURE OF THE ENVIRONMENTAL REPORTING INFORMATION SYSTEM

When creating standards for environmental reporting and a communication framework in the Czech republic using information and communication technology (ICT), it has been necessary to find a common understanding and consensus with European trends [Denzer, 2005]. It is expected that the proposed standards from projects would allow users (stakeholders, decision makers, public administration bodies, business organisation, academicians and citizens) to seamlessly interoperate and interchange environmental data and information on national and international levels. It has been anticipated to enable the use of not only environmental information and data, but also public information and data created or collected in other domains, areas, times, situations, etc. by statistical offices,

ministries, universities and institutes of the Academy of Sciences of the CR [Hrebícek., Pitner, Benko, 2003].

The web information system CDM presents all environmental reporting activities and their reporting processes that are described as process definition and stored in the reporting process repository. The CDM function of the process definition is to describe a reporting process in a form which supports automated manipulation, such as modelling, or enactment by a workflow management system. The process definition consists of a network of activities and their relationships, criteria to indicate the start and termination of the process, and information about the individual activities, such as participants, associated ICT applications and data [Hrebícek et al., 2005]. Processes are invoked automatically by the CDM and ME reporters take information about tasks that they should do. Finished reports are stored in a special repository. The fact, that data formats of all reports are described inside the process definitions, enables the creation of the global data model of the whole environmental reporting, or the creation of a data model for selected group of reporting obligations. The basic functions of the system CDM is shown in Figure 2.
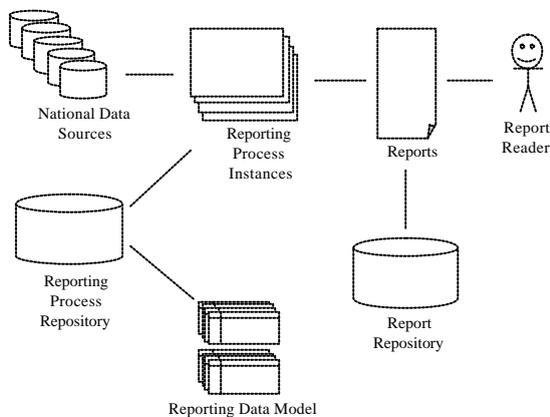

Figure 2. The basic architecture of the management system for the environmental reporting

4. ANALYSIS AND DESIGN METHODOLOGY

A modified framework of the SELECT Perspective methodology (http://www.selectbs.com) has been used during development of CDM information system as a methodology for analysis and design. The modification consists of using Unified Modelling Language (UML) at the beginning phases of the analysis not only for system architecture description but also for Business

Process Modelling (BPM) [Rumbaugh et al., 1991] [BPM, 2003].

Usually, the system analysis has two main phases. The first phase was Business Process Reengineering (BPR) when significant processes have been identified. During BPR, these processes have been modeled into the form of a UML activity diagram and a process hierarchy structure was built. Then the process hierarchy was transformed to use case structure. Usually one elemental process in Process Hierarchy Diagram (PHD) has been transformed into one use case as shown in Figure 3.
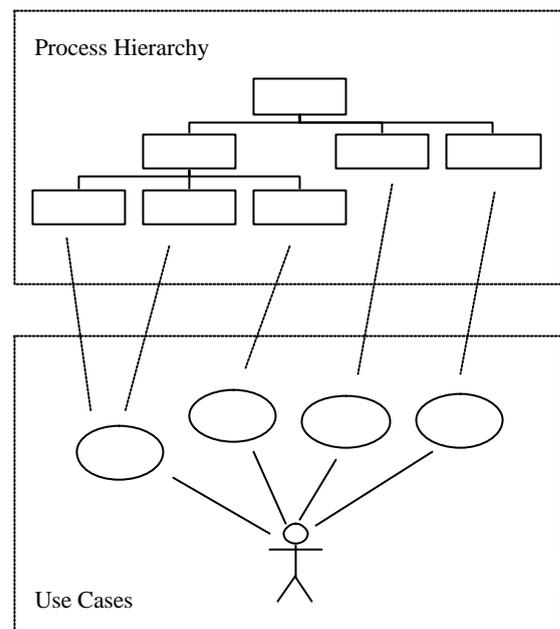
Figure 3. Transformation of process hierarchy diagram into the use case diagram.

In this way results of process analyses have been used as a base for high level design of management information system of environmental reporting. Described reporting processes have been transformed into the system use cases.

The Object Modeling Technique (OMT) has been used in the second phase to describe and decompose use cases. OMT was developed by Rumbaugh as a method to develop object-oriented systems, and to support object-oriented programming [Rumbaugh, Jacobson, and Booch, 2004]. Together with typical UML models used by OMT also some other UML tools have been used to make models of reporting processes and reports.

The new UML tools used during this part of analysis are activity diagrams, state machine diagrams and time diagrams. An activity diagram offers a base view of reporting process and is used to display the sequence of reporting activities.

Activity diagram shows the workflow from a reporting process start point to the finish point detailing the decision paths that exist in the progression of events contained in the activity.

A state machine diagram models the behavior of a single environmental report, specifying the sequence of events that a report goes through during its lifetime. UML timing diagrams are used to display the changes in states or values of reports over time. Moreover, it also shows the interaction between timed events and the time and duration constraints that govern them.

5. IMPLEMENTATION OF THE SYSTEM

The system CDM is implemented on the web server of the CENIA. It distinguishes two types of authenticated users. The first user type is the *Analyst*, who can insert, update and delete data coming from legislation analysis. It can also create requests and search the system database for information. The second user type is the *Person* who can search and read information from the system database, but does not have permission to change the data. This typical user is an official from the ME who supervises the project.
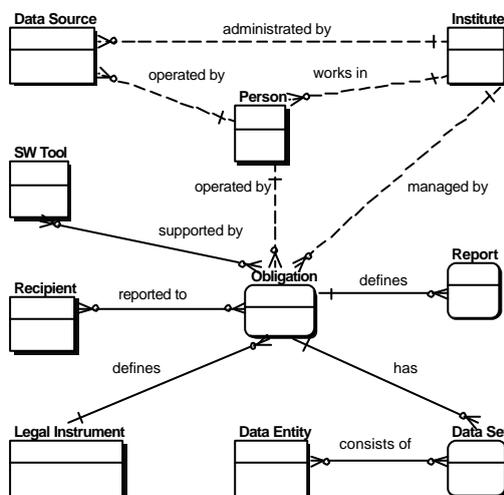
Figure 4. The basic architecture of the management system for the environmental reporting

The CDM system uses five Oracle basic data stores. Information about legislative regulations is stored in the *Legal instruments* data store where the international and legislative context of the reporting is placed. This part of the system is fully compatible with the ROD system of the EEA [EEA, 2004] and is automatically updated from this database.

Information about identified reporting obligations and their data formats are placed in the data store *Obligation*. Thus the entity includes attributes giving information about the report dates, periodicity, responsible persons, process scenario, subsidiary applications and tools, report recipients as well as input and output formats. The basic structure of the obligation entity complies with the structure used in the ROD system but other attributes respecting the national level have also been added.

Information about reports is stored in the entity *Report*. Data set formats of reports are placed in the *Data set* data store. The report data structure is recorded in the entities *Entity* including information about data attributes and relationships. This enables an automatic generation of the actual data structure of selected reports within the time period specified.

The main entities describing the national structure of reporting are the *Person* and *Institute*, holding information about all the response persons and institutions participating in the environmental reporting of the Czech Republic. The entity *Data Source* is containing metadata about more then forty environmental information systems of the CEIS, and the entity *Tool* is describing the software tools for reporting. The information about compiled and completed reports is stored in the entity *Report*.

Figure 5. Screenshot of CDM system – Reporting obligation list

The CDM system offers a lot of primary functions. The group of editing functions inserts, up-dates and deletes data of all entities and configures reporting obligations and reporting processes in the system. The system search functions are based on SQL technology and are oriented mainly (but not only) to information about reporting obligations and their datasets. Searching of a reporting obligation can be done by combination of 17 requirements and constraints. For example, system enables to generate a group of actual reporting obligation of selected institute or person in random time period and generate the data model

and the list of data sources which are needful for reports composition.

These functions are also used for reporting management when any reporter is automatically informed about deadlines of his/her reports and accessible software tools.

Today's implementation is built on Apache web server and Oracle database engine. Java, PHP, JavaScript and SQL have been used as programming languages. Templates for data conversion from national data sources are made in the form of XML and MS Excel files.

6.   CONCLUSIONS

The process of system analyses validated applicability of UML for modeling of reporting processes and report states and values. During system implementation were used mainly freeware tools. System is programmed in PHP and based on MySQL database machine.

The information system for international environmental reporting (CDM) of the Czech Republic has been developed under the auspices of the Czech Ministry of the Environment. It enables the management and monitoring of reporting activities in the CR and the design of a global data model for environmental information exchange and reporting purposes. It also performs systematic attributing, thereby providing a basis for a central output data warehouse to meet reporting obligations.

New European Union legislative requirements stipulate another field closely related to information/reporting obligations, namely informing the public. The solution reflects these requirements, too. It has to provide an information base for strategic planning, supra-field information support for public administration, and cooperation within the business sphere.

7.   ACKNOWLEDGEMENTS

8.   REFERENCES

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