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BUSINESS INTELLIGENCE SYSTEMS. NEW CHANCES AND POSSIBILITIES FOR HEALTHCARE ORGANIZATIONS

Abstract: The healthcare sector is one of the most developing sectors of the contemporary economy, increasingly considered in terms of market mechanisms. The managers of healthcare organizations need solutions that would allow them to improve decision-making, business processes, communication between doctors, patients and the administration, as well as effective access to different data. Business Intelligence systems may be helpful in this area. The article is only an outline of using BI for supporting the decision-making process in organizations in the healthcare sector. Our research attempts to answer the question concerning the general possibilities of using BI in healthcare organizations. Therefore, the main objective of our study is to identify the possibilities of using BI systems in healthcare organizations and the chances for healthcare organizations which appear due to BI systems implementation. The structure of the article is directed by this objective.

Keywords: Business Intelligence, healthcare organization, Hospital Information System.

1. Introduction

For many years BI has been adopted in large enterprises, particularly from the business sector, and hence the research on the possibilities of using BI has been focused on them, reflecting their situation and needs. There is a lack of in-depth research on using BI in healthcare organizations, and nowadays they are becoming an important beneficiary of BI systems. The need for a more systematic and deliberate study on BI and the factors that allow for success in BI initiatives in healthcare organizations is crucial. These organizations need to be cognizant and aware of the possibilities of using and the benefits from a BI initiative. The first studies show that the use of BI systems in healthcare organizations can be a source of competitive advantage and achieve various benefits.

2. The essence of Business Intelligence

The issue of Business Intelligence (BI) is the subject of wide discussion in the literature. Interest in this subject increased significantly when the reviews began

to appear, saying that BI systems are an essential component of modern company information infrastructure, since they contribute to its success and competitiveness.

Business Intelligence (BI) is the subject of extensive discussion in the literature [Davenport, Harris, Morison 2010; Wixom, Watson 2010]. Although for the last two decades the development of BI systems has been observed, there is still no clarity in the interpretation of the term [Olszak 2012a]. The role of BI systems and their influence on organizations have been subject to change (from simple static analytical applications into strategic planning, CRM, monitoring operations) [Olszak, Ziemba 2007]. It ceased to be regarded only as a category of technology, and became the measure of a new approach to managing the organization, work culture of the information, and even a new model called Business Intelligence-based organization [Olszak 2012a]. It is worth stressing that the main aim of Business Intelligence systems is to hold intelligent exploration, integration, aggregation and a multidimensional analysis of data originating from various information resources [Olszak, Ziemba 2007].

Currently, the term BI is closely associated with the issue of a data warehouse. This is a key technology used to build the type of system that integrates analytical data from different transactional systems [Inmon, Strauss, Neushloss 2008]. BI refers to decision-making, information analysis, knowledge management and human–computer interaction. Therefore, they are also often associated with such systems as: MIS (Management Information Systems), DSS (Decision Support Systems), EIS (Executive Information Systems), Management Support Systems, Business/ Corporate Performance Management [O'Brien, Marakas 2007]. However, there are several differences between these technologies [Olszak 2012a; Glancy, Yadav 2011]. BI systems are focused on supporting various business functions, supporting all the levels of management decisions, using the process approach, and advanced analytical techniques. They also allow for new knowledge discovery, which is important for the competitiveness of organizations in order to enter new markets, attract new customers and introduce new sales channels.

For the purpose of the research, it is assumed that Business Intelligence (BI) refers to technologies, applications and practices for the collection, data access, integration, analysis, and presentation of business information to enable employees (users) of the organization to gain a deeper business insight and help them in making more effective decisions. This means that the purpose of BI is to support better business decision-making.

Business Intelligence (BI) systems have traditionally used large volumes of static data that have been extracted, transformed and loaded into a data warehouse [Olszak 2012a]. These systems are designed to help organizations to understand complex processes and relationships by providing a comprehensive view of the organizational data [Kolowitz, Shresth 2011] (see Figure 1).
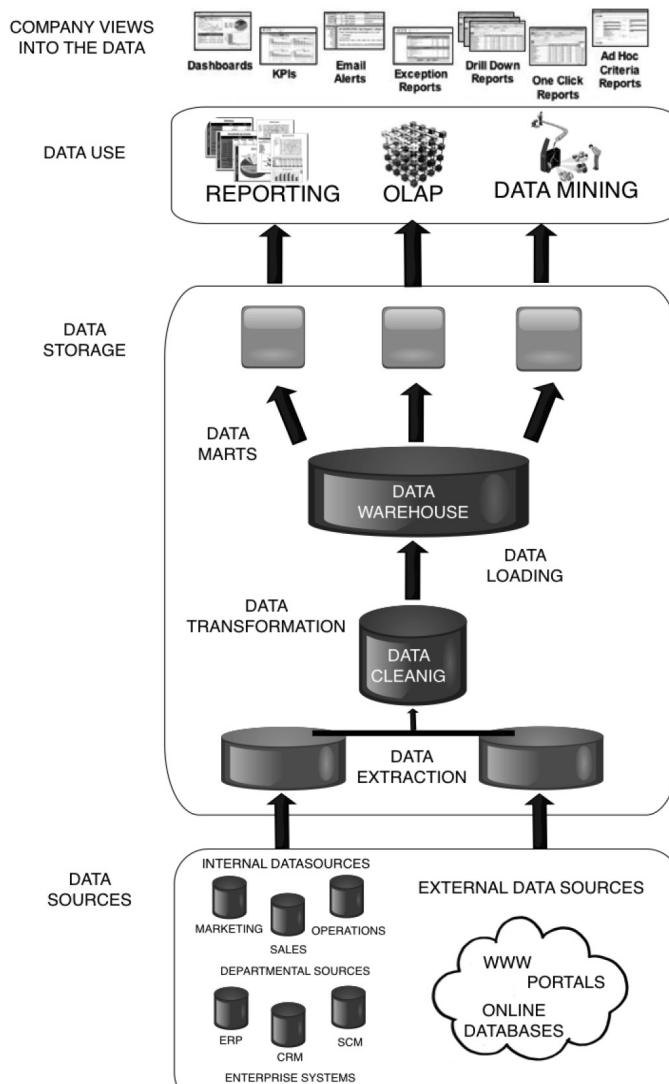
Figure 1. Scheme of Business Intelligence system

Source: own elaboration.

It is worth stressing that BI systems are not limited only to the context of data analysis, but also to collecting and presenting information [Olszak 2012b]. What is more, they do not focus exclusively on technology and/or applications, but also on business context, decision-making, etc. [Olszak 2012a]. It is worth mentioning that business intelligence seems to be recognized by many businesses as a valuable tool to reach strategic goals, increase profitability, improve customer satisfaction and ensure regulatory compliance [Olszak 2010]. To study various aspects of BI,

it is very important not to perceive this term too narrowly [Olszak 2012a]. Hence, BI is a broad category covering technologies, applications and processes responsible for the collection, storage, data access and analysis that can help users in making more effective decisions [Wixom, Watson 2010]. A BI system can be also defined as an integrated set of tools, technologies and programmed products which are used to collect, integrate, analyze and share data [Reinschmidt, Francoise 2000]. A BI system is composed of a set of the following essential components [Reinschmidt, Francoise 2000; Olszak 2007; Olszak 2010]:

– ETL (Extraction-Transformation-Load) tools responsible for data transfer from operational or transaction systems to data warehouses;
– data warehouses, environment to store, aggregate and analyze data;
– analyzing, reporting and presenting tools, such as: OLAP (tools which allow access and which analyze and model business problems and share information that is stored in data warehouses), data mining (tools for determining patterns, generalizations, regularities and rules in data resources), reporting and *ad hoc* inquiry (tools for creating and utilizing different synthetic reports), drill down reports;
– presentation layers that include customized graphical and multimedia interfaces or dashboards to provide users with information in a comfortable and accessible form.

Business Intelligence systems should be designed to aggregate data from various sources (internal or external) and transform those data into actionable information [Olszak 2010]. Hence, information from many different sources can be integrated into a coherent body for strategic planning and enhanced decision support [Tan, Sim, Yeoh 2011]. Thus, information may be delivered at the right time, at the right location and in the right form in order to improve the decision-making process.

When considering the successful implementation of BI systems in healthcare, it is extremely important to identify organizations and their users' requirements (by asking questions about: e.g. care provider capabilities, track record, cost and availability, encounter results, effectiveness, cost, time lines, conditions and treatment plans, patients), define some metrics and prepare suitable data access and presentation layer [WWW1].

3. Business Intelligence systems functionality

On the Polish market for BI vendors, one can find simple systems, and an extensive BI platform. In this paper the most common functionality of BI systems is presented. This specification was prepared on the basis of BI systems analyses. BI applications provide real-time performance, interactive access, analysis of critical importance to the organization. With these systems, users are able to access and use the massive amounts of information in order to analyze the relations and trends that are crucial for making effective decisions. Typical BI features and functions include workflow, reporting, in-depth analysis, data warehousing, data mining and comprehensive data visualization tools like scorecards and dashboards.

BI systems dedicated to healthcare offer interesting and useful features:

a) Data warehouse creation is very helpful in gathering business-critical information in one place – a data warehouse. Thus, the process of preparing and processing data corresponds to the current needs of the organization.

b) Reports and analyses creation. This solution allows the rapid assessment of the effectiveness of the whole organization, due to the ability to create dynamic reports and financial analysis of planning data, multidimensional analysis (OLAP), actual and forecast without the need for extensive IT knowledge users. In many BI systems, the reports are enriched by comprehensive and impressive graphical data presentation capabilities. The function of creating forecasts using data mining tools is useful.

c) A dashboard for users. The dashboard allows the monitoring of key performance indicators (KPI) and also incorporates the notifications (alerts) informing about the excess levels of selected variables, which allows taking immediate action. All the necessary reports are created at a "click" to get the effect in the form of analysis of the selected value, or display information to prevent the escalation of negative phenomena and upcoming opportunities. The dashboard also helps to detect new trends. Some systems offer analyses preparation using the "drag and drop" function (users can select desirable criteria (measures, dimensions) and move them with the mouse, for example, the area of the PivotTable). Hence, dashboards (their intuitive interfaces) make analyzing of data more friendly, and even inexperienced users can delve into complex analysis, track trends and prepare multiple cross reports.

d) Scorecards are one of the key elements of successful organization management, which allows better establishing management processes and transferring business strategy into specific goals for different areas of business: finance, customers, internal processes as well as infrastructure and development. Moreover, a predefined balanced Scorecard could help an organization to verify, through the monitoring of a series of key indicators if the defined strategy is being correctly implemented in the organization.

e) BI portals that are accessible through a web browser and enable creating standard reports and business analysis. Users have at their disposal their own dashboard (Dashboard), which on one screen provides dynamic reports, summaries, charts, etc. Dedicated dashboards are available from the individual tabs of the main portal.

Hence, thanks to the BI systems features and functions, analyzed data are grouped in order to accelerate the process of analysis. The main areas of analysis include: the administrative part (all the data associated with the current operation of any organization, e.g. financial indicators, costs, staff management, operating expenses, cash flows) and the medical part (healthcare-specific analyses, reposting and statistics, e.g. patient length of stay and the related income and expenses, profitability of individual departments, units, operations, research, occupancy and availability

of staff, detection of irregularities). The BI system improves business performance by providing reliable management information, eliminating unnecessary costs and increasing revenues. Moreover, clear-cutting and data on the functioning of the company allow managers at various levels to decide what action should be taken to achieve business goals and improve medical services quality.

4. Potential area of BI applications in the healthcare sector

Nowadays, this is more often considered in economic terms, as the subject of objective processes associated with market mechanisms. Thus, a healthcare organization should aim at treating patients as well as achieving the desired management outcomes. Nowadays healthcare is a very important part of our society and it is imperative for healthcare providers to do their jobs in an efficient and effective manner.

Likewise, in Polish conditions, the transformation of healthcare forced the progressive economization of health in order to shift the relationship between patient and doctor, depending on the market conditions. The Polish healthcare system (Health), together with its environment, is composed of different elements (the structure of government, local government, medical resources, patients, etc.) and its primary purpose is to protect public health [Batko 2011]. The concept of the so-called Triangle divides the participants in the health system into three groups: beneficiaries (patients), providers (doctors, healthcare facilities) and the payer (the insurer to provide financing), called the third party. Therefore, the structure of the healthcare system can be seen in the context of its stakeholders (healthcare market operators) [Batko 2011; Magda, Szczygielski 2012]. Providers of health services are primarily Independent Public Healthcare Units (SPZOZ), Private Healthcare Units (NZOZ), individual medical practices, dentalcare and medical facilities. Some of the healthcare units are comprehensive healthcare facilities, offering services partly within the NFZ (National Health Fund), but mainly paid for based on contracts [Magda, Szczygielski 2012].

The current healthcare system, particularly in Polish conditions, shows a lot of shortcomings, among which there are [Batko 2011]:
– poor quality of health information: redundancy, inconsistent standards for the collection and sharing of information;
– inability to obtain health information at the time and place where it is needed: the data collected in health records are limited, and EHR (Electronic Health Record) data are never collected. Some registers in health exist only in the paper form, which limits quick access to them;
– inadequate procedures: implementation of information systems not related to the relevant organizational changes;
– lack of co-operation of information systems: the existing solutions do not ensure interoperability, the lack of cooperation between systems makes management of

information impossible and adversely affects the accuracy, integrity, comparability and completeness of data;
– so far, systems have been developed primarily to support the work of administrative units, while being only to a small extent adjusted to the needs of patients, doctors and other users.

Due to the ranking results of the Patient Empowerment Index, the Polish healthcare system is perceived as one of the worst in Europe (25th position out of 31) [Report… 2009]. Research indicates that Polish patients wait too long in queues for treatment and professional consultation and have no access to information about places where they can get medical care in cases of sudden health deterioration or life-threatening situations. Thus, Polish patients are dissatisfied with public healthcare [Report… 2009].

An extremely important aspect of the healthcare transformation is computerization. Healthcare organizations are facing the problem of processing large amounts of data [Glaser, Salzberg 2011]. Its employees have to manage and integrate clinical, financial and operational information that increases with their performance. Previously, data were stored and organized in the traditional way (both paper and digital), which was time-consuming and did not provide the desired level of efficiency [WWW2; Houghton 2002]. Healthcare organizations, like business organizations, need to implement information management supported by information technology. Thus, information from all sources should be obtained, stored and analyzed by healthcare organizations.

A good solution for this purpose is Hospital Information System (HIS) used to manage healthcare organizations. This is a complete solution for managing medical, administrative, financial and legal data. The overall aim of HIS is to provide support of patient care, achieving optimal financial performance and streamline administration. Hospital Information Systems have a modular structure and include many applications addressing the needs of various departments and users of the healthcare organization. These systems include the integration of all clinical, financial and administrative applications. Nowadays more and more healthcare organization sall over the world, and increasingly also in Poland, use these systems [WWW3; WWW4].

HIS allows managing the data related to the clinic (i.e. Physician Information Systems, PIS; Electronic Medical Records, EMR; Electronic Health Records, EHR), finance department, laboratory, nursing (Nursing Information Systems, NIS), pharmacy (Pharmacy Information Systems), radiology (Radiology Information System, RIS) [WWW3].

A well developed and implemented HIS offers numerous benefits to a healthcare organization including the high quality of patient treatment and care as well as better financial management, but is not limited to them [WWW3]. It is worth stressing that HIS should be also patient-centric, medical staff-centric, affordable and scalable. As far as user friendly features are concerned, a good HIS system must be available on the web [WWW3]. Availability on the web means that authorized personnel can access the information whenever and wherever wanted.

Worldwide, as well as in Poland, there are more and more HIS vendors. One of the most recognizable in the world is SAP for Healthcare, and in Poland InfoMedica (a product of Asseco), Eskulap (a product of the Technical University in Poznań), KS-MEDIS (a product of Kamsoft).

However, the collection, processing and sharing of data in the information system is still inadequate today. Clinical data in healthcare continues to be isolated in information system silos where it is stored in proprietary or incompatible formats [Kolowitz, Shresth 2011]. Some of this data could be used in order to improve the process of treatment of patients and their care. However, there are many cases in which it is very difficult to quickly find and access these data without a time-consuming intermediate process [Kolowitz, Shresth 2011]. To be effective and allow for rational decision-making, it is necessary to create cross-sectional analyses and reports. This sector needs tools for preparing complex analyses. Nowadays an effective solution to this problem is commonly known as Business Intelligence (BI) systems.
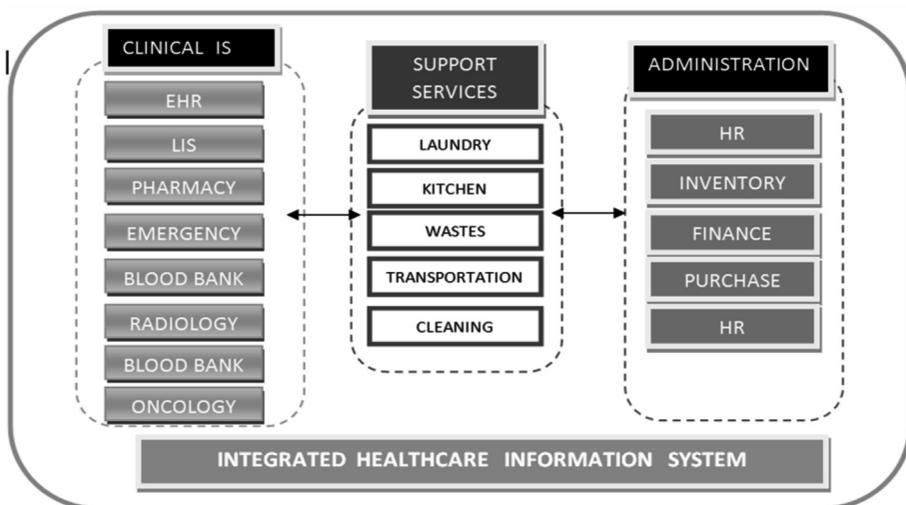

Figure 2. Scheme of Hospital Information System

Source: own elaboration.

BI systems can be used to improve decision-making at the highest level of the healthcare organization [Missi, Alshawi, Fitzgerald 2012]. BI systems are used to achieve larger strategic initiatives, such as operating margin, return on investment for strategic investments and the care quality indices [Microsoft 2009]. BI solutions can provide organization-wide access to information using familiar tools that are flexible enough to meet a wide range of needs and users. These tools can help reduce the cost of new solutions and accelerate the execution time. Different users (management, managers, medical professionals, administrative staff) can create reports and perform

analysis to improve their work and the work of the organization [Gaddum 2012]. BI systems help healthcare organization employees work more effectively as a team, ensuring that the goals of the department are met [Spil, Stegwee, Teitin 2002]. They can create reports and dashboards on the basis of data collected from various applications in a healthcare organization data warehouse (see Figure 2). Thanks to it, all kinds of data – clinical, administrative and external – can be stored in one place with applications which enable a single view into data.

In recent years we have seen more widespread use of IT to support business activities. Information systems in conjunction with progress in the use of BI have allowed organizations, including those from the healthcare sector, to better understand the various aspects of their operations by monitoring and analyzing business processes [Spil, Stegwee, Teitink 2002]. The data from clinical sources, by means of extraction, transformation and loading of data, are collected and made available in data warehouses. Monitoring of clinical data should be done on the basis of data collected from the HIS database [Panayotakis 2012].

To achieve its goals, a healthcare organization seeks to enhance its organizational capacity, standardization of business processes and the introduction of standards in the patients treatment and care.

5. Challenges of using BI systems in the healthcare sector

According to expert opinion, the healthcare sector is facing many global challenges today. Nevertheless, the use of IT significantly helps physicians in a number of ways as clinical performance and patient safety go hand in hand. Business Intelligence (BI) refers not only to data analysis, but also the knowledge of relating the results from the data analysis to decisions support.
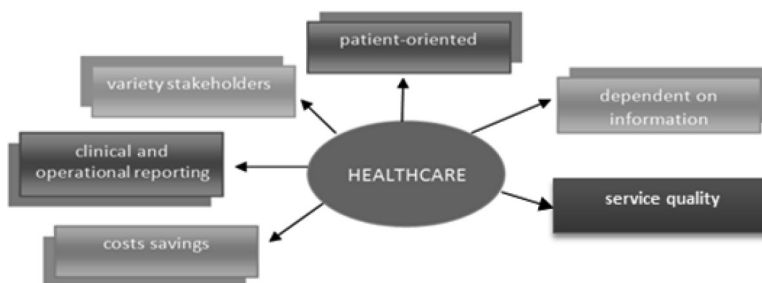

Figure 3. Main priorities of healthcare organizations

Source: own elaboration.

The healthcare sector is very specific in comparison to other sectors of the economy (see Figure 3). For example, management is unified in most sectors,

but healthcare has clinical and operational reporting [Kolowitz, Shresth 2011]. Moreover, healthcare involves a variety of stakeholders (customers) including clinicians, payers, government, service providers and users. Various stakeholders in a healthcare organization must operate on data in multiple information systems. Furthermore, healthcare systems are typically larger and more complex, and employ more people than other systems and they still benefit from total-system analysis.

On the other hand, all sectors, including healthcare, seek an improvement in quality, cost, and reducing delays through integrated processes. What is more, healthcare is patient-oriented, like in other sectors in which client and product are centers of their attention [Kolowitz, Shresth 2011].

The healthcare industry is very dependent on information. However, so far no technology that in real-time takes data and converts them into information has been developed. The data themselves (devoid of context) are little more than useless [Leonardi 2008]. So far, only Business Intelligence technology has been able to focus on key indicators easily and quickly to provide valuable information for healthcare organizations. Information obtained in this way may be used in the daily work of medical facilities for clinical diagnoses, financial decisions, the order of providing healthcare services and medicines, equipment management and others. Healthcare providers are increasingly using a Business Intelligence platform to solve problems related to poverty or the lack of appropriate information in order to provide complex healthcare, control of financial flows, operational and financial efficiency, patient safety and transparency of healthcare performance. If the medical organization wants to succeed, it is extremely important to remain viable and competitive and to make rational and informed decisions in the areas of treatment, finance and management. Physicians, surgeons and managers need current, accurate and trusted information delivered in a timely manner to ensure that the quality of care underlies their decision-making.

However, on the basis of literature review and an analysis of BI systems offered by Polish vendors, it can be noted that Business Intelligence tools can be used for a deeper understanding of healthcare, but the healthcare sector has many limitations related to the implementation of this technology. In literature there are a lot of analyses of opportunities and challenges of using BI systems in different branches of the economy. A summary of the perceptions, beliefs and challenges identified in the literature is presented in [Clavier, Lotriet, van Loggerenberg 2012] (see Table 1).

Challenges on the use of BI in healthcare organizations in some way correspond to those defined so far in other sectors. However, some differences can be observed. These challenges, identified by analyzing the BI systems and specification of healthcare organization, can be grouped as follows:

a) challenges for quality and data standards:
– in the healthcare sector a very large amount of often poor quality data is accumulated;

Table 1. Summary of perceptions, beliefs and challenges identified in the literature and case study

Perception/belief	Challenge (literature)	Challenge (case study)
Technology • BI is impossible without technology • Build it and they will come • BI is all about technology (according to a reflection of what is on the Internet) • Name our BI-related product "BI" to increase sales (i.e. defining BI) • BI requirement could quickly be met by latest BI gadget/tool • Investment in BI technologies must solve our need for BI	• BI is ambiguous/has an engineering worldview/defined by vendors • Leadership incorrectly perceives BI as an easy feat/non-complex, solved by implementing technology • BI prototypes are expensive, but alternative is long wait as BI is only usable when infrastructure is complete	• Questions on definition reveal uncertainty/misalignment on BI scope/definition • FB's BI projects concentrate on technology solution, implemented through project • Tools not used after peak periods or lengthy projects are cancelled • Technology purchased without regard for organization-wide strategy or proper business requirements gathered • One of the main BI challenges is maintaining tools
Process • Project Office/BI project is a repeatable, automated process like a "software factory" • Users want all data from source systems, should be process focused • Collect/process great volumes of data because technology has the capacity • BI process and technology decisions do not need to involve business	• Unstructured data unavailable (due e.g. to focus data from source system as priority) • Gap between IT/BI/business widened often by BI focusing on process and excluding business/IT or separation of these two • Focus/time incorrectly spent on collecting/processing data • Data overload = low/no use	• Wealth of information available in organization's systems overlooked • BICC inherits problems of project office (implied like a factory) • Users do not know BI process • Users are too busy for data overload, give them high level dashboards • Separation of customer and producer is best for process/productivity • More time spent on BI operations than on analysis/insight activities
Product • BI process ends with a product • Advanced feature-rich product is key to competitiveness • Mass produce reports/data to suit wide audience: ease of production • Focus is on licenses/product sold	• Users interrupted to use BI, not incorporated into process • BI use is dependent on context, not just on actual delivery • Focus on delivering product: little attention paid to organization's culture – fact or intuition-based decisions or how to sway all to vision of SVOT (Single Version of the Truth)	• Users do not recognize their own data after it is processed, do not use it • Too much data in a wrong format results in inability to use data • We make decisions based on credible individuals, experience and risk rather than fact/BI – when under pressure • Because a report exists it does not mean I can make a decision based on it
Capability • Implement the tool/set up a BICC or department and capability will be automatically enabled • BI resource is competent if skilled in a BI technology • The average business user has the capability or time to use BI tools • Decision-making capability is part of users' domain, not BI delivery responsibility	• Users do not know how to ask the right questions • Users struggle with BI's tech/data terminology • BI demands a broad capability/skills set in user and BI resource, not just how to use tools • BI users and stakeholders do not trust BI project process as they do not understand it. They do not know if challenges are true or if • BI experts use difficult terms to confuse/side-track them	• Users do not know their own data – requirements or how to use it • I should be implemented for the masses. Challenge is masses are not educated on decision-making • Decision-making skills absent • FB's BI department is under-resourced due to lack of available talent • Technology-savvy developers can easily get jobs in BI • FB's BI analysts do not know the business • Skills transfer is difficult due to varying needs of user community

Source: [Clavier, Lotriet, van Loggerenberg 2012].

–   a large part of the data is still stored in the paper form or scanned documents, rather than in the digital form, which makes data collection and sharing them in different geographic locations difficult;
–   the data come from various sources as currently there are few defined standards for data in the healthcare field, which makes it difficult to aggregate data, construct a data warehouse, load data into a rules-based engine in order to get access to actionable information and generate reports and *ad-hoc* analyses;
–   relevant qualifications and classification of data are a key element conditiong the continuity of decision-making;
    b) challenges for the selection of information and identifying key areas requiring support:
–   quality of healthcare is achieved by doing the right thing at the right time, in an appropriate manner and for the right person; so every day it is necessary to identify the key actions that health professionals have to perform, to determine the order, time and manner of their execution,
–   identifying the data helps to understand and interpret them by physicians meeting the challenges of everyday life, because medical data are increasingly difficult to manage on a daily basis;
    c) challenges for healthcare organizations personnel (especially medical staff) for handling information systems:
–   for many healthcare organizations and its employees the systems and applications are seen as a black hole as there are too many projects with too many complex systems with several sources for them to deal with; therefore, it is difficult for healthcare managers and health professionals to get a clear picture of the data in real time;
–   reloading data systems makes it difficult for doctors to find time and focus on their main goal – patient care;
    d) challenges for IT infrastructure and technologies:
–   healthcare organizations need computerization;
–   the infrastructure needs to be complete and integrated (one access point for all data, one warehouse);
–   all the processes and medical units in a healthcare organization require infrastructure and technology support;
–   problems with costs of infrastructure, HIS systems, BI system, infrastructure maintenance and also employee training.

6. Conclusions

To summarize, one can state that healthcare organizations can achieve a lot of benefits using BI systems. Research shows that the benefits of implementing Business Intelligence systems in healthcare organizations are evident (see Table 2).

Table 2. Benefits of using BI applications in healthcare organizations

Benefit	Description
Consolidation and protection of data	The possibility of a single point of access to data stored in multiple systems enables organizations to provide "one version of truth", which is one of the fundamental objectives of BI. By means of BI systems, it is also possible to consolidate and analyze clinical, administrative and financial data, which also serves to increase the efficiency in the data/work flow. Better protection of patient data is also possible by providing access to data only to those with appropriate access levels [WWW1]
Efficiency improvement	Users can access any type of information with a fast and consistent response time, independent of the data volumes analyzed or questions asked [Chee et al. 2009]. Due to this fact, the process of decision-making in areas like patient treatment is shorter and information-based, which also enables efficient staff scheduling [Microsoft 2012]
Increase revenues and reduce costs	By using BI it is possible to eliminate waste and mine data stores to examine and recoup denied claims in healthcare organizations [Microsoft 2009]. BI application interoperability reduces labor costs by eliminating expensive customized integration of computer system in healthcare organizations [Chee et al. 2009]. Costs of healthcare professionals, lab equipment and consumables, pharmaceuticals/medical material, treatment per diagnosis related grouping (DRG) and cost per type of medical intervention (e.g. specific medical operation) can be reduced as well [Panayotakis 2012]
Improved margins	BI (BI/balanced scorecard program) helps to improve gross margins of healthcare organizations
Resource planning and scheduling	Optimized utilization of outpatient clinics and independent areas by coordinating handling with waiting lists and allocating beds
Improved patient satisfaction	It can be achieved by using BI and analytic tools
Improved patient treatment and care	BI tools can be used in improving patient outcomes using point-of-care information. By means of BI, healthcare professionals have easy access to patient's data and they can create a variety of classifications/reports based on demographic data, sex, age and so on. Thanks to the evidence-based medicine and capture of medical history of the patient, doctors can accurately diagnose and apply efficient treatment with reduction of risks during treatment (e.g. related to on time admittance, the use of medicine, biomedical equipment, blood transfusions) [Panayotakis 2012]. Timely and effective clinical decisions are better facilitated by increasing the potential of BI
Reduction of medical errors and improved patients safety	It could be reached by supporting medical research and data treatment. BI systems can support a larger healthcare system by the exchange of medical information on a patient.
Improved decision-making	Especially in the area of comprehensive healthcare policy by the authorities of the organization of the health sector. It can be reached with monitoring the performance of doctors, departments and medical material requirements. Multiple groups or individuals can be put together by emphasizing the analysis and accurate data, which brings them closer to the point of service in order to enhance decision-making and make data actionable [WWW1]
Improved monitoring	Monitoring of the consumption of drugs, medical supplies, use of medical equipment, medical personnel, movement of patients.
Improved transparency	BI delivers transparency across organizational and information system boundaries by providing a clear view of data and quick access to disparate data – anytime, anywhere.

Source: own elaboration based on [WWW1; Chee et al. 2009; Microsoft 2009, 2012; Panayotakis 2012].

In addition to the benefits listed in Table 2, it is worth noting that BI systems help to see the overall picture of the hospital and allow the detection of all kinds of irregularities, fraud, embezzlement and reduce duplication of work.

Practice shows that the implementation of BI systems in hospitals brings measurable results. One example is the implementation of QlikView (a product of Hogart) at the University Hospital in Cambridge [WWW7]. This took place in 2007, and after four years the hospital reported more than a 25% saving in the management of the hospital, while improving outcomes. The NHS (the Polish National Health Fund's equivalent) saved the equivalent of 25% of bed occupancy in the hospital, reduced costs associated with changes in diagnoses and reduced the outflow of trained personnel.

BI systems provide reliable and consistent information from all the areas of organization activity. Data collected by organizations can be converted into useful knowledge due to the use of advanced data warehousing and analytics tools. Effective forecasting can prepare on this basis the comparison of data from the past to the current activities of the organization using prediction tools. Moreover, by analyzing external data (from the environment) the organization can demonstrate a rapid response to market trends, threat detection and create business opportunities. These data are better for decision-making and outcomes. BI systems are important from a financial perspective, because they allow for efficient budgeting, the rapid assessment of the effectiveness of the organization and the acquisition of information needed to make investment decisions and restructuring. Thus, the healthcare organization can make more effective decisions based on the information collected.

Nowadays, healthcare organizations have come to realize that data and Business Intelligence (BI) systems are crucial in the decision-making process that will improve patients outcomes and the quality of medical services.

References

Batko K., *Portale korporacyjne w procesie kreowania wizerunku organizacji z sektora ochrony zdrowia* [PhD dissertation], 2011.

Chee T., Chan L., Chuah M., Tan C., Wong S., Yeoh W., *Business Intelligence Systems: State-of-the-Art Review And Contemporary Applications*, Symposium on Progress in Information and Communication Technology 2009, http://spict.utar.edu.my/SPICT-09CD/contents/pdf/SPICT09_A-5_1.pdf (accessed: 23.03.2012).

Clavier P.R., Lotriet H.H., van Loggerenberg J.J., *Business Intelligence Challenges in the Context of Goods-and Service-Dominant Logic*, 45th Hawaii International Conference on System Science (HICSS), 2012, http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6149400&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6149400 (accessed: 10.10.2012)

Davenport T.H., Harris J.G., Morrison R., *Analytics at Work: Smarter Decisions, Better Results*, Harvard Business Press, 2010.

Gaddum A., *Business Intelligence (BI) for Healthcare Organizations*, 2012, http://www.ilink-systems.com/portals/0/ilink/pdf/BI_healthcare_organizations.pdf (accessed: 20.03.2012).

Glancy F.H., Yadav S.B., Business intelligence conceptual model, *International Journal of Business Intelligence Research* 2011, Vol. 2, No. 2, pp. 48–66.

Glaser J.P., Salzberg C., *The Strategic Application of Information Technology in Health Care Organizations*, Jossey-Bass, San Francisco 2011.

Houghton J., Information technology and the revolution in healthcare, [in:] *Equity, Sustainability and Industry Development Working Paper Series*, 2002, http://eprints.vu.edu.au/15924/1/ 15924.pdf.

Inmon W.H., Strauss D., Neushloss G., *DW 2.0: The Architecture for the Next Generation of Data Warehousing*, Elsevier Science, Amsterdam 2008.

Kolowitz B.J., Shresth R.B., Enabling Business Intelligence, knowledge management and clinical workflow with single view, *Issues in Information Systems* 2011, Vol. 12, No. 1, pp. 70–77.

Leonardi T., *Business Intelligence and Healthcare. The Cornerstone of Any Successful Healthcare Organization Will Be "Healthcare Business Intelligence"*, 2008, http://www.sentryds.com/wp-content/uploads/wp-business-intelligence.pdf (accessed: 15.01.2012).

Magda I., Szczygielski K., *An Assessment of Possible Improvements to the Functioning of the Polish Healthcare System*, 2012, http://www.ey. com/Publication/vwLUAssets/Ocena_mo%C5%BCliwo%C5%9Bci_poprawy/$FILE/Ocena_mozliwosci_poprawy_EN.pdf, (accessed: 14.04.2012).

Microsoft, *Business Intelligence for Healthcare: the New Prescription for Boosting Cost Management, Productivity and Medical Outcomes*, an exclusive report from Business Week Research Services, 2009, http://www.microsoft.com/health (accessed: 20.03.2012).

Microsoft, *Knowledge Driven Health. Think Bigger about Business Intelligence – Create An Informed Healthcare*, 2012, http://download.microsoft.com/.../Whitepaper_Health (accessed: 05.03.2012).

Missi F., Alshawi S., Fitzgerald G., *Towards a Framework for Realizing Healthcare Management Benefits through the Integration of Patient's Information*, 2012, http://is2.lse.ac.uk/asp/aspecis/20040110.pdf (accessed: 10.04.2012).

O'Brien J.A., Marakas G.M., *Introduction to Information Systems*,13th edition, McGrawHill, New York 2007.

Olszak C.M., *Tworzenie i wykorzystywanie systemów Business Intelligence na potrzeby współczesnej organizacji*, AE, Katowice 2007.

Olszak C.M., Systemy informatyczne analityczno-raportujące, [in:] J. Zawiła-Niedźwiecki, K. Rostek, A. Gąsiorkiewicz (Eds.), *Informatyka gospodarcza*, t. 3, CH BECK, Warszawa 2010.

Olszak C.M., Organizacja oparta na Business Intelligence, [in:] C.M. Olszak, E. Ziemba (Eds.), *Systemy inteligencji biznesowej jako przedmiot badań ekonomicznych*, Studia Ekonomiczne UE w Katowicach, Katowice 2012a.

Olszak C.M., *Analiza i ocena dorobku naukowego z zakresu Business Intelligence – wybrane zagadnienia*, [in:] C.M. Olszak, E. Ziemba (Eds.),*Technologie informacyjne w transformacji współczesnej gospodarki*, Studia Ekonomiczne UE w Katowicach, Katowice 2012b.

Olszak C., Batko K., The use of business intelligence systems in healthcare organizations in Poland, [in:] M. Ganzha, L. Maciaszek, M. Paprzycki (Eds.), *Proceedings of the Federated Conference on Computer Science and Information Systems FedCSIS 2012*, Polskie Towarzystwo Informatyczne, IEEE Computer Society Press, Warsaw, Los Alamitos, CA 2012, pp. 969–976.

Olszak, C.M., Ziemba, E., Approach to building and implementing business intelligence systems, *Interdisciplinary Journal of Information, Knowledge, and Management* 2007, No. 2, pp.135–148.

Panayotakis K., *Business Intelligence in Healthcare*, 2012, http://ezinearticles.com/?Business-Intelligence-in-Healthcare&id=268056 (accessed: 12.04.2012).

Reinschmidt J., Francoise A., *Business Intelligence Certification Guide*, IBM, International Technical Support Organization, San Jose, CA 2000.

Report, *Empowerment of the European Patient – Options and Implications*, Health Consumer Powerhouse, 2009. http://www.healthpowerhouse.com/files/EPEI-2009/european-patient-empowerment-2009-report.pdf (accessed: 14.04.2012).

Spil T.A.M., Stegwee R.A., Teitink C.J.A., Business organizations in healthcare, [in:] *Proceedings of the 30th Hawaii International Conference on System Sciences*, IEEE, 2002.

Tan C., Sim Y.W., Yeoh W., *A Maturity Model of Enterprise Business Intelligence*, IBIMA Publishing Communications of the IBIMA, Vol. 2011, Article ID 417812, http://www.ibimapublishing.com/journals/CIBIMA/cibima.html (accessed: 10.10.2012)

Watson H.J., BI-based organizations, *Business Intelligence Journal* 2010, Vol. 15, No. 2.

Wixom B., Watson H., The BI-based organization, *International Journal of Business Intelligence Research* 2010, Vol. 1, No. 1, pp. 13–28.

Websites

[WWW1] http://www.wavetwo.com/resources/Business_Intelligence_Healthcare_Whitepaper.pdf (accessed: 12.04.2012).

[WWW2] *Information Technology in Health Care*, http://www.medpac. gov/publications%5Ccongressional_reports%5CJune04_ch7.pdf (accessed: 12.04.2012).

[WWW3] http://www.biohealthmatics.com/technologies/intsys.aspx(accessed: 12.04.2012).

[WWW4] http://www.emrconsultant.com/education/hospital-information-Systems (accessed: 12.04. 2012).

[WWW5] http://www.simple.com.pl/produkty/simplebi/ (accessed: 20.03.2012).

[WWW6] http://www.comarch.pl/business-intelligence (accessed: 20.03.2012).

[WWW7] http://www.erp24.pl/business-intelligence/business-intelligence-leczy-pacjentow-i-finanse-szpitala.html

SZANSE I MOŻLIWOŚCI WYKORZYSTANIA SYSTEMÓW *BUSINESS INTELLIGENCE* W ORGANIZACJACH OCHRONY ZDROWIA

Streszczenie: Niniejszy artykuł stanowi jedynie zarys wykorzystania systemów *Business Intelligence* w celu wspomagania procesu podejmowania decyzji w organizacjach sektora ochrony zdrowia. Badania podjęte w artykule mają na celu odpowiedzieć na pytania dotyczące możliwości wykorzystania BI w ochronie zdrowia. Struktura artykułu jest zatem podporządkowana temu celowi. Omówiono w nim istotę systemów BI oraz potencjalne możliwości stosowania tych systemów w ochronie zdrowia. W artykule zaprezentowano również wyzwania, jakie stoją przed organizacjami chcącymi skutecznie wdrażać systemy BI, i korzyści, jakie organizacje mogą dzięki temu osiągnąć.

Słowa kluczowe: *Business Intelligence*, ochrona zdrowia, organizacje medyczne, szpitale, systemy informatyczne.