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CRISALIDE – Concept of Corporative Information System for Governance and Management of Digital City

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1 ABSTRACT

Corporative Information Systems (CIS) is a tool for decision making support for rather big business companies. Such systems were introduced approximately twenty years ago and have shown good results for businesses optimization since. The present-day demand is to move cities to a digital era. Considering this demand, let us take a look at a digital city governance and management from CIS ideology point of view.

CIS approach based on proposed methodology provides means for development and support of decision making process for different levels of governance and management. Governance and management should not be centralized, it should be distributed with weak feedback links.

In this paper, we present our experience in this field based on "Aqueduct" systems (product of SPIIRAS–HTR&DO Ltd.) implementation for different subject domains and ideas for digital city localization.

Keywords: CRISALIDE, city management, city governance, digital city, Corporative Information System

2 INTRODUCTION

The topic of Digital City was discussed numerous times at length within the context of CORP conference. Involvement in CRISALIDE project allows us to move from purely theoretical questions to practice. However, it raises a series of questions regarding determination of the basis for development of intelligent decision-making support system for city environmental management. In the organisational and technical systems' area, integration of decision-making support systems (DMSS) is not uncommon, but rather commonplace. In the mean time, one can hardly find many examples of city environmental management in the available literature. If we begin to study the products closely related to city management, we will find that a large corporation or an enterprise, for which the topic of DMSS was under development for more than one decade, is not far behind. That said, there are a lot of ready-made solutions on the market that claim a role of DMSS. Such products as R3 by SAP, Business one (Microsoft), 1S Accounting, to name but a few.

The experience of application of such systems as corporative information systems (CIS) has been controversial so far. One can find many enthusiastic reviews along with as many critical ones. It is due to the whole set of factors, most important of which are the following: complex and non-uniform subject area (CIS), sufficiently high initial cost of some products, sufficiently high cost of ownership and of product support, etc.

In this regard, CRISALIDE project is oriented on search and implementation of such DMSS that possesses a set of innovative properties, major of which are the following: reasonable cost of initial product, openness and flexibility, relatively low life-cycle cost, friendliness to users without special training in computer science. Drawing on the practical and theoretical experience in CIS development, the main goal of CRISALIDE project is localisation and further refinement of ready-made solutions in decision-making support field for the needs of city management.

The term DMSS in this context refers to the system of intelligent support for corporate city management. The following elements provide the basis of DMSS: intelligent subsystem based on first-order predicate logic and on other mathematical approaches, ontology system, intelligent GIS, the library of mathematical and simulation models, scenario system, computer communication systems and a number of other auxiliary systems. The scope of DMSS extends to automation of activities of city's officials on all management levels. Automation should result in enhancement of effectiveness of management and in reduction of number of people involved. It is an important point because sometimes automation leads to the opposite results.

3 GENERAL IDEA

The underlying idea of DMSS development may be formulated in three fundamental points: definition (justification) of main development tasks, definition of clear scope of works that are required for

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accomplishing of the given tasks and definition of expected results. Seeing that we are currently at an early stage of the project, these points are formulated in general terms without reference to specific global business processes of city management. Considering our positive practical experience, specific localisation poses little difficulties and transforms into typical technological task.

Main tasks in the process of design and implementation of CIS are the following:

- definition of the guiding idea of CRISALIDE;
- theoretical and technological justification of CRISALIDE;
- selection of core solutions for of CRISALIDE creation;
- development and implementation of CRISALIDE prototype.

Directions of major works:

- analysis of current state of CIS;
- determination of ways and approaches to further automation of city environment management system;
- development of CRISALIDE's implementation plan;
- realization of range of activities for CRISALIDE implementation.

Expected results:

- automation of cycle of e-government management;
- intelligent GIS platform as a serial software product;
- electronic workflow system;
- ontology, model, database and knowledge systems.

Having formulated the general idea of the project, let us have a short look at the process of subject domain investigation, namely, of e-government (if available) or of normal city/regional government.

4 PROCESS OF SUBJECT DOMAIN INVESTIGATION

The process of investigation of the object intended for automation (government) incorporates a number of stages, major of which we list below:

- Analysis of current level of Government's automation.
- Engineering of Government's business processes.
- Characteristics of existing CRISALIDE's elements.
- Investigation of inherited automation systems.
- Adaptation of basic technologies of CRISALIDE's building.
- Refinement (development) of ontology system.
- Refinement of CRISALIDE's architecture.
- Development of technical specification for CRISALIDE project's advancement.

Let us give a short characteristics of the most important stages.

Analysis of current state of automation includes a number of sub-stages:

- Analysis of a list of means and systems of automation (MSA) already implemented into government automation process.
- Estimation of duration of the works on creation of MSA.
- Estimation of principles of MSA creation.
- List of organisations involved in MSA creation.

Business processes engineering begins first and foremost with analysis of horizontal and vertical relations. The present state of CIS is largely determined by the fact that automation follows organizing structural

scheme. During the evolutionary development of CIS, automation is being based on various technological bases, which complicates interaction between information systems. Existing principles of government's automation and of CIS building, as a rule, are incapable to provide the opportunity to increase the degree of integration of information subsystems in CIS. The need to increase the degree of integration is driven by geometrical growth of resources necessary for subsystems' integration. Let us review the requirements for formal representation of business processes.

Requirements for business processes' description include, above all, the following actions:

- Analysis of government's city environmental management cycle.
- Analysis of levels of city management (strategical, operational, tactical).
- Analysis of management phases (initial data processing, concept development, decision-making, planning and execution, control and analysis of the activities).

Let us give a brief explanation for what we mean by levels of management since they are directly related to different levels of business processes:

- strategical (forms govenment's activities for the long-term perspective and reflects global trends of government's activities);
- operational (reflects task-solving for the middle-term perspective (business processes of a separate city's ministry);
- tactical (business process that reflects task-solving for the short-term perspective from real-time to a year (business processes of a city area, an important location or a situation).

Since the amount of business processes is significant even for the enterprise level, city level or regional level are also very complicated. Therefore, it makes sense to group business processes according to their importance:

- basic (directly identify the key results (strategic goals) of city or regional functioning);
- auxiliary (provide basic business processes (as a rule, support city's infrastructure);
- sustaining (corporate processes designed to support all basic and auxiliary processes).

Results of business processes' analysis are represented in the form of the following documents:

- A list of automated management tasks in the Government.
- Methodological apparatus that provides identification of business processes.
- A list of models for decision-making support for management entities in business processes of each level).
- Description of vertical and horizontal relations in business processes.
- A list of behaviour pattern models for management entities with indication of a list of conditions and procedures of transition into these conditions.
- UML-diagrams of business processes.
- Formal description of business processes that includes:
    - identification of management functions;
    - identification of subject and object of management;
    - a list of resources involved;
    - decision-making support model;
    - points of interaction of with other business processes.

Engineering representation and implementation of DMSS in CIS successfully solves the current task. However, in order to increase the life-cycle of MSA and to lower the cost of ownership, one should be encouraged to provide theoretical (scientific) support of any project of CRISALIDE project level. Theoretical framework of CRISALIDE project is essentially based on scientifically justified interconnected

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models, algorithms, methods intended to justify suggested ideological, methodological and technical solutions proposed in the project. The main goal of theoretical framework of CRISALIDE project is to form a scientific views for organization of co-processing of heterogeneous masses of information obtained from CIS's sub-systems in city's government and from automated management decision-making support system. As a basic theoretical approach we suggest a method of harmonization, integration and fusion of data, information and knowledge on all levels of management hierarchy.

Data harmonisation is a process of standardization of data obtained from different sources with a common format. Integration of information is a process of bringing together all information about an object obtained from different sources. Data fusion is a process of aimed at obtaining new knowledge about an object through processing of information at hand.

As major basic technologies for DMSS in CIS, we suggest the following:

- intelligent GIS;
- ontology system;
- expert system;
- scenario development and execution system based on inference machine;
- documentation system;
- computational models' complex;
- simulation and modelling system.

The key element of the suggested technologies is CRISALIDE project's ontology system. Ontology is a set of notions from the subject domain and of their interconnections. CIS should provide a unified model for representation of information for all participants of government's business processes: users and components of CIS. The ontology system is a form of existence of such unified model of information representation. Ontologies are characterized by uniformity, completeness and consistency of the notions used. Creation of ontologies, apart from uniformity of representation of heterogeneous information, allows to form a holistic view of the subject domain, to identify missing components of knowledge and to increase effectiveness of its repeated use. Major tasks of ontology system are the following:

- Elimination of data redundancies.
- Identification and formalization of missing data necessary for optimal integration of business processes.
- Consideration of particularities of business processes and possibility of modifying their structure and/or their functions.
- Increase of effectiveness of data reuse.
- Possibility of process management throughout the life-cycle of CIS.
- Support of information harmonisation, integration and fusion within the system.

5 GENERAL ARCHITECTURE

The structure of general CRISALIDE's architecture is currently presented as follows:

- methodological support;
- mathematical support;
- informational support;
- software support;
- technical support;
- security and data protection system;
- external communication system;
- life-cycle structure.

Let us elaborate on some elements of CRISALIDE's architecture. Methodological support is a set of documents that describe the technology of CRISALIDE's building, methods of choosing and application of processing technologies in order to obtain concrete results. The main goal of methodological support is to organize effective creation of CRISALIDE's components. Implementation of the correct methodology of organization of work on the project guarantees to achieve positive result for which it is required to distinctly and expertly to organize the whole process of project development. The basic function of mathematical support of CRISALIDE is a quantitative support of justified decision-making carried out by officials on all management levels. Moreover, mathematical support should solve tasks related to processing and representation of input and output information in CRISALIDE. Mathematical support should include a list of mathematical models, algorithms and methods that should be implemented into informational and analytical, informational and calculating and calculating components of specialized software in CRISALIDE and characteristics of these models, algorithms and methods as well.

Requirements for mathematical support are listed below. It should provide:

(1) Mathematical support of justified decision-making carried out by Government official on all management levels.

(2) Mathematical models, algorithms and methods, implemented into informational and analytical, informational and calculating and calculating components of specialized software in CIS.

(3) Completeness and adequacy of mathematical description of management processes implemented in Government.

(4) Requirements specified by Government's management system.

Mathematical models, algorithms and methods implemented in CRISALIDE must have a structure convenient for their integration into specialized CRISALIDE's software. A list of of mathematical models, algorithms and methods must be structured in accordance with levels and stages of management.

Informational support should allow to build dynamic information models for city environment management system which contain data corresponding to real parameters of city environment at any given moment in time. Dynamic information models of the subordinate managed objects should become the components of these models.

Dynamic information model of each component should represent states of information objects and their interaction, organized in accordance with a specified set of rules.

The concept of CRISALIDE development suggests creation of final software products, therefore, all its solutions must be implemented through a Project system in form of software systems. Accordingly, during the work on the project, one should clearly identify the appearance of the intended software.

The project must have formulated requirements for technical support and reliability of CRISALIDE's components that include:

- Typical exploitation model towards which the quantitative reliability requirements are applied.
- Failure criteria for stationary operating condition referring to which the reliability requirements are formed.
- The value of required continuous non-failure operating time.
- Limit states criteria referring to which the durability requirements are formed.
- Protective properties of CRISALIDE's components' criteria referring to which preservation requirements are formed.

Considering the specificity of CRISALIDE functioning related to processing of information that may be confidential and may contain commercial secrets, security and data protection system must be an integral part of the system and must evolve along with it. While working on the project, one must estimate levels of security of confidential information and commercial secrets.

6 SUPPORTING RESEARCH

Supporting research under the scope of the project are focused on a system of research and development (R&D) aimed at project's refinement. R&D system represents a set of scientific research and design and

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development projects undertaken in order to obtain a unified complex technical system: CRISALIDE for city Government. R&D system also should justify all the suggested solutions.

R&D system determines:

- the size and the topic of scientific research and design and development projects aimed at CRISALIDE's refinement;
- the time-frame for the said projects;
- the size and sources of financing for the projects;
- the anticipated team of executioner for the R&D.

R&D system should justify the order of execution and relation between scientific research and design and development projects, and should contain a prediction of a likely input of each research and project into the final version of CRISALIDE.

7 CASE STUDY

We would like to refer to a development of the concept of CIS for "Yamburggasdobycha" Company in 2007 as an example of implementation of the suggested technology into practice. At that time, assets of this company amounted to more than 30% of Gazprom Ltd. The goal of this project was to develop ideology, framework, technical solutions for the system of informational support of corporate management – CIS which aims at maximization of Company's potential capabilities in the interest of Company's mission. The role of CIS in this mission is to perform as a support subsystem that helps promptly and correctly make decisions on all management levels. As a result of this project, the ideology, framework and technical solutions for the whole life-cycle of an oilfield were developed. The next step after creation of the basic CIS for the abstract oilfield was development of scientific and technological basis for the CIS which allows to support management of the Company throughout its life-cycle. At the same time, maximum invariance of decisions was provided, regardless of geographical location and number of the oilfields, of organizational structure and staffing of the Company, of software and hardware available. The analysis of the current status of the CIS, based on the materials provided by the client, has shown that CIS is a combination of more than 40 information systems that are heterogeneous in scale, purpose and technology. Each one of the information systems, as a rule, affects the work of one or more structural divisions of the Company. At that, the division can interact with one or more information systems.

A list of fields of activity of "Yamburggasdobycha" Company can be presented in form of three groups of processes:

- key processes;
- auxiliary processes;
- supporting processes.

The key processes are the following:

(1)development of the raw materials basis;

(2) mining of the oilfield;

(3) production of gas and gas condensate.

Among auxiliary processes we can list:

(1) financial and economic activities;

(2) management of capital assets;

(3) capital construction;

(4) power supply;

(5) materials and machinery supply;

(6) transport.

The supporting processes are the following:

- management of fly-in/fly-out employees;
- staff management;
- environmental protection;
- quality management;
- ensuring labour safety and occupational safety;
- ensuring industrial safety;
- project management;
- legal enforcement;
- ensuring information security;
- staff's medical support;
- corporate documents circulation;
- document management.

Analysis of the current state of CIS of the Company has allowed to identify tree major problems:

(1) The current state of CIS is largely determined by the fact that automation of structural units was carried out separately and independently of one another.

(2) In the course of evolutionary development of CIS automation was carried out on different technological bases which caused difficulties in interaction between different information system (sometimes such interaction may even be impossible).

(3) Existing principles of Company's automation and of CIS creation do not provide adequate opportunity for increase of integration level of information subsystems in CIS. This is attributable to the need for geometrical increase of the resources required for subsystem integration.

The number of types of connections between divisions in this case can be calculated according to the given formula:

$$N = \frac{n(n-1)}{2},$$

where n denotes the number of structural divisions involved in one business process.

Creation of a common information model of integrated CIS allows to avoid this principal problem (fig. 1).

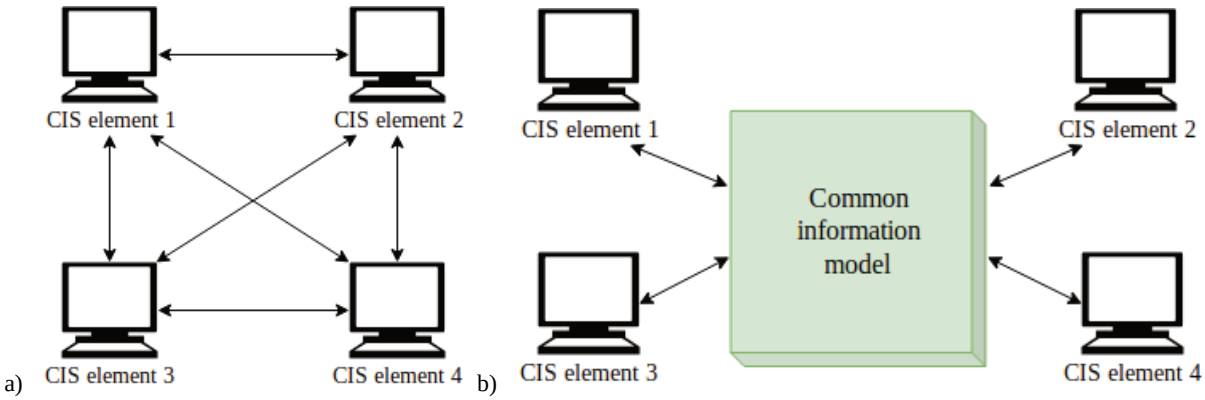

Fig. 1. Connections between CIS elements for the present approach (a) and for the perspective one (b)

The following integrated indicators of economical efficiency were chosen to evaluate the proposed solutions:

- Return on Investment, ROI;
- Total Cost of Ownership, TCO;
- Cost Benefit Analysis, CBA.

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The concept of development of corporate information system for "Yamburggasdobycha" Company, proposed by SPIIRAS-HTR&DO Ltd., was successfully accepted. Considering other successful implementations of this methodology of CIS development as a theoretical and technological basis, it is recommended for realization in the CRISALIDE project.

8 CONCLUSION

The main goal for CRISALIDE's creation is provision of optimal life-cycle of the city. The project should outline the ways of further modernisation of CRISALIDE, revise the current state and point at problem areas in automation of Government.

The focus of further development of CRISALIDE should be the process of integration of separate, including the existing, subsystems in order to solve complex, integrated tasks of management process.

Solutions, provided by the CRISALIDE project, will provide the opportunity to lower the costs of design, development and integration of separate CRISALIDE's subsystems and will allow to modify them in accordance with changing requirements.

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