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The Use of Business Intelligence Systems in Healthcare Organizations in Poland

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***Abstract*—Interest in applications of Business Intelligence (BI) in different areas of the economy has been growing from year to year. In recent years, it has been increasing in Poland as well. A relatively new area of using this systems is the healthcare area. Intelligent techniques provide an effective computational methods and robust environment for business intelligence in the healthcare domain. It seems to be very important, due to the fact, that much of the data storage in all kinds of system used in healthcare organizations resides in proprietary silos which makes access difficult [1].What is worth noting using of BI systems is determined by the efficiency of the intelligent techniques, methodologies and tools. This paper discusses the essence of BI, characteristics of the healthcare sector and potential applications of BI systems in the healthcare sector. Also tools and examples of BI systems used in the sector are presented in the paper.**

I. Introduction

HEALTHCARE sector is one of the most dynamic sectors of the economy and health has become one of the major priorities of both the European Union (EU) and the individual countries. Moreover, healthcare is one of the fundamental tasks of modern states, and issues relating to them are the subject of interest in various scientific disciplines. The transformation of the healthcare sector has therefore become the recent subject of research in many fields, especially medicine, psychology, social policy. Recently, it is the subject of interest of economists, as well as management and IT specialists.

Nowadays, healthcare systems face challenges due to demographic changes, technological advances in medicine and the limited possibilities to increase health funding, requiring more intensive search for the effectiveness of the systems [2]. The impact on this state of affairs has a lot of factors, which include: rising costs of medical services, rapid development of medical technologies, increasing Europe's aging population, changing disease patterns, rising expectations and entitlements of patients, large-scale inefficiencies in health care, the pressure to increase access to healthcare, the growing diversity of medical services, changes in the approach to financing and managing of healthcare and the growing importance of information technology in the sector [4].

Due to this we can observe a deepening rift between the possibilities of financing the health system and the needs arising from rapid technological development in medical science, aging infrastructure, the growing demands of an aging population and increased demand for medical care [3].

The solution to this problem seems to be the application of information technology (IT) in the healthcare sector, especially those that facilitate access to data and information and enable the support of decision making process.

II. Research Methodology

The article is only an outline of using BI for supporting decision making process in organizations of healthcare sector. It describes the selected issues posed in the title. In order to diagnose the problem the bibliographic query, analysis and synthesis methods were used. In order to recognize the development of using BI for supporting decision making process in organizations of healthcare sector in Poland, the case study method was used.

III. Literature Review

A. Characteristics of Healthcare sector in Poland

Nowadays, healthcare began to be considered in economic terms, as subject of objective processes associated with market mechanisms, and of achieving desired management outcomes. Due to the definition of World Health Organization (WHO) – healthcare includes activities such as preventive measures, mitigation and treatment in order to ensure the health of the citizens. It is also perceived as a group of individuals and institutions aimed at ensuring the public healthcare [3].

Analyzing the healthcare sector we should pay attention to the fact that human health is a specific good [5][6]. There is no market where it could be purchased. It is not for sale, therefore, does not have the price. Each health service, as opposed to health, has a price and is the subject of economic activity in the market. Medical services are unique because of the importance that each of us assign to health and its loss [5]. Due to this fact we can say, that the market of medical services is different from the markets of all other goods and services. This market has its payers, providers and beneficiaries. Therefore it can be concluded that health is a value. Health services (eg medical consultation) can be purchased, so can be good (eg, drugs) or combination of services and goods, namely advice and medical procedures (eg surgery, physiotherapy treatment) [5].

Currently, the healthcare system in Poland is based on an insurance model and on the basis of article 68 of the Polish Constitution (dated 2 April 1997). According to it every Polish citizen has the right to health services, regardless of their financial situation and the public authorities should ensure equal access to healthcare services financed from public funds. Until recently, this meant only access to the public health service. But with the advent of private sector healthcare is carried out involving both public entities and private ones [6].

The market of health services, although it exists on the bodies and mechanisms characteristic for the market model is characterized by the absence of perfect information and the co called asymmetry of information [5]. This means that patients do not have sufficient knowledge about their condition. This results in the presence of a strong asymmetry of information (especially – the doctor to patient relationship). This asymmetry stems from the fact that the doctor has the expertise needed to make a diagnosis, the patient is aware that he himself has no qualifications that enable him to make rational choices [7]. Therefore, the organization of the healthcare sector should provide this service to patients to reduce their uncertainty and concerns about the treatments and its effectiveness. However, the transformation of the healthcare sector in Poland forced the progressive economization of health, in order to shift the relationship between patient and doctor, depending on the market conditions. What's more, getting to know the market of medical services one cannot ignore medical insurance market were failures occur with much greater force [8].

The current model of the system after implementing the reforms can be described as mixed. It involves the insurance model properties regarding the method of financing benefits and operation of service providers (declared equality of public and private entities) and a choice of service provider by the patient (limited contracted units- otherwise the patient needs to finance a benefit) [7].

By treating the market as a system, attention must be paid to existing elements and their interrelationships. Health services market is made up of similar elements present in each market, the market items, market stakeholders and the relationships between them [5].

The 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 [3]. The concept of the so-called. triangle divides the participants in the health system into 3 groups: beneficiaries (patients), providers (doctors, health care - health care facilities) and the payer (the insurer to provide financing) called a third party. Therefore, the structure of the healthcare system can be seen in the context of its stakeholders (healthcare market operators) [3][7].

A characteristic feature of healthcare is the wide variety in the way (how), place (where) and time (when) to provide services to the patient. This results in introduction of the division into: primary healthcare and specialized, outpatient care (open) and stationary (closed), emergency care, short and long-term treatment. Striving to improve the performance of healthcare is based on the optimal use of healthcare databases, the existing material, financial and personal resources (medical personnel, along with their skills), devoted to their activities [1][8].

Providers of health services are primarily Independent Public Healthcare Units (SPZOZ), Private Healthcare Units (NZOZ), individual medical practices, dental care and medical facilities. Some of the healthcare units are comprehensive healthcare facilities, offering services partly within the NFZ (National Health Fund), but mainly paid basic on contracts [7]. The healthcare provider acting in accordance with its professional conscience wants to cure the patient quickly and efficiently, thus not counting the cost.

The current healthcare system, particularly in Polish conditions, shows a lot of shortcomings, among which are [3]:

- 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 are exist only in paper form, what 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 to a small extent adjusted to the needs of patients, doctors and other users.

Due to the ranking results of the Patient Empowerment Index, Polish health care system is one of the worst in Europe [9]. Polish healthcare system as compared to the European healthcare systems took the distant 25th position out of 31. Research indicates that Polish patients wait too long in the queues for treatment and for professionals, do not have access to the information where they can get medical help in case of sudden deterioration of health or life-threatening. Up to 2/3 of Polish respondents are dissatisfied with public healthcare [9]. The ranking shows that the best healthcare systems are in Denmark, Germany, but also in Switzerland and Finland. The EU is also ranking the Czech Republic, Slovakia and Hungary better than Poland.

B. Computerization of the healthcare sector

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. Extremely important aspect of developing the healthcare sector is its

computerization. Healthcare organizations are facing the problem of processing large amounts of data [2]. 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 difficult to ensure the desired level of efficiency [10] [11]. One of solutions to this problem is healthcare information technology (HIT), including tools for telehealth, health information exchange, and personal health records. These systems are based on integrated management systems for supporting the holistic management of business organizations (Enterprise Resource Planning, ERP). And even in the medical facilities classic ERP systems adjustable for medical activities (eg, Impuls 5 BPSC) are implemented. All these systems have modular structure. Most professional healthcare organizations all over the world, and increasingly also in Poland, now rely on Healthcare (Hospital) Information Systems (HIS) that help them manage all their medical and administrative information [12][13]. In the literature we can find various titles and acronyms which all declare similar approaches to managing the information flow and storage in healthcare routine services, as Hospital Information System (HIS), Healthcare Information System or Patient Data Management System (PDMS). All these terms refer to the integrated information systems that are used to manage organizations in the healthcare sector. They are a complete solution for managing the medical, administrative, financial and legal data. The overall aim of HIS is to provide support patient care, achieving optimal financial performance and streamline administration.

These systems include the integration of all clinical, financial and administrative applications. HIS includes many applications addressing the needs of various departments and users of healthcare organization. They manage the data related to the clinic (ie. 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) [12].

A well developed and implemented HIS offers numerous benefits to a healthcare organization including the quality of patient treatment and care as well as better financial management but not limiting to them [13]. It is worth stressing, that HIS should also be patient centric, medical staff centric, affordable and scalable. Moreover to the user friendly features, a good HIS system must be available on the web [13]. Availability on the web means 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 (product of Asseco), Eskulap (product of Technical University in Poznan), KS-MEDIS (product of Kamsoft).

In Poland the majority of patient information (medical records) are collected in paper form or with the paper placed on the computer (very often by scanning). This is a big convenience for physicians, but the storage of such data is cumbersome, expensive, and access to them is difficult. Paper medical records may generate medical errors caused by poor handwriting legibility. Pre-printed forms, standardization of abbreviations, and handwriting became the incentives to improve the handling and storage of medical records. Also when paper records are stored in different locations, collating them in one place by a health professionals is time consuming and complicated, and the process could be simplified by electronic records. Electronic records improve the standardization, collection, processing and sharing of medical data. That is why more and more medical institutions in the world use the EMR.

The terms EHR (Electronic Health Record), EPR (Electronic Patient Record) and EMR (Electronic Medical Records) are often used interchangeably, although some differences between them can be noticed [14]. EMR may for example be defined as a computerized medical record created in an organization that delivers care (hospitals, ambulatory environments) that can serve as a source of data to the EHR [15]. Electronic medical records tend to be a part of a health information system that allows storage, retrieval and modification of records [3]. The EHR is generated and maintained within the institution, such as a hospital, clinic and gives patients, doctors, other health professionals, employers, insurers access to the payer and the patient's medical record [14]. It is often erroneously identified with the database of patient information [3]. This system is directed to public and private institutions providing medical services, and through them also to patients and doctors with information available in the system [16]. Using this system, medical staff will have access to patient medical records whenever they are needed, which would certainly increase the efficiency of the healthcare sector [3].

EHRs may contain a variety of data including demographic, medical history, medications and allergies, immunization status, laboratory results, radiology images, personal information such as age and weight. A Personal Health Record (PHR) is generally defined as an EHR that the individual patient controls.

However, the collection, processing and sharing data in the information system is inadequate today. Clinical data in healthcare continues to be isolated in information system silos where it is stored in proprietary or incompatible formats [1]. Some of this data could be used in order to improve the process of treatment of patients and taking care of them. However, there are many cases where it is very difficult to quickly find and access to these data without a time-consuming intermediate process [1]. To be effective and allow for rational decision-making it is necessary to create cross-sectional analyzes and reports. Nowadays effective solution to this problem are commonly known as Business Intelligence (BI) systems.

A. The essence of Business Intelligence

The issue of Business Intelligence (BI) is the subject of wide discussion in the literature. Interest in this subject has 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.

Literature of the subject provides different interpretations of the Business Intelligence. Although through last two decades we could observe the development of BI systems [17], it is still no clarity in the interpretation of the term. BI systems have evolved from simple, static analytic applications into a solution that can be used in strategic planning, customer relationship management, monitoring activities, the study of profitability of products, etc. 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 [17].

Currently, the term BI is closely associated with the issue of data warehouse. This is a key technology used to build this type of system that integrates analytical data from different transactional systems [18]. 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 [19].

However it should be remembered, that we can observe certain, significant differences between these systems. MIS are mainly focused on business process automation, DSS provide techniques for analyzing information to use them later to assess potential decisions [17]. The EIS present the information in the aggregate, and highly personalized forms, and their beneficiaries are the top-level managers. BI systems combine the capabilities of these earlier systems, which previously operated independently. The focus is on supporting the various business functions, supporting all levels of management decisions, using the process approach, and advanced analytical techniques [20]. They also allow for new knowledge discovery, which is important for the competitiveness of organizations to enter new markets, attract new customers and introduce new sales channels.

For the purpose of the research it is assumed that the 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 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 [17]. These systems have helped organizations understand complex processes and relationships by providing a comprehensive view of the organizational data [1] (Fig 1.).

BI systems are not limited only to the context of data analysis, but also to collecting and presenting information [21]. What's more, they do not focus exclusively on technology and/or applications, but also the on the business context, decision-making, etc [17]. 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 [22].

If we are to study various aspects of its development, it is important that the BI system is not understood too narrowly [17].

BI system can be defined as an integrated set of tools, technologies and programmed products, which are used to collect, integrate, analyze and share data [23]. BI system is composed of a set of following essential components [22] [23] [24]:

- ETL (Extraction-Transformation-Load) tools that are responsible for data transfer from operational or transaction systems to data warehouses,
- data warehouses to provide some room for thematic storing of aggregated and analyzed data;
- analyzing, reporting and presenting tools such as: OLAP (tools which allow users 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 are designed to accept data from any source- internal or external to the organization- and transform those data into actionable information [22].

In order to implementation BI systems in healthcare successful it is extremely important to identify organizations and their users requirements (by asking questions about: ei. 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 [25].

B. Potential area of BI applications in Healthcare sector

BI systems can be used to improve decision-making at the highest level of the healthcare organization [26]. BI systems are used to achieve larger strategic initiatives, such as operating margin, return on investment for strategic investments and the care quality indices [27]. 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 [28]. BI systems help healthcare organization employees work more effectively as a team, ensuring the goals of the department are met [29]. They can create reports and dashboards on the basis of data collected from various applications in healthcare organization data warehouse (Fig. 2). Thanks to it all kinds of data:

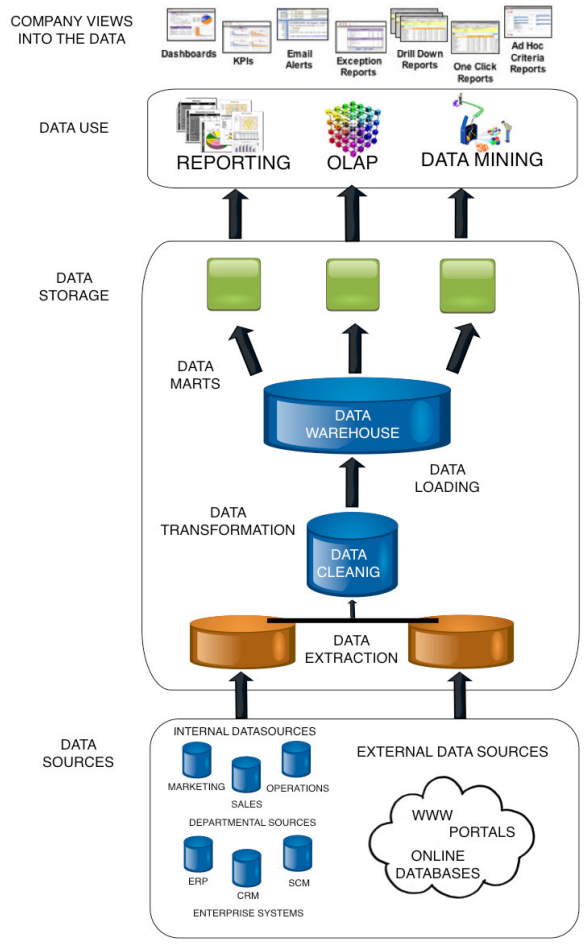

Fig. 1. Scheme of Business Intelligence system

clinical, administrative and external can be stored in one place with applications, which enable 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 allowed organizations, including those from the healthcare sector, to understand the various aspects of their operations better by monitoring and analyzing business processes [29]. 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 made on the basis of data collected from the HIS database [30].

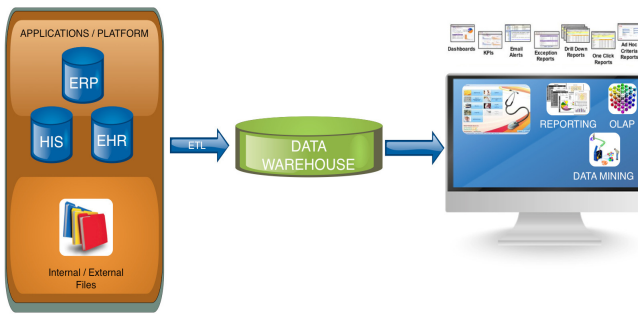

Fig. 2. The scheme of BI for Healthcare organization

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

C. Examples of BI systems dedicated to Healthcare Organization in Poland

On the Polish market for BI vendors one can meet simple systems, and extensive BI platform. Two systems are worth mentioning here: *Simple.BI* (http://www.simple.com.pl) and *Comarch BI* (http://www.comarch.pl).

Simple. BI is a comprehensive, fully integrated Business Intelligence platform that enables the construction of classic reporting systems and corporate performance management solutions that support enterprise [31].

Simple BI system offers interesting and useful features like [31]:

1. Creating reports and analysis
   - the ability to create dynamic reports and financial analysis of planning data, actual and forecast without the need for extensive IT knowledge users
   - comprehensive and impressive graphical data presentation capabilities
   - built-in data mining (Data Mining)
   - ability to use report templates to ensure the accuracy and detail of presented data
   - performing ad-hoc, with the possibility of entering data into the model in ad-hoc
   - input data using templates
   - import external documents in different formats from different systems and applications (spreadsheets, text files, PDF files, databases, etc.)
   - create KPI - Key Performance Indicator
   - scorecard development for any business areas
   - creating dashboards
   - providing functionality via a web portal (Internet Access)
2. Built-in alerts, which are a function of information (are designed to automatically warn the user of certain events and trends) or prediction (supervising enables advance warning of likely changes).
3. Data warehouse creation: which allows gathering business-critical information in one place - data warehouse, allowing the elimination of redundant data.

By using TARGIT module analyses can be faster and better, because the user performs a much smaller number of clicks than any other tool on the market [31]. The system has built-in features, with one-click to get the effect in the form of analysis of the selected value, or display information about the biggest emerging threats or most emerging opportunities. The system enables the rapid preparation of an analysis using the "drag and drop" function. The user selects the criteria (measures, dimensions) that interest him and moves them with the mouse, for example, the area of the PivotTable. The "complete data" in the instant method can achieve a result of the analysis or report.

Thanks to more and more friendly and intuitive interfaces, systems and business intelligence, even less expert users of

IT tools can delve into the complex analysis, track trends and prepare multiple cross reports. The common interface allows each worker get needed information quickly at any given time. Increasingly popular are the BI portals that are accessible through a web browser and enable creating standard reports and business analytics. 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.

As regards the Comarch BI - a dedicated data warehouse is possible to prepare and process their data and create reports and analysis corresponding to the current needs of the organization [32]. The analyzed data are grouped in order to accelerate the process of analysis. Comarch Business Intelligence offers a dashboard for users, who are not IT specialists, which allows all the necessary reports at a "click".

The main areas of analysis include [32]:

- administrative part: operating expenses (in different sections), the costs of supplies, transportation, operation, training costs and an increase in staff competence, the cost of investments and risk analysis, financial indicators and KPIs, cashflow, suppliers.
- medical part: the patient length of stay and the related income and expenses, profitability of individual departments, units, operations, research, occupancy and availability of staff, (including projections), the use of medicines lists and detection of irregularities.

Comarch Business Intelligence makes it possible to increase the speed of acquiring management information. Based on the treatment and cleaning of data in the warehouse, current information is always available. With the subscription, constantly performed reports are always delivered on time, and thanks to the alert in case of disturbing events, the system automatically sends a report with all the necessary information to diagnose the problem and take the necessary action [32]

This BI system improves business performance, during the analysis, in collaboration with analysts Comarch improves business processes and captures bottlenecks. Moreover, analytical platform increases productivity by providing reliable management information, eliminate unnecessary costs and increase revenues [32]. Furthermore, with the use of data warehouse the significant reduction in waiting time for analysis and relief transactional system is enabled. This solution offers: cross-sectional report, rapid acquisition of information, cross-reporting of various data sources, processing and arranging the data warehouse, reliable and easily accessible information, defining an integrated scorecard. Comarch Business Intelligence Platform allows to create forecasts using data mining tools. By organizing and analyzing historical data, it is possible to predict the future. For example, customer behavior, their segmentation, and sales forecasts. Moreover, clear-cutting and data on the functioning of the company allow managers at various levels to resolve what action should be taken to achieve business goals. Thanks to the intuitive business areas, the system is quickly responding to a given query, and builds even complex reports and statements simplified to "drag and drop" method.

V. FINDINGS

A. Challenges of using BI systems in Healthcare sector

Due to the experts opinion, healthcare sector is facing a lot of global challenges today. Nevertheless the use of IT significantly helps the 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.

Healthcare sector is very specific in comparison to other sectors of the economy. Considering management of this sector in comparison to others, it is not hard to see, that management is unified in most sectors, but healthcare has clinical and operational reporting [1]. Moreover healthcare involves variety stakeholders (customers) including clinicians, payers, government, service providers, and users. On the other hand all sectors, including healthcare, seek improvement in quality, cost, and delay through integrated processes. What is more, healthcare is patient-oriented, a in other sectors, in which client and product are centers of their attention [1]. Considering system integration, healthcare systems are typically larger; more complex, and employ more people than other systems and they still benefit from total-system analysis. The challenge in healthcare sector is the fact, that various stakeholders in healthcare organization must operate basic on data in multiple information systems.

Healthcare industry is very dependent on information. However, so far no technology that in real-time takes data and converts them into information was developed. The data themselves (devoid of context) are only slightly more than useless [33]. So far, only Business Intelligence technology is 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 decision, order of rendering healthcare services and medicines, equipment management and more. Healthcare providers are increasingly using business intelligence platform to solve problems related to poverty or 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 quality of care underlies their decision-making.

However, on the basics of literature review and analysis of BI systems offered by Polish vendors it can be noticed, 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.

These challenges, identified by analyzing the BI systems and specification of healthcare organization, can be grouped as follows:

1. Challenges for quality and data standards:
- in the healthcare sector a very large amount, often of poor quality data is accumulated,
- a large part of the data is still stored in paper form or scanned documents, rather than in digital form. This makes data collection and sharing them in different geographic locations difficult,
- the data come from various sources. Currently, there are few defined standards for data in the healthcare field. This makes it difficult to aggregate data, construct data warehouse, load data into a rules- based engine in order to get access to actionable information and generate reports and ad-hoc analysis,
- relevant qualifications and classification of data is a key element conditioning the continuity of decision making.

2. Challenges for 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 do, to determine their 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.

3. 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 box. There are too many projects with too many complex systems with several sources for them to deal with. Therefore, 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 – care of patient.

B. Potential benefits of using BI applications in healthcare sector

The main goal of each Healthcare organization in controlled and competitive environment, is to reduce operating costs, while maintaining a consistently acceptable level of patient treatment [30].

Due to the research, the benefits of implementing Business Intelligence Systems in healthcare organizations are evident:

1. *Consolidation and protection of data* – the possibility of a single point of access to data stored in multiple systems. This enables organizations to provide "one version of truth", which is one of the fundamental objectives of BI. Through the use 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 [25].
2. *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 [34]. Due to this fact the process of decision making in areas like patient treatment is shorter and information-based. It also enables efficient staff scheduling [35].
3. *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 [27]. BI application interoperability reduces labor costs by eliminating expensive customized integration of computer system in healthcare organizations [34]. 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 [30].
4. *Improved margins*. BI (BI/balanced scorecard program) helps to improve gross margins of healthcare organizations.
5. *Improved patient satisfaction* by using BI and analytic tools.
6. *Improved patient treatment and care*. BI tools can be used in improving patient outcomes using point-of-care information. Through the use 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 accurate diagnosis 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) [30]. Timely and effective clinical decisions are better facilitated by increasing the potential of BI.
7. *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.
8. *Improved decision-making* in the area of comprehensive health care 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 [25].
9. *It helps to see the overall picture of the hospital*.

10. *Improved monitoring* of: ie. consumption of drugs, medical supplies, use of medical equipment, medical personnel, movement of patients.
11. *It allows to detect all kinds of irregularities, fraud, embezzlement and reduces duplication of work* [36].

V. CONCLUSIONS

To summarize, it can be stated that, healthcare organizations are swimming in an ever-deeper pool of data. Without the system that is responsible for collecting, providing and analyzing the most relevant data, these organizations will not be able to use these data in practice and healthcare organizations can still be rich in data but poor in information.

Healthcare organizations are realizing that the data and Business Intelligence (BI) systems are crucial in making decisions process that will improve the patients outcomes and quality of medical services.

Moreover, to achieve the full benefits of BI healthcare organizations must assemble a strategic approach to decision making in solving every day, tactical problems. The greatest benefits and improvements can be made based on historical data collected from financial systems, operational and clinical systems. It should be noted that the main objective of BI systems implementation in healthcare organizations is still to reduce costs, instead of the further improvement of medical necessity.

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