Journal of Applied Business Information Systems

http://www.jabis.ro

Hybrid Support Systems: a Business Intelligence Approach

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Abstract: *The area of the Decision Support System (DSS) was extended, and it is today more than an application based on spreadsheets. In our opinion, DSS is, nowadays, a concept that defines any kind of information technology focused on the support of the decision making process. In this respect the research of DSS, mainly in the last twenty years resulted in the appearance of new technologies and concepts regarding the storing processing and analyzing data and information necessary for the decision making process. Consequently in the DSS landscape appeared, the technology of the "Data Warehouse", the OLAP ("On-Line Analytical Processing") applications, the "Data Mining" techniques and the artificial intelligence technologies (expert systems and the intelligent agents). In this paper we present a conceptual architecture of Hybrid Support Systems (HSS) based on Business Intelligence for decision-making process support.*

Keywords: *Hybrid Support Systems, Business Intelligence, Decision Support, OLAP, Data warehouse.*

1. INTRODUCTION

The concept of Business Intelligence within information systems was relatively recently underlain since 1990, although many technologies covered by this concept are rather old. Business Intelligence can be explained as Organization Intelligence in the context of data, information and knowledge refinement processes [4][7].

In order to define the concept of Business Intelligence and its role within the decision making processes, it is necessary to historically analyse the decision support applications and technologies that ultimately led to the emergence of this concept.

According to IBM, in the decision support systems evolution there where three generation stages[1] :

- the **first generation**: Query and reporting based on batch processing information systems. The first information systems where based on batch processing of operational data. The outputs of these applications came down to a large number of reports with higher relevance in operational processes rather than decisional processes. The optimal use of these systems in decision processes was carried out by people with IT knowledge and experience. Thus, the managers could use these systems for decision processes only through IT experts that were capable to process system data.
- the **second generation**: Data warehouses. Data warehouses represent a big step for decision support systems. Compared to the first generation, data warehouses have several advantages:
  - they are designed to directly ensure the decision support for managers and not for the applications on the operational level in every day activities of the organizations.
  - they contain information (refined data) for the decision maker's needs.
  - they can contain and process historical data, as well as centralized information based on current data.
  - they are based on client/server technology which provides more accessibility for the users.

[1] Sueli Almeida, M. et al, *Getting Started with Datawarehouse and Business Intelligence*, IBM – International Technical Support Organization, San Jose, 1999, p. 1.

- the **third generation**: Business Intelligence. With all their complexity, data warehouses are not a complete solution for fulfilling the information and decision needs in an organization. The solutions based on data warehouses are usually oriented towards the technological part than solutions regarding the activity in the organization. Most of the products related to data warehouses are rarely customized according to the specificity of the organization in which they are implemented. For this reason, in the implementation stage, the focus is on the technology, namely the construction of the warehouse and very little on the specific needs of the organization and how it accesses the warehouse.

To address shortcomings regarding the information and decision customization of the data warehouse, Business Intelligence systems were developed.

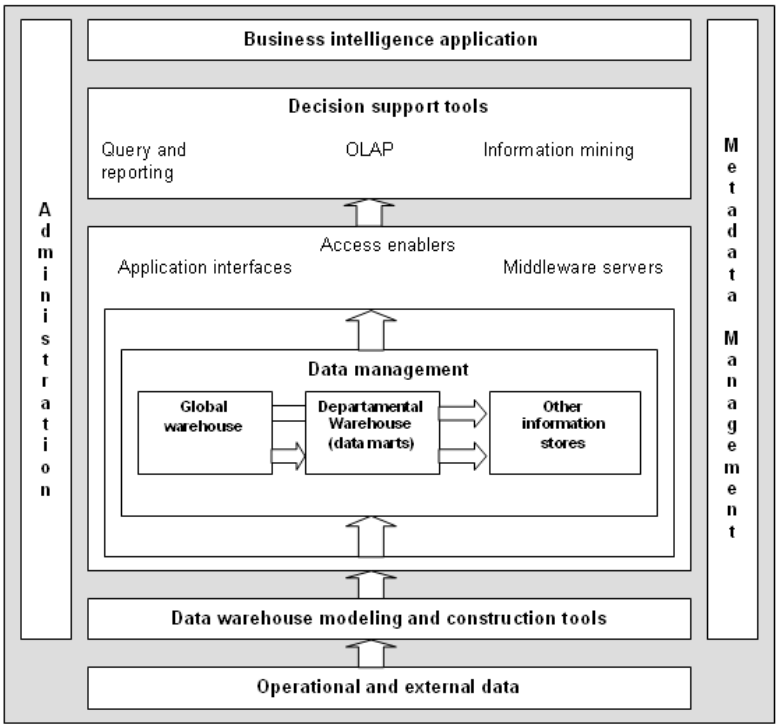
Synthesizing the most important properties of Business Intelligence, one can say:

- That not only they include the latest and the best decision support technologies, but also they offer predefined and customized solutions for different activities.
- They are focusing on accessing and delivering economic information to decision-makers.
- They include all the information resources needed for supporting decisions, not only the information included in data warehouses.

IBM defines Business Intelligence: *"Business Intelligence means using data for making the best decisions for the company. This means accessing, analyzing and discovering new opportunities"* [6].

In our opinion, the most important objectives of Business Intelligence are:

- Collecting and analyzing a large amount of data and information gathered either from operational databases, either from the company's data warehouses.
- Obtaining forecasts regarding strategic indicators for the organization.
- Combining the Knowledge Management Process with decision processes.
- Making the best out of decision support technologies and providing managers with complex and competitive information.



Source: [6], IBM

Figure 1. BI system structure – IBM view

According to IBM, the structure for a BI system (figure 1) consists of all technologies for supporting decisions as well as the procedures and techniques for managing and combining them in order to maximize the efficiency of the decision making process.

Considering the two approaches, one can say that Business Intelligence is a new vision of the organizational decision process. The BI activities are anchored on information-decision infrastructure provided by DSS combined with other computerized instruments for decision supporting (DW, OLAP, DM, KM and ES).

These activities take part in combining the capacities provided by the information-decision system with the vision and the complex decisional needs of the decision makers. From this point of view, we can say that BI adds value to both decision support systems and the managers of the organization.

Generalizing, we can say that BI has a greater economic connotation linked to managers' vision and it is focused mainly on the decision process. The technical support for BI is ensured by existing technologies integrated in a Hybrid Support System (HSS) or Hybrid Decision Support Systems (HDSS). This kind of systems forms a real Business Intelligence Support System (BISS).

We think that considering the technology integrated in a BI system, the DSS is a basic component that can be combined with other decision support instruments, and the result is a HSS.

2. CONCEPTUAL ARCHITECTURE OF HYBRID SUPPORT SYSTEMS

Grouping the BI support technologies by the relationships between them, we propose a conceptual architecture for BI based on DSS (figure 2).

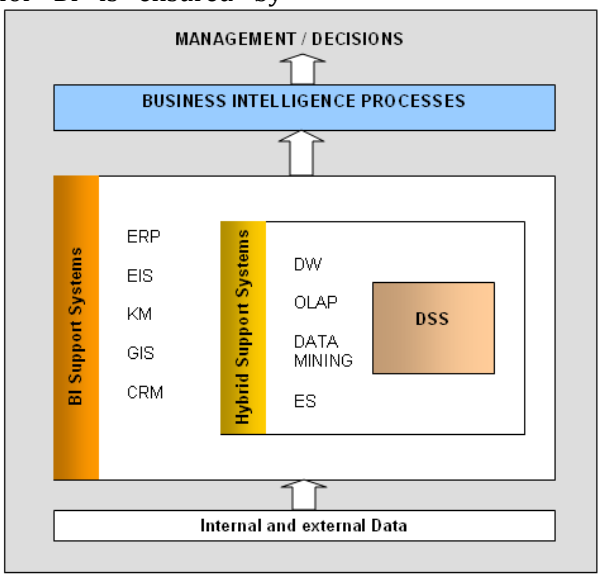


Figure 2. Support architecture for BI based on DSS.

Hybrid Support Systems (HSS) represent the systems that are the result of integrating DSS with other tools and technologies for decision supporting in order to maximize the efficiency and efficacy of organizational decision-making process.

The context of BI favors the design, the implementation and the use of HSS.

The best architectures of HSS can be:

- the DSS – Data Warehouses integration: maximizes the efficiency of aggregated organizational data processing and analysis;
- the DSS – OLAP integration: maximizes the efficiency of multidimensional data analysis and extended operation of system models;
- the DSS – Data Mining: maximizes the efficiency of data analysis and the optimization and the extension of system models;
- the DSS – Expert Systems: maximizes the management capacity of data and models as well as the system capacity to manage knowledge;
- the GDSS – Neuronal Networks: allows creating a new structure for knowledge acquisition and storing.

Since 1990, based on developing technologies for data storing, sending and processing there was a set up of aggregating historic and operational data into data structures that allow a unitary data analysis, much faster and less expensive for the organization.

The existing On Line Transaction Processing (OLTP) systems were not capable to meet the new decisional requirements any more. The decision support systems (DSS) in the organization have suffered a change in the DBMS component, by developing the Data Warehouse technology.

The Data Warehouse technology aggregates and integrates many large databases and organizes them in a subject-oriented structure (decisional elements) that supports the decision-makers in an organization or other data-based applications. Aggregation consists of both current operational-level data and historical data. The structure is based both on actual data (the database) and on the rules for calculation, extraction, refining, querying and metadata (data about data). [3]

There are several definitions of the Data Warehouse concept.

The most accepted definition belongs to William Inmon, one of the pioneers of this concept. According to him, the data warehouse is "a collection of subject-oriented, integrated, non-volatile and time-variant data for the management's decision support system" [3].

The Data warehouse architecture can be structured according to several approaches. Thus, Gray and Watson (1998) split the data warehouse in three parts:

- the actual data warehouse, that contains data and software instruments for managing data;
- applications (back-end) for extracting and taking over the data in the organization's databases or external sources, consolidating and loading data in the actual data warehouse;
- client applications (front-end), through which the users access and analyze the data in the data warehouse.

We think that data warehouses fill out or substitute very well the DBMS component of the DSS. In our opinion, the combination between DSS and data warehouses creates a competitive Hybrid Support System.

A way to integrate the two technologies is displayed in figure 3.

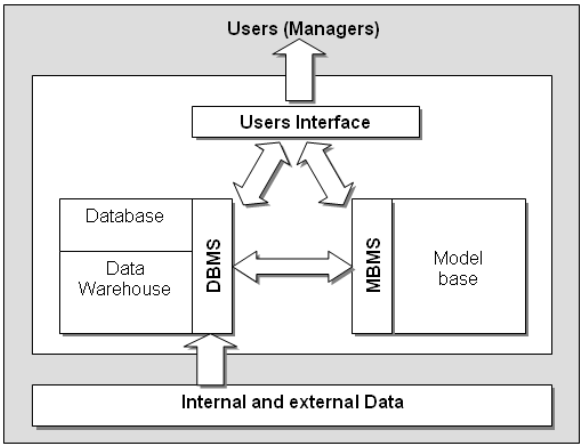


Figure 3. The architecture of a hybrid support system based on data warehouses.

The OLAP technology was preceded by a series of instruments that struggled to optimize data access and analysis. One of the most important technologies to access a database is the OLTP technology (On-Line Transaction Processing).

The OLAP (On-Line Analytical Processing) designates a series of techniques for processing and centralizing data stored in multi-dimensional databases in order to be offered to the decision-makers in a flexible form for analysis.

E. F. Codd, who defines five rules that describe an OLAP application [1], introduced the concept of OLAP in 1993. These rules were grouped in a set, called FASMI (Fast Analysis Shared Multidimensional Information).

Considering the DSS, we think that the OLAP technology brings changes both within the DBMS component and the model based management system.

Although OLAP systems can answer easily to questions like "Who?" or "What?" their main feature is finding the answer to more complex questions like "What if…?" or "Why ?".

OLAP allows users to make decisions regarding future actions.

OLAP instruments can be categorized according to the database architecture, which provides data for online analytical processing:

- multidimensional OLAP (MOLAP or MD-OLAP);
- relational OLAP (ROLAP), also called multi-relational OLAP;
- management query environment (MQE), also called hybrid OLAP (HOLAP).

The data analysis process within OLAP applications can only be achieved by using languages that allow operations on cubes. Such languages are SQL, MDX and RISQL.

Using OLAP in the decision process creates a complex architecture of DSS. We think that through its functions, an OLAP application can be used as an independent instrument or decision support, but also in combination with DSS, leading to the construction of a HSS.
The OLAP intersects with the DSS in both the DBMS component and the model management one.

In figure 4, we propose a conceptual architecture for a hybrid support system based on OLAP.

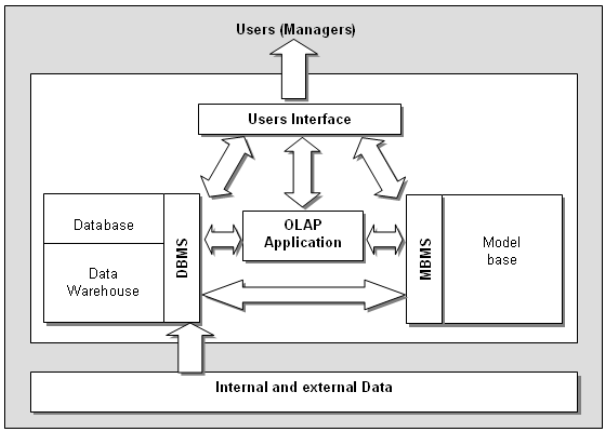


Figure 4. The architecture of a hybrid support system based on OLAP.

The bare information storage in a data warehouse does not always bring the benefits that an organization needs, especially considering the implementation of a BI system. We need to extract hidden knowledge within the warehouse in order to be able to fructify its value. As the quantity of data in the warehouse increases, it becomes more and more difficult if not impossible for the analysts to identify the trends and relationships between data using simple tools for queries and reports.

Not even the usage of the OLAP allows discovering the hidden relationships in a data warehouse. With the help of OLAP technologies, one can see the information that is searched on purpose by the users. This process represents a verify-oriented analysis, based on what is already known.

Data mining is one of the best methods to identify new trends and patterns of business out of the multitude of data available. Data mining discovers information in the data warehouse that usual tools for queries and reports cannot distinguish effectively. This process represents a discovery-oriented analysis.

Simoudis (1996) stated a widely agreed definition. According to him, Data Mining is the process, through which one extracts valid information, unknown before, comprehensive and actionable, out of the data warehouse and it is used in making important decision for business. [5]

There are four main operations associated with data mining techniques:

- foresight modeling;
- database segmentation;
- link analysis;
- deviation detection.

Considering the capacities of data mining, we think that integrating this technology with the DSS creates a high potential in optimizing and updating the models in DSS.

In figure 5, we propose a conceptual architecture of a hybrid system based on data mining.

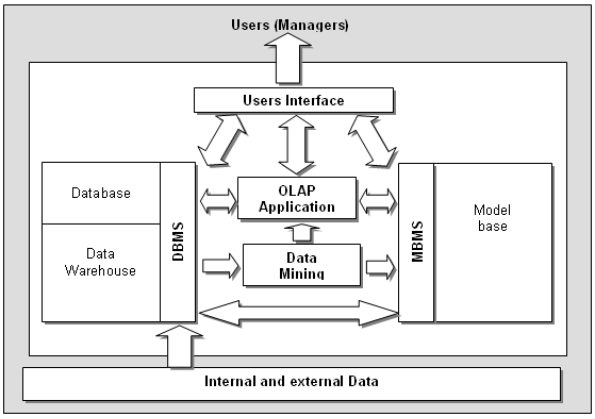


Figure 5. The architecture of a hybrid system based on data mining.

In our opinion, now, the implementation of HSS in the management of organizations oriented towards BI is very expensive and complex. The complexity and the high price of this kind of implementation come from the heterogeneous technologies and frameworks involved, and the hardware resources needed.

Nevertheless, the organizations can integrate these systems on different levels of complexity and compatibility, so that the cost of implementation will be the lowest.

We consider that the success of implementing new technologies for decision support depends largely on the maturity and the structure of the information system of the organization.

3. CONCLUSIONS

In our opinion, currently, SSH implementation in the management of BI oriented organizations is very expensive and complex. The complexity and high cost of the implementation result from the heterogeneity of technologies and frameworks involved, and hardware resources needed.

However, the organizations can integrate these systems on levels of complexity and compatibility so that implementation costs are minimal.

We believe that successful implementation of new technologies for decision support depends heavily on the maturity of the information system of the organization.

ACKNOWLEDGEMENTS

This paper is part of the research project POSDRU/89/1.5/S/59184 *"Performance and excellence in postdoctoral research within the field of economic sciences in Romania"*, Babeş-Bolyai University, Cluj-Napoca being a partner within the project.

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