



USE OF BUSINESS INTELLIGENCE TOOL IN HEALTH PROTECTION ENTITIES

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Abstract: The paper aims to present the rationale for the introduction of Business Intelligence (BI) Systems into a health protection units and to show the benefits of such systems, e.g. better time-keeping and quality of input data to the decision-making process. The paper points out also that implementation of these systems helps to understand what kind of unused possibilities are still available in the organization concerning the state of knowledge, trends and tendencies in the markets and in the environment in which the organization operates and competes. It is also emphasized that computerisation, automation and implementation of analytic tools in the administrative (“grey”) and medical (“white”) part of the hospital is obvious in the constantly developing health protection sector. The scope of study comprises business intelligence systems which combine operational data with analytic tools in order to present them to decision-makers and enable them to make informed decisions based on hard data. This paper also stresses the importance of unstructured and structured data and discusses the potential and necessity of developing BI tools for data extraction, integration, cleansing, search, analysis and provision in pursuance of the adopted objectives. The research and methodology presented in this paper is based on source literature, analysis of author’s own research based on documents from several medical facilities in the Silesia province, conducted in-depth uncategorized oral interviews (overt or covert) with experts in the field of health policy and author’s own observation of changes taking place in the health protection sector. The paper demonstrates that creation of data warehouses as data repositories, progress in data cleansing, increased hardware and software capacities and emergence of Internet architecture – all of these tools combined together create a more abundant BI environment than the one available earlier in the particular health protection entity, which consequently improves the quality of medical services provided in those entities.

Keywords: Business Intelligence, decision-making processes, management systems, data analysis, data warehouses, computerisation, health protection

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Introduction

The development of technology, computerization and management methods providing managers with simple and quick access to reliable and comprehensive management information¹ constitute the basis for making the right managerial

¹ However, the availability of information alone is not a condition of progress in an organization. Having even huge information resources without the ability to use them often leads to chaos identical with disinformation and paralysis of the organization’s development. Drawing conclusions from the information available, leading to knowledge and making right decisions, is necessary for survival and development in the present times.

decisions. These types of activities are crucial for modern management and have a real impact on the organization's success. It is to eliminate the growing problem of the so-called excess knowledge and the ensuing information chaos, and thus, the impossibility of extracting significant and necessary messages from "unnecessary and redundant" information, which becomes more and more frequent. Also, a common obstacle is obtaining data from various sources (areas of company operations) and their unification, consolidation or interpretation. The antidote to the mentioned problems can be and is Business Intelligence (BI) class tools, which offer applications and technologies for collecting, analysing and sharing data in order to make better business and economic decisions (Krakowski 2016, p. 157).

A few years ago, only the largest and richest organizations could afford to implement BI tools in the organization. It was connected with a time-consuming, cost-intensive and labour-intensive implementation process. It also required significant investment outlays, including outlays for equipment and required licences. Today, the market situation is different. The BI systems start playing a pivotal role also in smaller enterprises.

In Poland, systemic changes in the field of health protection are introduced very slowly and are rather episodic, far from the long-term development model of this market sector. Management in the healthcare services sector has to face the increasing demands resulting from the ongoing changes. Thanks to the restructuring of the healthcare industry, new circumstances have arisen, in which one should look for other than in the past ways to manage organizations in this sector.

Effective implementation of the suitability strategy and assessment of the healthcare unit's management system requires a single and complete picture of the current economic and medical situation in this system. The amount and multiplicity of data, including the data of patients obtained from multiple sources and their considerable dispersion, make making the right decisions in the present conditions a complicated task. Possibilities of using the existing medical IT systems are significantly limited, as they are not compatible with each other, which makes analysing data much more difficult. The data is isolated from each other and contains information generally only in the structural form. Also in medical facilities where large amounts of medical data are used in the so-called unstructured form, i.e. in the form of paper documents, their use in decision-making processes is not optimal, mainly due to the lack of appropriate technological capabilities to process and use them. Only a small number of branches can boast of having comprehensive electronic data.

Introducing a managerial information system that collects, filters and processes data describing the current and past condition in various activity fields of the healthcare unit gives the possibility to satisfy information needs of the management staff in the healthcare sector. Electronic data processing facilitates using data in the decision making process at the management level and encourages regular reporting, which should lead to the elimination of decision errors (Jelonek 2018, pp. 13-15).

Therefore, it becomes necessary to apply such a management concept that will ensure effective implementation of business and medical goals with the effective use of actual information resources while maintaining the required and binding standards of the treatment process. The solution supporting these management processes can be business intelligence², which gives value to data and leads to their effective use in decision-making processes also in the aspect of supporting organization strategies, both in economic and medical areas. BI class tools are based on specialized registers, data warehouse (Chodkowska-Gyurics 2014) type and BI class analytical tools. The process of total or partial computerization covers almost all areas of their activity. BI systems combine data from all sources and on this basis they create a readable message. They provide a range of related opportunities, including shortening the waiting time for data, and instead of several reports, the manager receives one optimized report that is a compilation of all partial reports. The resulting combination can be analysed and data can be modified depending on the kind of information that is needed at the moment (Smok 2010).

Therefore, in the era of growing competition, in order to make better organizational and economic decisions, effective digitization and computerization of management processes is an asset that facilitates business success (Banaszak, Kłos, Mleczko 2011, p. 232-233). In addition to planning, communicating, collecting, filtering, securing data and presenting rational analytical and reporting solutions, BI can be a very useful instrument to observe the researching competition or benchmarking activities. The experience of the growing number of units in the private and public sectors shows that currently BI tools are becoming a more common and desirable solution used in management. Excess information flowing into the unit means that in order to maintain a competitive advantage on the market, organizations should support their operations with modern and optimized solutions on a regular basis. It can be said that without proper implementation and use of business intelligence tools, the organization is doomed to lose the fight against competition.

Business Intelligence – the meaning of the concept

As commonly understood, business intelligence is an information technology used to transform and process large amounts of data into information and then into knowledge – a term that means using the organization's data resources to make better decisions regarding its development, which is addressed primarily to decision makers. Thanks to the use of BI, information can be managed more effectively³.

² *Business Intelligence* – is a concept of solutions designed to integrate and process data in such a way as to use them in relatively easy way in the decision-making process. BI can be defined as a broad category covering technologies, applications and processes responsible for organizing access to collecting and storing, as well as analysing data. Business intelligence at the practical and individual level is an analytical and reporting tool that supports decision-makers in the enterprise (see more: Januszewski 2011, pp. 7-20).

³ According to the definition by A. Stabryła, *information management* – is a field of management aimed at controlling the flow of information processes and providing information to users with specific needs. Information management consists in controlling the acquisition, creation, modification and sharing of information (see more: Stabryła 2012, p. 359).

In turn, according to J. Kisielnicki, business intelligence is a broad category of applications and technologies used for collecting, gathering, analysing and providing data (Kisielnicki 2013, p. 294).

It should be noted that the management and consumption of information held in enterprises usually look as follows: data flow to the user from various sources that the user must systematize and group, select, analyse and later assess their usability. Unfortunately, this procedure is very time-consuming, especially in small and medium-sized enterprises, which employ fewer employees. With well-chosen BI tools, the employee can analyse the material in a much shorter time. First of all, information is collected faster and more efficiently, and reports are generated automatically ([http://www.sage.com.pl/...](http://www.sage.com.pl/)).

As in other areas of the economy and the services sector, the progressing process of computerization of healthcare is already a fact. Among other things, business intelligence systems support these processes.

Business intelligence systems are highly specialized tools that set drastic performance requirements focused on data warehouse technologies that support effective business management. They provide a number of possibilities related to shortening the waiting time for data by the unit's management. Data properly configured and tailored to the specific needs of a given healthcare unit support processes related to, among others, operational efficiency management, budget planning, controlling and profitability assessment, and finally the calculation of operating costs ([http://domdata.pl/...](http://domdata.pl/)).

Business intelligence tools enable data integration, which affects achieving a new dimension that will enable the unit to:

- find data;
- search for correlations between phenomena;
- understand these phenomena and draw conclusions.

Today's BI solutions are so "smart" that the system itself can recognize information that can be combined into tables or entire spreadsheets. In addition, the program can submit the data to initial selection and then to processing. A significant part of these operations is carried out automatically or is intuitive in use ([https://www.jcommerce.pl/...](https://www.jcommerce.pl/)).

Implementations of the BI system should be considered at two levels: IT (i.e. technical and technological) and business (i.e. organizational). Solutions at the IT level should result from the management of the healthcare unit and business goals. A proper selection and combination of technologies are important, and at the business level they are connected with the change in the organizational culture of the healthcare unit, consisting in the exchange of knowledge and information ([http://www.bi-pro.pl/...](http://www.bi-pro.pl/)).

It can, therefore, be concluded that business intelligence is an information management system of the third generation. According to J. Surma, this business decision support system (DSS) covers a comprehensive spectrum of technologies, mainly:

- OLAP tools⁴;
- data extrapolation tools;
- knowledge management tools (Surma 2009, p. 13).

In other words, business analytics, i.e. business intelligence, is a comprehensive concept – its scope includes such areas as cost optimization, improvement or efficiency and quality, building what-if scenarios⁵, or creating a comprehensive analysis of savings. Therefore, it should be stated that business intelligence is not only information technology, but a vision of the information system and the improvement in the management of a given healthcare unit, the more so as the underlying assumption of the business intelligence system is to democratize access to all information in the organization.

It is very important for ensuring proper knowledge management. It is essential that the current information is available to every participant in business processes, and not only to a small group of employees. The ultimate goal is to enable management to be decentralized, i.e. to increase the operational efficiency of each level of management as well as the entire organization through simple and quick access to information: coherent, current and of high-quality. In order for this vision to be fully carried out, the right combination of relevant information technologies is necessary⁶. Among them, one can list, for example, news portals, database management systems, OLAP technologies and Internet technologies.

Applications of Business Intelligence tools in healthcare units' management

In principle, the implemented business intelligence system should improve management in three areas in the healthcare unit:

1. Operational – (i.e. all activities directly related to the production of a product):
 - identifying cost reduction of medical services and administrative operations;
 - optimizing the use of all available resources;

⁴ OLAP (*OnLine Analytical Processing*) – in IT the part of the broader category of business intelligence, which also includes relational databases, reporting and the so-called *data mining* (exploration of data used for automated discovery of statistical dependencies and schemas in very large databases). OLAP is decision support software that allows the user to quickly analyse information contained in multidimensional views and hierarchies. OLAP tools are often used to perform sales trend analysis or financial analysis (warehouse data). They are also useful for pre-viewing the data set by the analyst in the preliminary phase of statistical analyses. In the healthcare sector, *OnLine Analytical Processing* tools are used most often to analyse treatment costs, maintenance costs of a healthcare unit, reimbursement, budget analysis of a facility, analysis of a physician profile (see: [https://mfiles.pl/...](https://mfiles.pl/)).

⁵ *What-if?* – scientific answers to hypothetical, but important questions that probably rarely come to people's minds.

⁶ The ubiquitous “gathering” of information is a huge challenge for analysts, with simultaneous lack of connection of systems and data among themselves. In everyday work, two, three or more tools and systems are often used that do not communicate with each other, but are involved in the implementation of one business process. In the long run, it causes problems in the performance of tasks, loss of control over the process, not to mention the lack of opportunities to improve the process and draw conclusions.

- assessing the effectiveness of white and grey parts;
 - ensuring transparency, completeness and correctness in the implementation of medical procedures;
 - conducting an assessment of the effectiveness and efficiency of the medical procedures used;
 - increasing the patient's sense of safety;
 - elimination of medical errors;
 - individualization of patient treatment/therapy;
 - shortening the waiting time for access to medical information;
 - comprehensive coordination of medical processes;
 - supporting the decision-making process in the field of hospitalization of patients in accordance with applicable standards;
 - the ability to analyse data to select and apply the best patient therapy;
 - the ability to analyse the effectiveness and efficiency of medical procedures;
 - data visualization;
 - effective communication between co-workers.
2. Tactical – at this level, the task of business intelligence systems is to provide information for making business decisions, e.g.:
- elimination of possible fraud and swindle in performing medical procedures;
 - reducing the risk of making wrong business decisions;
 - raising the quality of services provided;
 - providing services in accordance with applicable standards and norms;
 - shortening the time of making decisions;
 - increasing the level of patient satisfaction with medical services;
 - creating a complimentary patient data flow system;
 - creating the so-called managerial dashboards – used in making business and medical decisions;
 - shortening the period of generating economic analytical reports, as well as medical ones.
3. Strategic – at the strategic level, their task is to set goals and control their implementation. They give the opportunity to compare various historical results on the basis of which future scenarios can be predicted, i.e.:
- building an accessible and complementary description of businesses and medical processes implemented in a given organization.

Therefore, it can be said that BI mainly contributes to achieving better effects of healthcare institutions. Units that have implemented such analytical solutions in various areas of their operations will notice the measurable benefits of their implementation very quickly.

In summary, as in other areas of the economy, including healthcare, the use of BI in the management of healthcare facilities can be presented as in the diagram below.

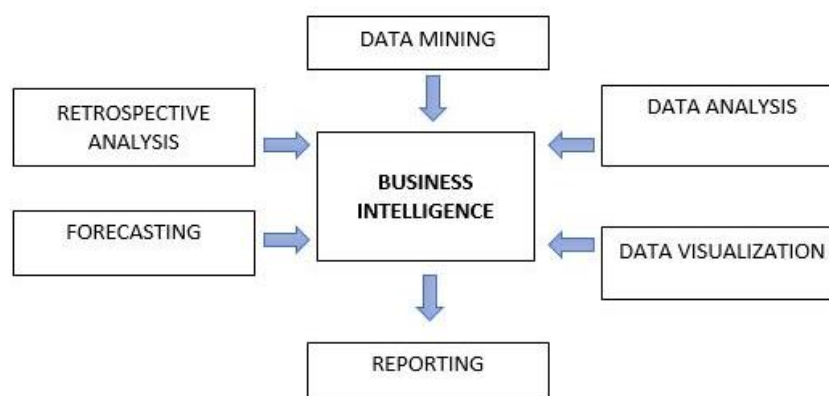


Figure 1. The use of the BI systems in healthcare facilities

Source: Own study

The basic analytical method that supports management decision making is *reporting*⁷. Then, the *ex-post retrospective analysis*⁸, as well as forecasting⁹, are used. *Data visualization* and *data mining* are equally common supporting techniques. Similarly, decisions and actions in the area of healthcare (in the medical field) are supported and implemented by the *ex-post* analysis, very often by pre-defined *reporting*¹⁰ and acquiring knowledge and forecasting from actual data (i.e. data mining)¹¹. In the areas mentioned above, analyses are primarily performed on the basis of a *spreadsheet*¹², and additionally, the *Statistica*¹³ program is used in the medical field.

⁷ *Reporting* – it converts data into information that helps to carry out analysis, budgeting and planning processes that support decision making. One of the key aspects of reporting is the visualization of information, both in terms of matching it to the right audience and its availability (see: <http://www.codec.pl/...>).

⁸ *Ex post* (retrospective) analysis – otherwise known as the initial analysis, contains an assessment of the results of actions taken in the past. The known condition is the basis for taking the current and future goals.

⁹ *Forecasting* – it is a rational, scientific, predicting of future events, i.e. inference about unknown events based on known events.

¹⁰ *Pre-defined reporting* – ready, pre-defined report templates that can customize the reporting system to the user's needs.

¹¹ *Data mining* – (the term of data exploration, knowledge acquisition, extracting data, data extraction is also encountered), - one of the stages of knowledge discovery in databases (KDD). The idea of data exploration consists in using the speed of the computer to find regularities in data collected in data warehouses hidden for humans (due to the limited time possibilities) (see: <https://www.statsoft.pl/textbook/...>).

¹² *Spreadsheet* – a computer program presenting data, mainly numerical, in the form of a set of large two-dimensional tables, allowing for automatic processing of these data and presenting them in various way. The most important spreadsheet tool are functions (mathematical, statistical, date and time, financial, database, logical), by means of which data entered into the spreadsheet is automatically processed. It is also possible to create various types of simulations. Using a spreadsheet, you can also visualize data by presenting it in the form of graphs (column, bar, pie, line, layers, etc.), which allow you to better understand mutual dependencies and tendencies (see: <https://sjp.pwn.pl/...>).

Conclusions

In the majority of healthcare facilities, the level of awareness of BI tools, their implementation and dissemination is observed to be relatively low. The main reasons can be the resistance of employees to progress, computerization and the implementation of analytical tools. Lack of training, expanding knowledge in this area is associated with the lack of awareness of the benefits resulting from its implementation and the lack of sufficient staff competence (Rostkowski 2012, p. 103). The reason for this is also the low level of organizational culture¹⁴. Another equally important factor is the lack of funds for the implementation of a particular type of system, as well as difficulties in determining the ROI (return on investment) from such an investment.

In summary, the main obstacles in the implementation of business intelligence in healthcare facilities are:

- lack of adequate resources to implement BI tools (among others, financial, HR);
- high complexity, heterogeneity, variety and diversity of IT systems used and the lack of solutions enabling their integration and ensuring high-quality data;
- the unstable economy resulting from frequent changes in legal regulations and in the field of health policy;
- low awareness of organizational culture;
- lack of knowledge and experience in the use of BI;
- lack of qualified staff (<http://www.hypatiaresearch.com/...>).

The most important benefits that any healthcare institution can achieve thanks to the implementation of BI tools is the increase in the level and efficiency of management, including shortening the waiting time for management data, budget planning, cost optimization, assessment of the profitability of medical procedures, and finally, calculation of the operating costs. It results in expanding and increasing the level of medical services leading to an increase in the level of patient satisfaction, as well as greater satisfaction with the work of the employed personnel, mainly medical staff.

In addition, the existing analytical BI systems can be used for a large number of existing (but not yet analysed) patient health data and related medical data to better understand the obtained information and results and to design optimal therapeutic clinical pathways.

In particular, the benefits of implementing BI systems in healthcare in *improving the quality of health services*, among others, may be as follows:

¹³ *Statistica* program – it is a universal system used for statistical data analysis, graphing, operating on databases, performing data transformation and creating applications. The system includes a comprehensive set of advanced analytical procedures used in science, business, technology and data mining. The program contains files with examples, thanks to which you can carry out various analyses (with many sample datasets to choose from) and create charts – see <https://www.statsoft.pl>.

¹⁴ Using traditional analytical systems, conducting any analysis usually turns out to be time-consuming, and once it is obtained, it often becomes obsolete. In static reporting, the manager usually receives a report at a high level of aggregation, without the ability to review its lower level. At this level of insight into data, there is not enough information to understand the cause of the phenomenon or follow it in time to find a solution.

- searching for more cost-effective and more medically effective methods of diagnosing and treating patients;
- the doctor’s assessment of the treatment method he/she has chosen;
- predicting the occurrence of particular diseases;
- searching for trends that lead to the improvement of the health, quality and lifestyle of the society;
- analysing the genetic material contained in the basic set of chromosomes (i.e. the human genome), in order to introduce individual treatment (it will be possible to adapt the drugs and methods of treatment to the requirements of a given patient) (see more: <http://pmorawski.spoleczna.pl/...>).

In turn, in the field of *supporting the work of medical personnel*, the benefits may be as follows:

- detection of diseases at earlier stages, when they can be more easily and quickly cured;
- the ability to predict the occurrence of specific medical conditions or deterioration of the patient’s test results;
- predicting the disease progression and its determinants, including risk assessment of complications;
- detecting epidemiological threats and improving the control of pathogenic outbreaks and the speed of reaction to the existing circumstances;
- doctor’s comparison of the current medical case to historical cases (historical data) for better patient diagnosis and personalized treatment;
- analysis of patients’ profiles in order to identify people for whom preventive treatment should be applied, including lifestyle change, i.e. preventive care;
- identification of patients at the highest risk of developing life-threatening diseases. Thanks to the data on the history of the most common diseases in people under treatment juxtaposed with the reports coming to insurance companies;
- receiving and analysing in real time large amounts of data from hospitals as well as home devices monitoring vital functions. The analysis is done to monitor safety and predict possible adverse events;
- detecting drug interactions, their side effects.

Also in the field of *supporting research and scientific activities*, the benefits may include the following:

- supporting work on clinical trials of new drugs, thanks to the possibility of analysing “all data” instead of choosing a sample for research (evidence-based medicine, EBM)¹⁵;
- selection and choice of a group of patients in the case of which the tested drug is likely to have the desired effect and no side effects occur;
- the use of modelling and predictive analysis for the design of better drugs and medical equipment and apparatus (see more: <http://rocznikikae.sgh.waw.pl/...>).

¹⁵ EBM – use of reliable scientific evidence in clinical proceedings regarding the effectiveness and safety of therapy. Such evidence is provided by test results based on observations and experiments.

Summing up, the implementation of business intelligence systems in security institutions may contribute, among others, to the improvement of patient service, designation and implementation of appropriate pathways (ways) of patient treatment, support of clinical treatment, monitoring of healthcare safety, creation of a complementary system of patient data flow, shortening the waiting time for access to medical information, optimizing the use of all available resources, shortening the period of generating economic and medical analytical resources, as well as creating management control systems. The introduction of these solutions will bring the health sector in Poland closer to the possibility of online monitoring the patient's status.

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WYKORZYSTANIE NARZĘDZI KLASY BUSINESS INTELLIGENCE W JEDNOSTKACH OCHRONY ZDROWIA

Streszczenie: Celem artykułu jest pokazanie zasadności wprowadzenia do jednostki ochrony zdrowia systemu Business Intelligence (BI) oraz zobrazowanie korzyści, jakie z tego płyną, np. poprawa terminowości i jakości danych wejściowych do procesu decyzyjnego. Ponadto treści zawarte w opracowaniu pokazują, że wdrożenie tych systemów pomaga zrozumieć, jakie jeszcze dana organizacja posiada niewykorzystane możliwości, dotyczące stanu wiedzy, trendów i tendencji występujących na rynkach oraz w otoczeniu, w którym ona funkcjonuje i konkuruje. W artykule podkreślono także, że informatyzacja, automatyzacja oraz implementacja narzędzi analitycznych do części „szarej” i „białej” szpitala ma charakter oczywisty w ciągle rozwijającym się sektorze ochrony zdrowia. Zakres badawczy artykułu obejmuje systemy BI, które łączą dane operacyjne z narzędziami analitycznymi, pozwalające przedstawić i umożliwić decyden-
tom podejmowanie świadomych decyzji na podstawie twardych danych. Niniejszy artykuł podkreśla również znaczenie danych niestrukturalnych oraz strukturalnych i omawia potencjał oraz potrzebę opracowania narzędzi BI do pozyskiwania, integracji, czyszczenia, wyszukiwania, analizy i dostarczania danych w dążeniu do osiągnięcia założonego celu. W artykule źródłem danych oraz zastosowaną metodyką ich pozyskiwania były informacje pochodzące z zebranej literatury dotyczącej wskazanej problematyki, analiza badań własnych opartych na dokumentach pochodzących z kilku placówek medycznych z terenu województwa śląskiego, przeprowadzone pogłębione nieskategoryzowane wywiady ustne (jawne bądź ukryte) z ekspertami z zakresu polityki zdrowotnej oraz obserwacja własna zmian zachodzących w obszarze sektora ochrony zdrowia. W publikacji wykazano, że powstanie hurtowni danych, jako repozytorium, postępy w oczyszczaniu danych, zwiększone możliwości sprzętu i oprogramowania oraz pojawienie się architektury internetowej – wszystkie razem tworzą bogatsze środowisko BI, niż było to wcześniej dostępne w danej jednostce służby zdrowia, co w konsekwencji podnosi jakość świadczonych usług medycznych w tych podmiotach.

Słowa kluczowe: Business Intelligence, hurtownie danych, informatyzacja, procesy decyzyjne, systemy zarządzania