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STUDY OF THE OPPORTUNITY TO APPLY DECISION SUPPORT SYSTEMS IN E-GOVERNMENT

The paper considers the problems of applying decision support systems (DSS) in e-government. Key properties of DSS are reviewed. The demands for DSS in e-government are described. Proposals and recommendations on the use of technologies and techniques in the development of DSS for e-government are offered.

Keywords*: Data Warehouse, Data Marts, Decision Support System, OLAP, OLTP, DataMining.*

Introduction

Although there are different definitions of e-government, the consensus is that it is generally a way of providing information and delivering public services to citizens, businesses, other government authorities and public officials, wherein personal interaction between the government and the applicant is minimised, and the use of information technology is maximised [1]. Four models of interaction of e-government are:

- government-to-citizen (G2C);
- government-to-business (G2B);
- government-to-government (G2G);
- government-to-employees (G2E).

According to the models, it follows that the activities of e-government include implementation of services for citizens and businesses, in addition to improving the activities of government agencies by improving the efficiency of its internal operations and establishing interactions with other government agencies, including those in foreign countries.

To solve these problems, it is necessary to pay close attention to the development of government information systems that provide automated procedures of data collection, processing and storage required to perform entrusted functions. The systems must be capable of influencing the process of making decisions and predictions and considering alternative solutions.

Studying the properties of DSS

Online Transaction Processing (OLTP), which include Database Management System (DBMS), application development tools, and report generators, have been used for analytical data processing. A wide range of industrial problems can be solved by using OLTP systems, for example, banking and exchange transactions, statistics for website visitors and automation of inventory and document accounting. The key function of such systems is the simultaneous execution of a large number of short transactions requested by a large number of users. Analytical capabilities of OLTP-systems are often limited to using them for daily activities of the organisation, and they are performed in real time. Since they provide users with the data from constantly updated DBs, they do not monitor the dynamics of process changes over long periods of time, do not implement data processing, and most importantly, do not form conclusions from available data. The key target of DBs is transaction processing, and a performance indicator is the number of transactions performed per second.

In [2], DSSs are described as a system that operates the data, communications, documents, knowledge and models. ADSS is defined as an interactive computer system designed to assist a decision maker in the use of data, documents, knowledge and models to identify and solve problems. The foremost characteristic of DSS is that a new high-quality method is used for the interaction between a human and computer. Decision-making, which is the main function of

DSS, results from an iterative process, as shown in Figure 1 [3], which involves DSS as the computing unit and management facility and a human as the controller who specifies the input data and evaluates obtained calculation results.

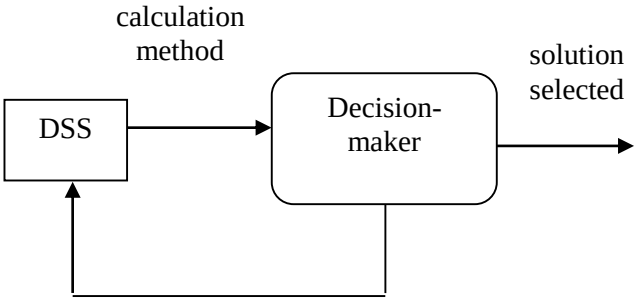


Fig.1. DSS as an iterative process

DSS must meet the following basic requirements:

- the system must be built with the use of open architecture applications and provide an interface for expanding the set of standard features;
- information requests must be executed for an extremely short time, providing an operational analysis mode and a decision-making mode;
- the ability to work with users who have no special knowledge.

The properties of DSS make them essential in e-government, as their use contributes to the efficiency of internal activities of government agencies by improving the decision-making process. For example, in [4] one of the criteria to justify the necessity and importance of implementing e-government is the improvement of the efficiency and effectiveness of management decisions. [5] states that e-government activities deliver services to citizens and shift activities of public authorities into information technology, implementing the specific functions of public authorities and assisting decision-making processes.

The use of DSS in government agencies may contribute to the work of both managers and analysts. DSS ensures that the managers can accomplish the following:

- make prompt effective management decisions;
- obtain reliable data about the current state of affairs in the organisation;
- develop adequate information model of enterprise.

Analysts should be capable of the following tasks using DSS:

- forming a document archive;
- searching, evaluating and systemising the data in the archive promptly;
- conducting reviews and comparative and dynamic analysis;
- developing a hypothesis;
- predicting developments in a situation;
- composing briefs and reports.

Key technologies and techniques used in the development of DSS in e-government

The key technologies and techniques used in the development of DSS in e-government are reviewed below.

Data warehouse technology. The first stage of the development process of DSS is based on the concept of the data warehouse (DW). The main advantage of the concept is that uncoordinated data is integrated and becomes problem-oriented and time-structured, which in turn allows the exploration of dynamic trends and the implementation of various kinds of analytical applications. DW technology, which is one of the main elements of DSS architecture,

is based on modified database technology. Typically, DW contains basic data, historical data, integrated data and metadata. This can provide a comprehensive analysis and the analysis of temporal trends and other information, which supports decision-making. DW is a subject-oriented, integrated, stable, time-related and unchanging set of data.

The data marts are extracted from DW, which include thematic and narrowcasting information oriented to the solution, in addition to tasks in the financial, technical and human resources realms. Analytical processing is performed with the use of Business Intelligence (BI) tools to extract the data from DW, which is later transmitted to the users for prompt decision-making. These tools include complex multidimensional on-line analytical processing (OLAP) data analysis [6, 7] and data mining technology.

Depending on DW architecture, three types of DSS can be distinguished [8,9]:

1. DSS using independent data marts (Figure 2)

Advantages:

- The data mart is implemented quite quickly;
- The marts are designed to response to a specific number of requests;
- The data in the marts are optimised for use by certain groups of users, which facilitates their content improvement and increases productivity.

Disadvantages:

- The data is stored in different data marts, which leads to data duplication and increases storage costs;
- The process of filling the data mart with a large number of data sources is potentially very complicated;
- The data is not consolidated at the enterprise level, so the unique business view is missing.

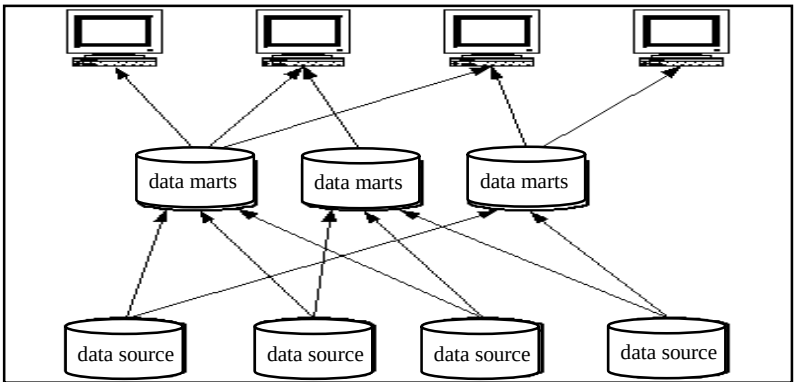


Fig. 2. Independent data marts

2. DSS based on the two-level data warehouse (Figure 3)

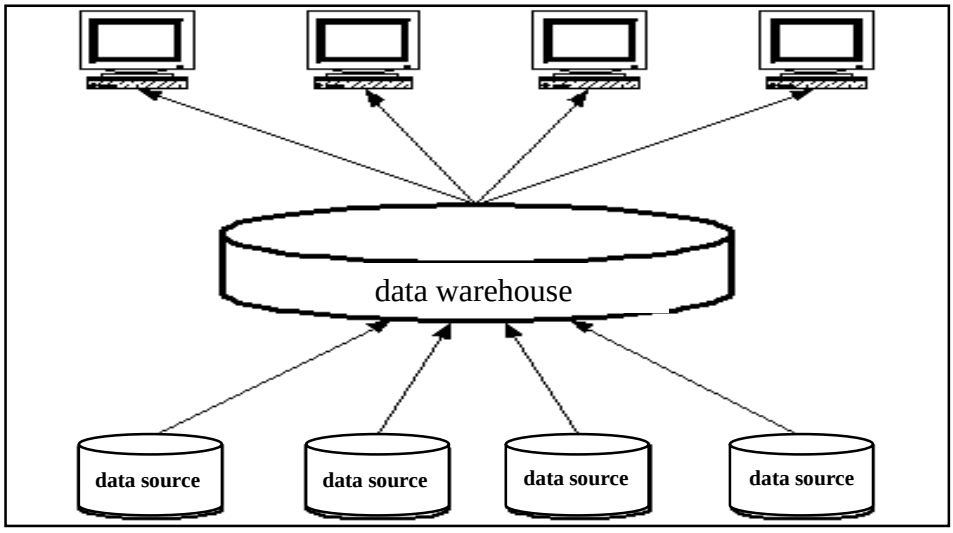


Figure 3. Two-level data warehouse

Advantages:

- The data is stored in a single copy;
- Minimum storage costs;
- No problems with the synchronisation of multiple copies of data;
- The data is consolidated at the enterprise level that provides a unique business view.

Disadvantages:

- The data do not support the needs of individual users or groups of users;
- System performance problems may occur;
- Problems with the delimitation of the data access rights of users may occur.

3. DSS based on the three-level data warehouse (Figure 4)

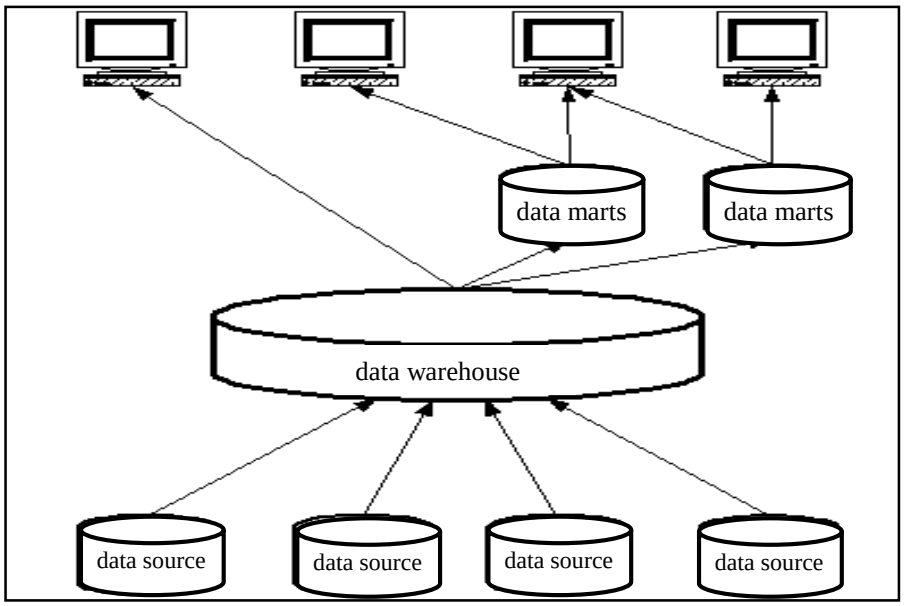


Fig. 4. Three-level data warehouse

Advantages:

- The development and completion of data marts is simplified, as the data is filled in from a single, standardised, reliable source of purified, normalised data;

- The data mart is synchronised and consistent with the corporate performance. A corporate data model is available. Relatively easier expansion of the warehouse and addition of new data marts is possible;
- Guaranteed performance.

Disadvantages:

- Data redundancy is possible, which leads to an increase in the requirements for data storage;
- Consistency with the accepted architecture of various areas with potentially different requirements is required.

Each of the abovementioned architectures has positive and negative sides, and the right choice is a key factor in the successful operation of the system. When selecting DW architecture, the guidelines should involve the most important characteristics and properties of the architectures for the operation of government agencies in terms of solving strategic and tactical tasks, and with consideration of material and technical capacities and human resources.

Online analytical processing (OLAP). Data is the basis for analysis decision-making, but the data in the data warehouse cannot be directly used by the managers. Decision makers use various analytical tools to extract information and knowledge from data. One of them is OLAP, which converts the data into a data warehouse in a multidimensional cube, analyses current and historical data, and then generates ad-hoc queries and reports in a multidimensional environment to assist decision-making. Visualisation of the dependencies found in the use of OLAP technology, which provides a multidimensional view of the data and random cut-offs of analysed data using graphical shells, significantly increases the efficiency of the system analyst at this stage.

Data Mining. An important part of the decision-making procedure is to identify the key problems of the subject area; to analyse trends, comparisons and exceptions inherent in the data accumulated in the data warehouse; and to verify and interpret the discovered mechanisms, which in turn stimulates the search for adequate solutions. Informational and analytical support is implemented through data mining techniques which have a broad scope depending on the task.

Data mining is the process of discovering valuable information in the vast amount of data, and it can detect hidden information from the text database, relational database and spatial data. The search for and analysis and evaluation of all kinds of data in the e-system of public administration, especially unstructured data, can predict future development trends and support the development of a number of major policies. The application of data mining in e-government performance will increase the government's prompt response to sudden emergency situations and improve the innovative capacity and quality of staff.

Modelling technique. Since the model is an abstraction of the real system properties, which regularly change, modelling is the key DSS technology. To study complex systems, such as decision-making systems in government agencies, a corresponding simplified model must first be created and described, and then its properties can be identified and studied under real conditions. Various factors influencing scientific solutions are analysed, which provides a scientific basis for the development of the final model to make the right decision.

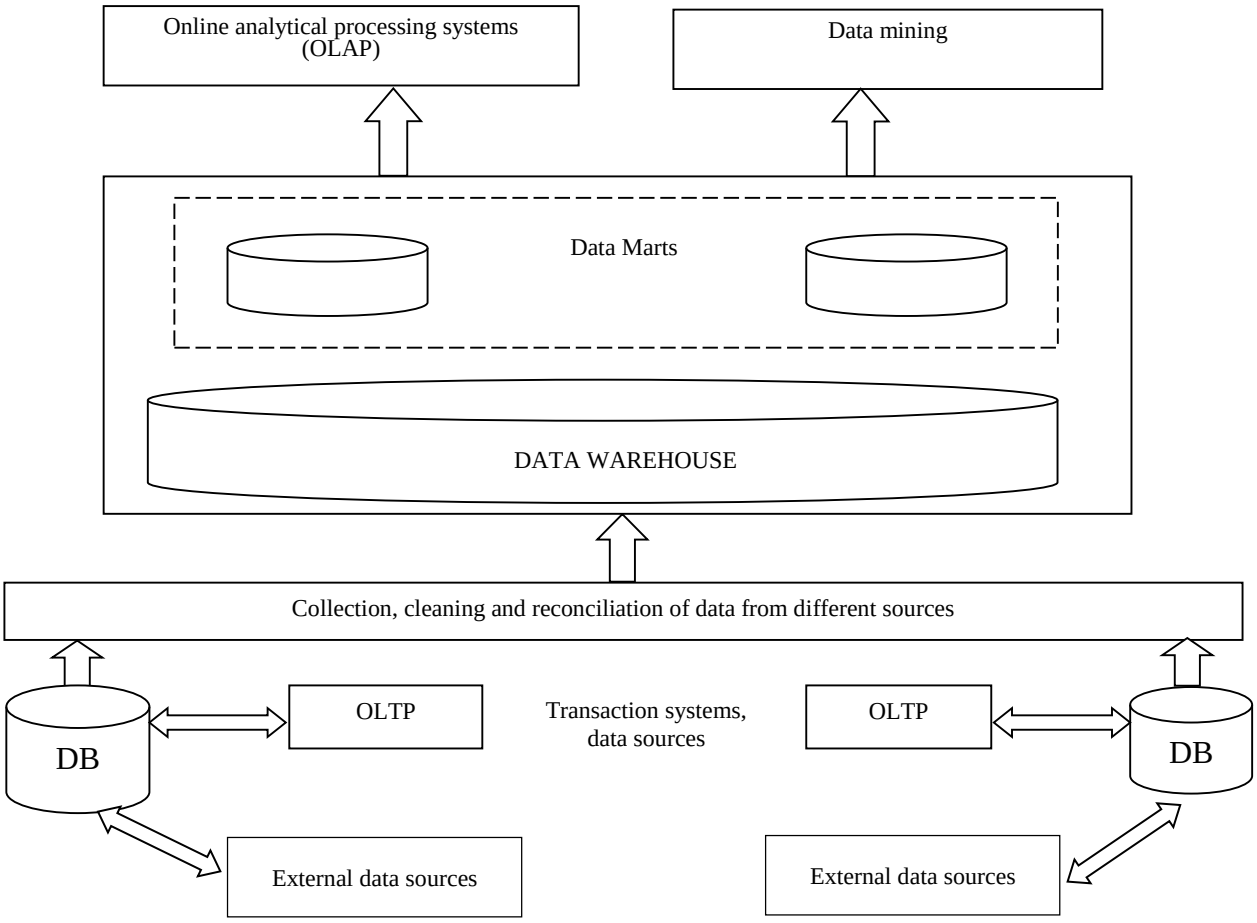
Knowledge representation and output technique. In the process of decision-making in government agencies, one may encounter a variety of fuzzy tasks that require the DSS adopted in e-government to use both non-fuzzy and vague reasoning, and to maintain appropriate techniques of knowledge representation to provide the necessary assistance to managers in decision-making.

Case Study

Currently, as a pilot project, the Institute of Information Technology of ANAS is developing DSS in the foreign policy, based on HD and OLAP, with consideration of the above-mentioned proposals and recommendations. Figure 5 shows a conceptual diagram of the system proposed in [10].

DW consists of information about foreign trips of the institute's employees. At present, all the documentation associated with the foreign trips of the employees of ANAS is stored in paper or electronic form in the archives of various departments such as human resources, accounting, or another department; the storage of the information is disorganised and unsystematic. As Figure 5 shows, OLTP is included in DSS as data sources.

A poly-cube OLAP-model with a fuzzy OLAP-cube is developed within the system [11], including 2 GB RAM and 2.2 GHz OLAP-server on Microsoft Windows 7 for the developed system. Microsoft Analysis Services 2008 is used for OLAP analysis. SQL- server is used as a database. Microsoft Visual Studio 2008 Query LanguageT-SQL is the realisation medium.



The system is planned to be applied in the Department of International Relations of the Azerbaijan National Academy of Sciences (ANAS), which is a state agency implementing the policies of Azerbaijan in the sphere of science.

Conclusion

DSS is required for e-government, as its application contributes to the efficiency of internal activities of government agencies by improving the decision-making process. The key technologies and techniques recommended to be used in DSS for e-government include DW, OLAP, data mining, modelling techniques and data representation and output techniques.

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