BI APPLICATIONS IN LOGISTICS

Gordana M. Radivojević[*]
University of Belgrade, Mihajlo Pupin Institute, gordana.radivojevic@pupin.rs
Gorana R. Šormaz
University of Belgrade, Mihajlo Pupin Institute, gorana.sormaz@pupin.rs
Bratislav S. Lazić
University of Belgrade, Mihajlo Pupin Institute, bratislav.lazic@pupin.rs

Abstract: Contemporary business conditions in the global market require a fast and efficient decision-making. The basis for quality decision-making are the right information at the right time and the right place. The development of information and communication technology – ICT has led to the generation and collection of large amounts of data on business resources, processes, markets and customers. The key to a successful business becomes the possession of quality information and decision making based on the current state of the business system and market demands. Business Intelligence – BI is a set of methodologies, processes, architectures, and technologies that enable the processing of large amounts of data and their transformation into a high-quality and useful information and knowledge. This paper will describe the BI technology and the possibilities of its applicability. In particular, it will show the effects of BI in the field of logistics.

Keywords: logistics, business intelligence, data warehouse, decison making, reporting.

[*] Corresponding author

1. INTRODUCTION

In contemporary market conditions, information and knowledge are the key elements for effective decision making. Business systems monitor their performance, results and performance indicators and according to market demands and competition's behavior, make decisions about their plans, market expansion, operation and future development. Modern information systems - IS enable the support of business processes, collection and processing of business data and obtaining reports on work concerning the activities, processes, or the entire system. Global market and fierce competition have imposed new demands on business systems: the speed of reaction and decision-making based on large amounts of data on previous and current operations. This has led to the need for the right information at the right time that will enable the creation of new business value.

Business Intelligence – BI is a modern approach to processing large amounts of data, their transformation into high-quality information and presentation possibilities in a form that corresponds to the users. Historically, BI is continued development of the IS that give support to decision making in a business system. A necessary condition for the development of BI systems is the existence of a modern technology of data storage. Traditional database systems are oriented towards the storage and processing of individual transactions and do not provide access to information and an integrated view of the business system. DWH (Data Warehouse) is a database technology that provides access to business information with high performance and safety.

This paper will describe the BI technology, possibilities and examples of its application in the field of logistics. The paper consists of four parts. The first part describes the DWH technology. The second part includes a description and advantages of the BI technology. The third part shows the possibilities and examples of application of BI in the field of logistics. Concluding remarks are in the fourth part.

2. DATA WAREHOUSE

Data Warehouse – DWH is a modern database technology that provides input, storage and processing of heterogeneous data from different sources in order to provide a solid basis for the analysis and reporting to end-users. From the system point of view, DWH corresponds to the organizational scheme of the business system, from the level of the data source to the decision-making level. From the technological point of view, DWH is a set of layers that provide reception, transformation,

processing and online analytical data processing. DWH system facilitates the storage and processing of large amounts of data from integrated heterogeneous sources in optimized multidimensional data patterns.

Some of the reasons for designing the DWH system are [7]: Integration of data with business functions and processes in order to obtain a complete picture of the individual parts or the entire business system; The possibility of simultaneous execution of large queries and reports, and routine operation of business users with other features of the system; Reorganization of data in order to perform reports and queries more quickly; and Ensuring quality through a strict check of data entry – the consistency and integrity of data.

The development of the DWH system is very complex and requires ad-hoc methodologies and the appropriate life cycle. In literature there are three approaches to the development and maintenance of the DWH system: system pattern evolution, the development of different versions of the pattern and system maintenance [3]. Changes in the DWH system are inevitable in practice because it needs to correspond to the real business system and its requirements. Today there are developed quality software tools that enable maintenance of the DWH system and a consistent implementation of changes in all layers. An example of the DWH architecture is shown in Figure 1.

Data is collected from various internal and external sources: different transactional database off line import of data from files, manual entry of data from documents, import of data from ERP (Enterprise Resource Planning) and CRM (Customer Relationship Management) systems, and import of data from external systems (suppliers, Point of Sale – POS, banks, etc.). ODS (Operational Data Storage) layer receives and stores all data from internal and external sources. ETL (Extraction, Transformation and Loading) layer checks the consistency of data in accordance with the defined rules, establishing relations of data integrity and charges the data patterns in the DWH. In the summary layer the aggregation of data is done at different levels of detail according to the needs of analytical data processing. The analytical layer includes a set of data models, which are the basis for the generation of different reports, as defined in the business system. The OLAP cube are data models designed to meet the needs of OnLine Analytical Processing data. Data mart is a logical subset of the DWH defined according to the specific needs of the business process or user groups, in order to obtain

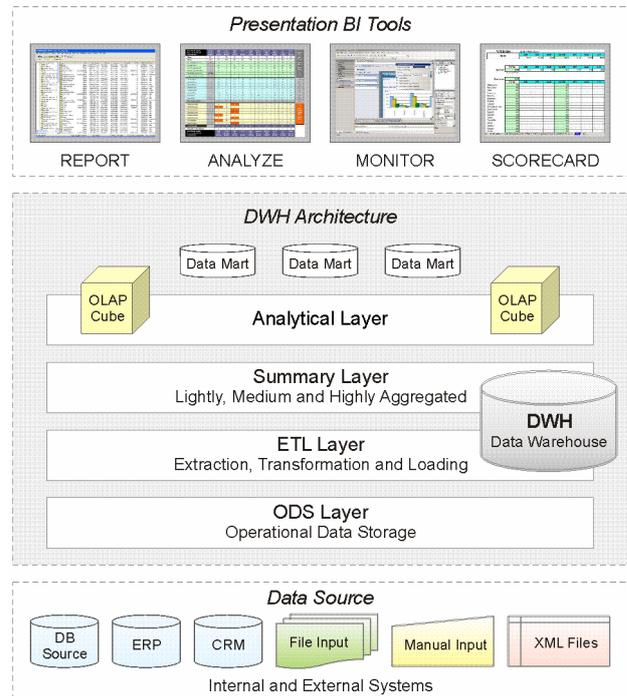various business reports that support the making of actual decisions.

Figure 1. DWH architecture

3. BUSINESS INTELLIGENCE

Business Intelligence – BI is a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information and knowledge. BI provides business information and the analysis of key business processes, quality decision-making at different management levels and improvement of the performance in the business system. The role of BI in the process of decision making is shown in Figure 2.
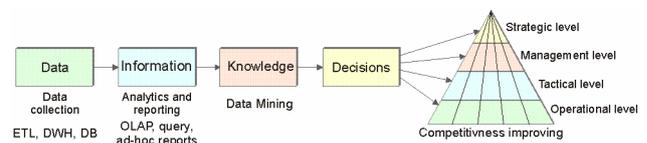

Figure 2. The role of BI in the decision-making

The development of information technology – IT has enabled the development of modern platforms to help work with large amounts of data. On one hand, the volume of data being generated and stored in business systems is constantly growing, and on the other hand, there is an increasing number of users and their needs for high-quality information and new knowledge. BI meets the requirements of business systems because it can get information quickly, reliably and in an appropriate form.

The BI system can be observed from different angles. The BI system allows the transformation of data into information and knowledge, thus creating new conditions for decision-making in the business system. Decision-makers in a business system use the BI analytics to support adoption of quality and timely decisions at all management levels. The real value of the BI system is reflected in the added value that is generated: better understanding of one's own resources, the implementation of changes in the business system, opening of new markets, acquiring new users, etc.

In almost all business systems there are developed reporting systems that are based on traditional approaches and are a standard part of the IS and ERP systems. These reports are usually standard, historical and static. Classic reports do not have the ability to analyze data on a variety of business processes, monitor business performance in real time, link data from various organizational levels and perform planning that aligns business strategy and financial objectives.

BI enables overcoming of these problems and provides new opportunities to business systems in the context of fast market changes. BI refers to all business processes and activities, includes all data and transform them into reliable and quality information providing timely response to business issues. The right information at the right time and the right place is a prerequisite for making decisions at the operational, tactical and strategic level, and quality decision-making leads to the creation of additional value in the business system.

BI is a modern and contemporary approach to the monitoring of the business system, which requires specific hardware and software infrastructure and the DWH system. The central part of BI technologies are analytics and reporting, which, on the modern IT platform, got new possibilities in terms of application of analytical and statistical models, BI application integration with other business systems and the possibility of different forms of presentation. Forrester's research shows that the BI technology is evolving and that companies, based on new trends, can gain a competitive advantage in their fields [1].

The BI system consists of a number of applications that are designed for analytics and reporting on certain processes, performances, causal relationships that exist between different parts of the system or are created according to specific customer requirements. The use of these applications can indicate the performance of the process and of the entire system, the analysis of deviations and proposal of measures that lead to improving

productivity. Standard reporting systems provide quantitative characteristics in form of tables, which makes it difficult to realize the causes of deviations from planned values. BI uses data at different levels of aggregation, has the ability to connect with analytical models and a good visualization of the output, which makes information easier, faster and simpler for use and decision-making.

BI platform enables the development of different types of applications depending on the method of data processing, complexity, user interaction and form of presentation of information. The main types of BI applications are [2]:

- **Standard Reports** are predefined reports that use data from the DWH system through developed data models. They enable a smaller amount of interaction with the user through the input of certain parameters that define the extent of reporting. This type of application is commonly used for reporting systems that are essential in the daily operations of the user.

- **Ad-hoc queries and reports** allow users to search data through multidimensional data models (the OLAP cube). Simple Ad hoc tools provide results in the form of tables, while advanced tools provide forming of complex reports. Ad hoc reports are made when needed and are a response to the current customer requirements.

- **Analytical applications** are complex reports that combine different sets of business information sorted according to certain characteristics, with one or more approaches for information analysis. These applications are related to the analysis of specific business processes and activities.

- **Data mining applications** are developed in more advanced BI systems where there are already other types of applications in use. They are associated with the transaction systems and / or other business applications. Typical examples are applications for the prevention of fraud with credit cards and e-business applications. Both examples are based on an analysis of historical transactions to identify patterns of behavior and in real time prevent the abuse of credit cards, that is, propose purchase of additional products based on previous purchases.

- **Dashboards and Scorecards** are the most advanced version of BI applications because they include a large collection of data relating to different business processes and

the visualization of results in a way that is fastest to present new information and knowledge to the user. Dashboards are most commonly used to monitor and manage processes and activities, ensuring monitoring changes in real time. Balanced Scorecards is an approach of monitoring business performances from different aspects, which enables users to monitor the current situation and provides the possibility to warn of future changes.

- **Embedded BI applications** are much more sophisticated than the standard operational reports. These applications handle historical data from the DWH on a variety of business processes in order to provide support for making operational decisions. Embedded BI applications are associated with other business applications to which they forward the results of processing. They are often associated with DM techniques to help identify patterns at the operational level.

BI applications can have different output data formats (interactive, HTML, PDF, RTF, Excel, PowerPoint), which can be displayed on screen, printed, e-mailed or faxed to customers or stored in a repository or used as documents in the e-trade (Figure 3).
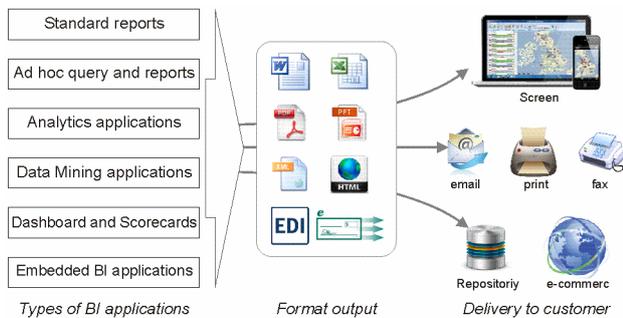

Figure 3. Various formats of BI applications output results

BI applications can be run on demand, automatically at specified time periods, or after certain events in the business system. For example, reporting applications that run on a daily basis for managing customers, accounts and invoices for payment delivered at the beginning of the month to customers via e-mail, analytic applications that are executed when the value of sales falls below the defined level.

The main issues raised by the improvement of operations and improvement of business performance are *how is it done now* and *why*, and *how it should be done*. The answers to these questions have a direct impact on the future way of

doing business. BI allows monitoring and management of the business system through different types of applications that provide an immediate response to the user on the state of business processes and activities. Figure 4 shows an example of business functions in a company and different types of BI applications that support them.
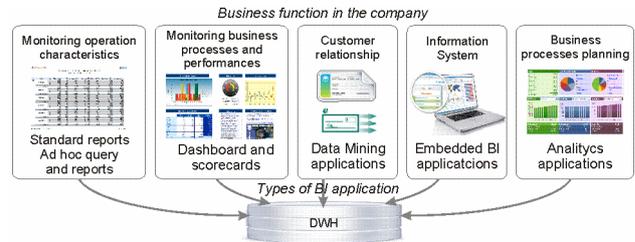
Figure 4. Business functions and BI applications

The application of BI in the business system can provide: improvement of the operational functioning of business processes, and improving the business system management process [8].

4. BI IN LOGISTICS

Business organization and decision-making system in a company can be schematically represented in the form of a pyramid. In accordance with the hierarchy, business processes and organization of work, there are four organizational levels in a company: operational, tactical, managerial and strategic [5]. Horizontal and vertical integration include information flows that are exchanged at the same level or between different organizational levels. The existence of high-quality and reliable information is the basis for effective decision making at all levels in a company.

The application of BI in a company can be realized at all levels of organization so that the BI applications support business processes and the decision-making system. Various types of applications are used to support the operational tactical, managerial and strategic management (figure 5):

- At the operational level it is necessary to monitor the operation of the activities and processes in real time - standard reports;
- At the tactical level the values of business performances and key performance indicators are monitored (Key Performance Indicators – KPI) – dashboards and Scorecards;
- At the management level the analysis and the analytical data research are done, after being obtained from the lower system levels – analytic applications; and

- At the strategic level, planning and forecasts are done, and based on that, in accordance with the financial resources, business strategies are defined.
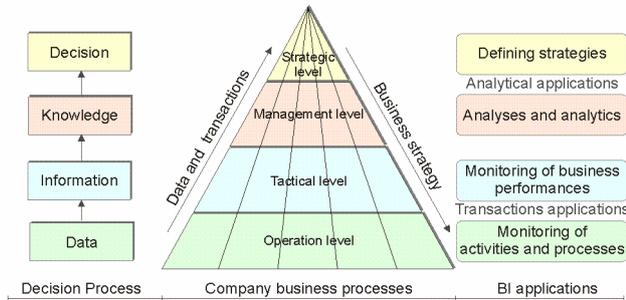
Figure 5. The application of BI applications at different levels decision-making

The hierarchical structure of the decision-making process, from the data to decision making, corresponds to levels of decision making in the business system, and BI applications are the support to business functions at different levels.

In the field of logistics BI systems can be applied in all companies that manufacture the products and/or provide services – production systems, logistics and distribution centers, goods terminals, storage systems, fleet management, retail, etc. The application of ICT in logistics has enabled automatic generating and storing of large amounts of data related to the processes and activities in a company, customers, business partners, participants in the supply chain, market conditions, etc. In a large number of companies the data is not analyzed sufficiently in order to take full advantage of the information and acquire new knowledge. The BI technology allows the processing, analysis, and data analytics, in order for companies to improve their performance and achieve competitive advantage.

The applications of BI in logistics can be divided into the following groups:

- KPI – BI applications enable monitoring of key performance indicators of all the activities and processes in near real time. Contemporary models of reports provide quick and reliable information, rapid response in emergency situations, the automatic exchange of necessary information with other participants in the process, continuous monitoring of performance, etc.
- Warehouse Management – there are numerous examples of the use of BI applications in the analysis of inventory, survey and analysis of storage performance,

storage activities cost allocation, analysis of inflows and outflows from the warehouse, determining the allocation of goods and monitoring storage performance [6].

- Transport Management – BI applications can be designed for the analysis of transport costs, route planning and scheduling, performance analysis of drivers and vehicles, the analysis of delivery time cycles depending on various factors, capacity planning in line with expected demand trends, evaluation of the carrier that provides the service and analysis of the causes and consequences [6].
- Customer Relationship Management – The company exchanges information with its customers in the form of orders, invoices, reports on implemented services, payment reports, etc. The BI technology enables automation of all these activities by providing the users with the appropriate documents in defined time periods. On the other hand, analysis of the data collected on users gives the company new knowledge and makes it possible to create a custom offer for a particular user. In a similar way, BI applications can be used for managing relationships with business partners, customer analysis and resource planning.
- Management of services provided to users – BI applications enable better communication with users, management of elements of the service provided, analyzing of customer satisfaction, data analysis on user profitability, adapting to the needs and requirements of users etc.
- Supply chains – supply chains mostly use three types of BI applications: standard reports, dashboards and scorecards. Dashboards allow monitoring of realization of supply chains in near real time, and reporting of all links in the chain with necessary data. The main advantages of BI in supply chains are: following the realization and actual performance, increase of visibility, faster and more reliable exchange of information, improving the performance at the level of participants and at the level of chains, a better introduction to the events that generate additional costs, the ability to react quickly in case of delays, etc. [4].

In literature there are many examples of application of BI applications in logistics processes

and supply chains. Companies indicate a number of positive effects of application. Some of the examples are [8]:

- Western Digital, hard drive manufacturer with annual sales of more than $ 3 billion, uses BI for better warehouse management, purchasing, product life cycle and CRM. BI has enabled the reduction of operating costs by 50%.

- CompUSA, selling computer equipment and software, use BI to analyze their sales trends. In the first phase of the BI system implementation they have earned more than $ 6 million.

- TransCo is a large manufacturing company, with more than 4000 authorized dealers, over 2000 suppliers, hundreds of thousands of parts, and more than a million units in stock in its distribution centers in North America. TransCo use BI technology to track and analyze business performance in order to improve their services and reduce safety stock levels.

- Walmart has its promotion in the market tied to improving core business processes: planning, demand forecasting, sales, supply chain management and cost management. BI technology has been applied throughout the company, and many BI applications are used: to monitor their supply chains in real-time, to manage inventory and ordering, to process orders, and so on. Effects that are achieved go far beyond their competitors.

5. CONCLUSION

Today, the BI technology is applied in all areas, from the manufacturing and service systems, marketing, financial institutions to medicine, pharmaceuticals and sports. The BI can be applied wherever there is need to analyze large amounts of data in order to arrive at quality decisions, where sales and marketing are the basis of success, where it is necessary to decide fast based on current events, where a large number of transactions is monitored in order to reach conclusions, where there are a large number of products and clients.

The BI is applied in all logistic systems for monitoring performance, monitoring of business processes, receiving reports on systems operation and analysis of business indicators. The greatest advantages of the BI technology are: the possibility of an intuitive, clear and rapid reporting; shortening of time of submission of the report, possibility to submit the report in different formats and to different users, the possibility of integration of the BI applications with a variety of IS and ERP systems, development of the BI applications for various management levels of the business system etc.

ACKNOWLEDGMENT

REFERENCES

[1] Evelson, B., Nicolson, N., 2008. Business Intelligence – An Information Workplace Report, [on line], Available at: http://www.forrester.com/ Topic+ Overview+Business+Intelligence/fulltext/-/E-RES39218, [Accessed: 11.09.2013.]

[2] Kimball, R., Ross; M., Thornthwaite, W., Mundy, J., B., Becker, 2008. The Data Warehouse Lifecycle Toolkit, John Wiley & Sons, January 10, 2008.

[3] Oueslati, W., Akaichi, J., 2010. *A Survey on Data Warehouse Evolution*, International Journal of Database Management, Vol. 2(4), pp.11-24.

[4] Partridge, A., R., 2013. Business Intelligence in the Supply Chain, Inbound Logistics, Available at: www.inboundlogistics.com, [Accessed: 12.09.2013.]

[5] Radivojević, G., Popović, D. 2009. *Information Systems in Logistics*, XIX International Triennial Conference MHCL, University of Belgrade, Faculty of Mechanical Engineering, pp. 199-202, October 15-16, 2009, Belgrade, Serbia.

[6] Rao, P., S., Swarup, S., 2001. Business Intelligence and Logistics, Available at: www.wipro.co.in, [Accessed: 12.09.2013.]

[7] Stewart, S., 2008. Data Warehouse Basics, [on line], Available at: www.rapid-business-intelligence-success.com/data-warehouse-basics.html, [Accessed: 18.07.2012.]

[8] Williams, S., Williams, N., 2007. The Profit Impact of Business Intelligence, Morgan Kaufmann Publishers is an imprint of Elsevier, San Francisco, USA.