BUSINESS INTELLIGENCE TECHNOLOGY:
THE CROATIAN CASE

Katarina Ćurko[*]

Each company aims to improve its business performance. Business Intelligence (BI) helps enterprises to optimize their decision-making capabilities and to attain unprecedented levels of competitive advantage. Its usage leads to conditions, procedures and mechanisms for creating quality information and business knowledge. By these the organization can successfully respond to numerous pressures in dynamical and complex environment. The main objective of the paper is to present what the business intelligence is, and show the results of the research about the level and use of business intelligence in Croatian large organizations.

1. INTRODUCTION

Business intelligence is not a new concept. Organizations have always striven for a better access to data and for a better understanding of business information in the hope of a becoming more competitive.

One of the reasons for letting user needs unsatisfied is that the development of information systems in many organizations is characterized by the disintegration despite significant expenditures for new information technologies. Many non- or loosely connected applications were developed. The result was the spider web environment, which is an anomalous, heterogeneous collection of systems and data (Inmon, Zachman, Geiger, 1997). That data is not sufficient for high quality analysis and support of decision making.

---

[*] Katarina Ćurko, PhD, University of Zagreb, Faculty of Economics, Department of Business Computing, Trg J. F. Kennedya 6, 10000 Zagreb, Croatia, Phone: + 385 1 2383 282, E-mail: katapur@efzg.hr

In the new generation of information system environment, the information resources are unified from a business perspective and dispersed from a physical and technological perspective. The need for unified resource of information for decision-making led to an integrated collection of data called the data warehouse. The data warehouses are used or being developed in approximately 70% of the worldwide companies (Cutter Information Corp., 1999). Quality data and information alone are not sufficient; one of the distinguishing assets of successful companies is knowledge. Usage of techniques and tools for extracting useful knowledge from the available data (e.g. from the data warehouse) is necessary for a company that has to respond to the environmental business pressures.

At the current stage of the knowledge discovery techniques, there are two widely used enabling techniques (Turban et al 1999): online analytical processing (OLAP) and data mining. The OLAP tools are currently used in 60% of the worldwide companies (Cutter Information Corp., 1999). The data warehouse, OLAP tools and data mining are the most used business intelligence technologies. Often, people refer to data warehouse and business intelligence synonymously.

2. BUSINESS INTELLIGENCE

Business intelligence is the ability of an organization to understand and use information to its gainful operation (Osterfelt, 2000). The enabled technology for the business intelligence has been rapidly expanded and improved in the recent period. As a consequence more and more complex business questions can be answered using these technologies: from the user friendly querying tools to the OLAP and data mining tools (Figure 1).

Value	Technology	Purpose
Data	Ad Hoc Query	Information on demand
	OLAP	Identification of trend and patterns
Knowledge	Data Mining	Identification of hidden trends and unusuall relationships

Figure 1. Value and purpose of the business intelligence technologies (Wu, 2000)

Of course, on the other side quality and integrated data are required, most commonly in the form of a data warehouse. Business intelligence has been driven by activities in data warehousing, data mart technology, on line analytical processing (OLAP) tools, extraction, transformation and loading (ETL) tools, data cleansing, information portals, data mining, business modeling. This paper is focused in the most widely used business intelligence enabling technologies: data warehousing, OLAP, and data mining, these terms are described in the rest of this chapter.

2.1. Data warehouse

As in many organizations multiple data sources have been developed and grown, the problem of quality data support for business decision-making appears. For good business decision-making it is necessary to have the access to all available and consistent data, moreover additional external data is needed more and more often. Irregular and heterogeneous collection of data sources in an organization is called the spider web environment (Inmon, Zachman, Geiger, 1997). The main deficiencies of such an environment are:
- the lack of consistency of results achieved in analyzing data,
- the difficulty of getting results,
- the lack of integration of data,
- the lack of historical data,
- the lack of metadata.

The solution to this problem is a concept known as a data warehouse. Data warehouse (DW) is an integrated, historical collection of detailed and summarized data that is fed by the spider web environment and external data sources. It is organized by business areas (subject oriented) and is user-friendly, especially for manager and user who is usually a business analyst.

The major characteristics of data warehouse are (Turban et al, 1999; Inmon, Imhoff, Sousa, 1998):
- Data are organized by a detailed subject, containing only information relevant for decision support,
- Data in the data warehouse are coded in a consistent manner (integration),
- The data warehouse contains both summary and detailed data,
- Data are kept for several years in order to be used for trends forecasting and comparisons over time (time variant),
- Once entered, data are not updated (non-volatile).

Internal and external sources of data may be used to fill the data to the data warehouse. The share of external data is greater for higher levels of decision-making.

Decision support systems that are used by managers at different management levels are usually based and built upon data warehouses. As a part of a modern decision support system, a quality on-line analytical processing, i.e. complex ad-hoc queries in an easy way using advanced yet user-friendly software tools, is possible. In this way too large reports that often consist of non-relevant information and are often not used by managers can be avoided.

Data warehouse is composed on two parts: data and the basic mechanisms for manipulation of the data. The data part of the data warehouse consists of basic data and aggregated multidimensional data. Mechanisms of manipulation are extraction, transformation, aggregation and indexing procedures.

The most delicate part of the data warehousing is the extraction as the quality data sources have to be provided. It has to be decided which internal and external data will be fed into the warehouse, and the inconsistencies among data sources must be resolved during the data entry (e.g. unifying of key attributes, unifying of the data formats, and others).

Benefits of data warehouses are most obvious in the companies with several computer platforms and versions and with many different data sources. According to Cutter Information Corp., the most important benefits organizations seek from their DW efforts are: better business intelligence (39%), reduced time to locate, access and analyzing information (21%), consolidation of disparate information sources (20%), strategic advantage over competitors (11%), faster time-to-market (5%), replacement of older decision support systems (3%).

Since much effort and high investment are required to build and maintain a data warehouse it is necessary to undertake a careful feasibility study. An organization may think of development the data warehouse if (Turban et al, 1999):
❑ Large amounts of data need to be accessed by end users;
❑ The operational data are stored in different systems;
❑ An information based approach to management is in use;
❑ There is a large and diverse customer base;
❑ The same data are represented differently in different systems.

2.2. OLAP tools

The goal of business intelligence is to help finding answers to business questions that will translate to better decisions. One of the simplest tools that have been in use for the last twenty years are ad-hoc query applications which give users the ability to access data and information on demand.

The problem with this type of data access is that it is not suitable for a large volume of data, nor can they be used effectively by end users (Turban et al, 1999). Furthermore, the visual form of the result of the query is usually not suited to final user needs, especially for higher levels of management.

On-line analytical processing (OLAP) tool is the combination of analytical processing procedures and graphical presentation (user interface). OLAP tools provide users with the ability to explore and analyse large amounts of data, their relationships, and present data in different perspectives (data visualization), involve complex computations, etc.

The key features of an OLAP application are (Forsman, 2000):
❑ multidimensional views of data,
❑ calculation intensive capabilities and
❑ time intelligence.

A multidimensional view of data that is usually used in OLAP applications provides quick and flexible access to data and information. Typical applications performed on multidimensional data views are (Jarke et al, 2000): roll-up, drill-down, slice and dice, and pivoting.

Also, more complex and serious analyses are possible, such as time series and model, charting, forecasting, modeling, statistical analysis and "what-if" functionality. Analytical processing procedures represent methods of detecting different forms of information needed in the decision process.

Presentation of information represents user interface and determines the way to examine queries and display of query results in form of text, picture, graphics, etc.

It is important that interface enables pleasant work within a graphical environment, which will assure simple and fast running of queries, and a visually appropriate display of query results.

OLAP technology potentially provides several benefits to an organization (Forsman, 2000):

❑ increases the productivity of business managers, analysts, and whole organization by inherent flexibility and timely access to strategic information,
❑ enables developers to deliver solutions to business users faster, as well as to provide better services,
❑ provides the ability to model real business problems and respond more quickly to market demands.

2.3. Data mining

There are many definitions of the data mining. Data mining, by its simplest definition, automates detection of key patterns in a database. Data mining is the exploration and analysis, by automatic or semiautomatic means, of large quantities of data in order to discover meaningful patterns and rules (Berry, Linoff, 1997).

Gartner Group defined data mining as the process of discovering meaningful new correlations, patterns, and trends by sifting through large amounts of data stored in repositories, using recognition technologies as well as statistical and mathematical techniques (STATSERV). And finally, one of the popular citations defines data mining as a non-trivial process of identifying valid, novel, potentially useful and ultimately understandable patterns for data (Fayyad et al, 1996).

Since OLAP is retrospective in nature (Turban et al, 1999) and a user should understand how to navigate the data, data mining provides prospective knowledge discovery. It automatically discovers hidden trends and patterns in large volumes of data. A significant distinction between data mining and other analytical tools is in the approach used in exploring the relationships among the data.

Analytical tools usually support a verification approach, in which the user hypothesizes about data interrelationships and then verifies or refutes those hypotheses. This approach relies on intuition of the analyst to pose the question and refine the analysis based on the results of potentially complex queries against a database.

Data mining uses discovery-based approaches in which pattern matching and other algorithms are used to determine the significant relationships among

68

data. Data mining algorithms can look at numerous multidimensional data relationships concurrently, highlighting those that are dominant or exceptional. Data mining includes: association, classification, estimation, prediction, affinity grouping, clustering, description and knowledge discovery.

There are several techniques and algorithms used in data mining tools (Figure 2), from statistic analysis, through rule induction and nearest neighbor algorithms, to neural networks and genetic algorithms (Kennedy et al., 1999).
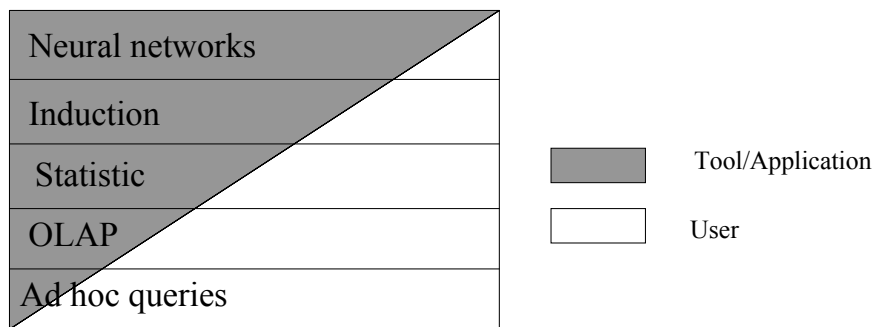

Figure 2. Progression of data mining techniques in the order of user involvement (Wu, 2000)

As shown in Figure 2, data mining enables users to discover knowledge and provides them with greater depth and understanding of data than ad hoc querying and using of OLAP applications.

3. BUSINESS INTELLIGENCE IN CROATIA

Research was conducted on the sample of 106 large companies randomly selected from the list of "400 biggest" companies in Croatia (Privredni Vjesnik, 1998) in the period from May 1 - September 30, 2000. The selection of the companies was based on their revenues. The size of the selected companies was analyzed according to the revenue and the number of employees in 1999.

In order to ensure that the responses reflect the organizations' perspective of the business intelligence, the CEOs and IS executives were asked to answer the questionnaire.

The research of the business intelligence was related to adoption of the DW, OLAP and data mining technology. It also analysed successfulness and

initiators of the data warehouse project, management level of users, key tools used and some other aspects.

Results of the research showed that the majority (approximately 80%) of the respondents are familiar with the term data warehouse (DW). Only these respondents answered the rest of the questionnaire.

Even 35% of the respondents use, while 11% develop data warehouses. According to (Cutter Information Corp., 1999) approximately 65%-70% of the companies worldwide are currently using and/or developing data warehouse applications. The percentage of the DWs, which are used, or being developed is lower in Croatian companies (46%), but is satisfactory.

Only 8% of the respondents do not plan to develop DW at all. The majority answered that such an apllication is of no interest to the organization, or that they did not need it. The main reasons for this are the lack of information and knowledge about the data warehouse efficiency in supporting decision-making processes.

Table 1 shows the initiators of the DW project. As evident, the DW, in most cases, initiative came from the IS department. But, in 30% of cases, such an initiative came from the top and line management, but it never came from the general manager. This finding shows that, in some organizations, management is aware of the importance of data quality for making business decisions.

Table 1. Initiator of DW project

Initiator	Percentage
General manager	-
Top management	20%
Line management	10%
IS department	61%
Other	8%

The organizations that already have, or develop a DW, indicated that the main reasons for introducing the data warehouse were the reduction of time needed to find, access and analyze data (80%). Participants in the DW project are shown in Table 2.

Table 2. Participants in the DW project

Participants	Percentage
IS department	57%
Consultants	40%
IS department, consultants and users	3%

As demonstrated by Figure 3, DWs are used mostly on the management level. However, they are more used on the lower level of management.
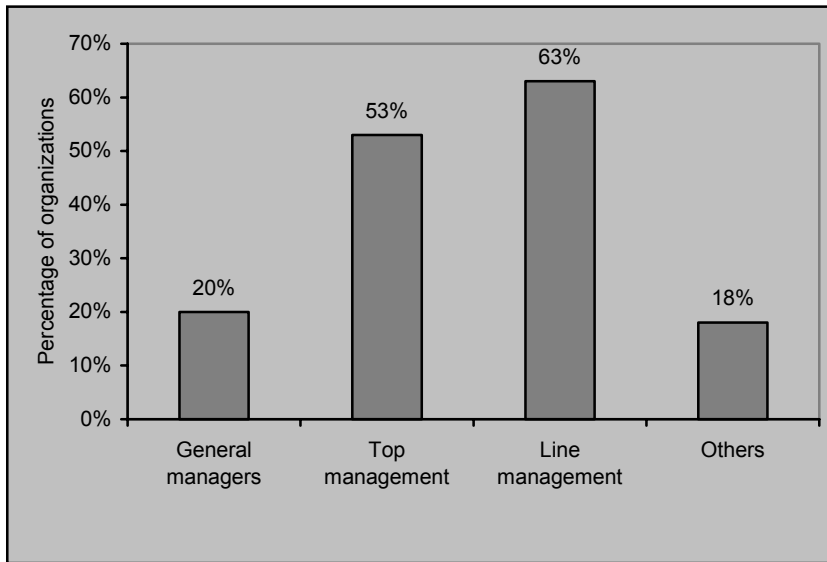

Figure 3. Users of DW

Respondents (companies who use or develop a DW) were asked about the data warehouse usefulness. Almost all of them estimated that their data warehouse is useful. Results are shown in Figure 4.

Analysis of the data warehouse tools presents a large variety of used tools; however, Oracle tools and MS SQL server tools were used in most organizations.
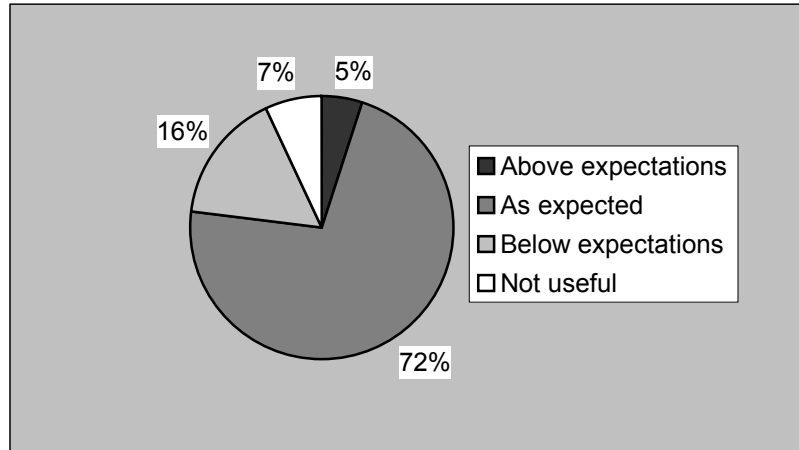
Figure 4: Usefulness of DW.

In the rest of this chapter, results of the research into the OLAP tools and data mining technology are presented. As evident from Figure 5, OLAP tools are in use in only 18% organizations.
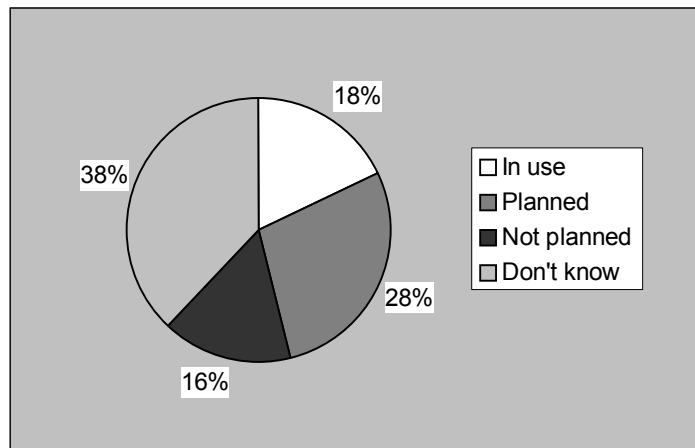

Figure 5. Usage of OLAP tools

It was expected that the level of OLAP tools usage is somewhat similar to the state of the data warehousing, as these two technologies are complementary (Forsman, 1997). Some organizations do not plan to use OLAP tools, mostly because they don't have appropriate data sources, or because the management

72

doesn't support it. But, the fact that 38% of IS executives don't know what OLAP tools are, is unexpected.

Satisfaction of users with OLAP tools is lower than in case of DWs. Even 25% of respondents who already use OLAP tools stated that their satisfaction is below the expectations. The use of OLAP tools was mostly suggested by IS department.

It was expected that the data mining tools and techniques are not widely used in Croatian organizations for different reasons: organizations are relatively small, tools are expensive, quality and quantity of data on which the data mining techniques are to be applied is in many cases not sufficient, etc. As evident from Figure 6, they are in use in only a few organizations.
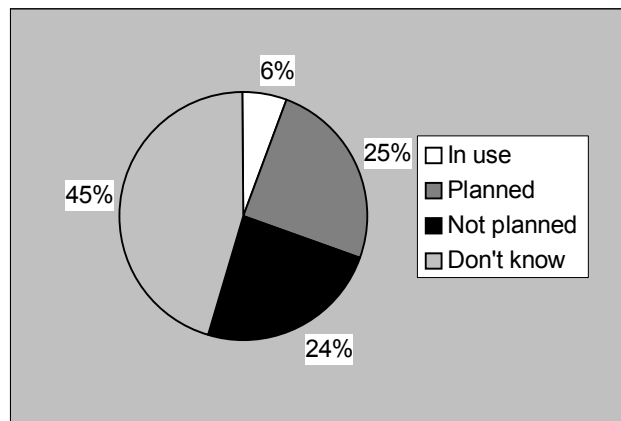

Figure 6. Usage of data mining tools

IS executives are not informed about the new development of information technology in the data mining area, even more than in the case of OLAP tools, since almost half of them do not know what data mining is.

On the other hand, in some organizations, IS department has suggested introduction of data mining tools, but management did not support the idea. In the organizations that already use such tools, or plan to use them, this initiative, in most cases, came from the IS department.

4. CONCLUSION

Business intelligence is the ability of an organization to understand and use information for achieving competitive advantage. It plays a key role in helping companies optimize their decision-making process and management.

Correct, prompt and visually appealing information becomes an important resource for efficacious decision-making and management. Only information system based on the modern information technology, which is the data warehouse concept, can provide data and information needed for management of business processes. The data warehouses are used, or being developed, in 70% of the worldwide companies.

However, quality data and information alone are not sufficient. Usage of techniques and tools for extracting useful knowledge from the data warehouse is necessary for a company that has to respond to business pressures from the environment. There are two widely used enabling techniques of the knowledge discovery: online analytical processing (OLAP) and data mining. In the companies worldwide, level of the OLAP tools usage is somewhat similar to the rate of the data warehouse (60%).

The research in Croatia included tree business intelligence technologies: data warehouse, OLAP tools and data mining. Results of the research showed that many organizations are aware of the meaning of business intelligence (almost 80% of the respondents are familiar with the term data warehouse). Approximately 46% of Croatian companies are currently using and/or developing data warehouse applications. Taking into consideration that Croatia is less developed country and one of the countries in transition, the state of the data warehouse technologies is expected and satisfactory.

OLAP tools are in use in only 18% organizations, while even 38% of IS executives don't know what OLAP tools are. This result is unexpected. The data warehouse and OLAP tools are two complementary technologies, so it could be expected that the level of the OLAP tools usage is somewhat similar to the state of the data warehousing. Data mining tools and techniques are in use in only a few organizations.

The question is, have the managers have realized the importance of quality information for making business decisions and management? Results show that managers are often among the initiators of data warehousing. Satisfaction with the business intelligence tools is a little higher, if the initiator of the project

were a manager, but it is not statistically significant. On the other hand, CEOs and IS executives identify managers as the obstacle to introducing new, contemporary information technology.

REFERENCES:

1. Berry Michael, J. A., Linoff, G., (1997), *Data Mining Techniques for Marketing, Sales and Customer Support,* John Wiley & Sons, New York
2. Cutter Information Corp. (1999), *Data Warehousing for Business Intelligence*, Internet: http://www.cutter.com/itgroup/reports/dwissues.html
3. Fayyad U., Piatetsky-Shapiro G., Smyth P., Uthurusamy R. (1996), *Advances in Knowledge and Data Mining,* AAAI/MIT Press
4. Forsman, S., (1997), *OLAP Council White Paper,* OLAP Council, Internet: http://www.olapcouncil.org
5. Inmon, W. H., Imhoff, C., Sousa, R. (1998), *Corporate Information Factory,* Wiley Computer Publishing
6. Inmon, W. H., Zachman, J. A., Geiger, J. G. (1997), *Data Stores, Data Warehousing and the Zachman Framework*, McGraw-Hill
7. Jarke, M., Lenzerini, M., Vassiliou, Y., Vassiliadis, P., (2000), *Fundamentals of data warehouses,* Springer
8. Kennedy, R., Lee, Y., Van Roy, B., Reed, C. D., Lippmann, R. P., (1998), *Solving Data Mining Problems through Pattern Recognition,* Prentice Hall
9. Kimball, R., (1996), *The Data Warehouse Toolkit - Practical Techniques for Building Dimensional Data Warehouses,* John Wiley & Sons, Inc.
10. Osterfelt, S., (2000), "Business Intelligence: The Intelligent Customer", *DM Review* (http://wdmreview.com), November
11. *Privredni vjesnik,* (1998), Special issue on 400 Croatian largest companies, June 29, Zagreb.
12. Turban, E., McLean, E., Wetherbe, J. (1999), *Information Technology for Management: Making Connections for Strategic Advantage,* 2nd Edition, John Wiley & Sons
13. Wu, J., (2000), "Business Intelligence: What is Data Mining", *DM Review* (http://wdmreview.com), August
14. STATSERV, Internet; http://www.statserv.com/datamining.html

TEHNOLOGIJA ZA RAZVOJ POSLOVNOG IZVJEŠTAVANJA (BUSINESS INTELLIGENCE): HRVATSKI SLUČAJ

Sažetak

Svako poduzeće teži unapređenju svojih rezultata. Business Intelligence (BI) pomaže poduzećima da optimiziraju svoje sposobnosti za odlučivanje, te postignu nekada nedostižnu razinu konkurentske prednosti. Uporabom ove tehnologije stvaraju se preduvjeti, procedure i mehanizmi za kvalitetu informacija i poslovnog znanja. Njihovom, pak, uporabom, organizacija može uspješno odgovoriti brojnim pritiscima u dinamičkoj i složenoj okolini. Temeljni cilj ovog rada je predstaviti pojam poslovnog izvještavanja (Business Intelligence), te prezentirati rezultate istraživanja vezanog uz njegovu uporabu u velikim hrvatskim poduzećima.