

# Review on Business Intelligence Solutions in Healthcare Sector

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**Abstract:** Business Intelligence applications are trending now-a-days in many different fields. Recent new area of using this application is in healthcare. This paper focuses on the different approaches taken for data management and improving the outcomes of previous BI systems such as providing up to date and accurate system performance (such as data warehouse model, analysis services and reporting services) through BI applications. Also, different tools used in BI systems are discussed in the paper.

**Keywords:** BI (Business Intelligence), ETL (Extraction, Transformation, Loading), Data Warehouse, Healthcare.

## I. INTRODUCTION

Business Intelligence is discipline made up of various related activities that include gathering, storing, analyzing, sharing, querying and reporting of data to make better decisions. BI is used in several sectors such as finance, food industry, fashion industry, pharmaceutical industry, video games, etc.

The healthcare sector now-a-days has become a constant progressing sector. As this area is rapidly developing there are many issues been faced which are subject of interest of scientific disciplines. Healthcare sector face many problems due to increasing population, technological progress in medicines and lack of funds, changing disease patterns, lack of decision making, etc. Application of Business Intelligence in health care sector can be the solution to these problems [1].

The study conducted by Osama Ali is one of the initial studies that proposed to provide timely and accurate data and proceed towards the improvement of quality for a well-known health condition of hip fracture that has been discussed. Here, Business Intelligence is used for this purpose. The patient's flow framework that includes his admission in the hospital, surgical treatment period, his stay period and the rehabilitation care has been discussed. BI is used for improving this flow framework and the outcomes are stated [2].

The study conducted by John Lewis is one of the initial studies that proposed careful and perceptive application of Business Intelligence that can transform data into information and information further into knowledge and help to improve outcomes and operational efficiency. Here, the researchers have discovered the issues in traditional systems and applied Business Intelligence to overcome these issues which resulted in reduced costs and improved clinical care quality in Cancer centers. The historical and real-time datasets are combined to improve the outcomes that improved decision making [3].

## II. BUSINESS INTELLIGENCE IN HEALTHCARE

Healthcare is changing rapidly and so is the industry's need for analytics and business intelligence. The lack of Business Intelligence strategy is considered as one of the nine fatal flaws in Business Operations Improvement (BOI). The application must be looking forward to look for the following:

- Manage patient's population
- Reduce waste
- Improve quality of care
- Improve clinical decisions
- Optimize financial and operational performance
- Allocate scarce resource

The three key benefits that BI realizes with clinical Data Warehouse are:

- Enabling a more efficient, scalable reporting process
- Ensuring consistent data that everyone can trust
- Enabling meaningful, targeted quality improvement.

## III. THE USE OF BUSINESS INTELLIGENCE SYSTEMS IN HEALTHCARE ORGANIZATIONS IN POLAND

Celina M. Olszak and Kornelia Batko proposed a research methodology for supporting decision making process in organizations of healthcare sector using Business Intelligence. In order to diagnose the problem, the analysis 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 [1].

### A. Healthcare sector characteristics in Poland

The healthcare system in Poland is based on the basis of article 68 of the Polish Constitution (dated 2 April 1997) and on an insurance model. According to this article, every citizen has the right to health services, despite of their financial situation and the public authorities should ensure

equal access to healthcare services financed from public funds. The transformation of the healthcare sector in Poland resulted in progress of economy in health, in order to shift the relationship between patient and doctor, depending on the market conditions.

The primary purpose of healthcare sector is to protect the public health. So, the participant in this sector are divided into triangle form: beneficiaries (patients), providers (doctors, health care - health care facilities) and the payer (the insurer to provide financing) called a third party. It also focuses on the characteristics in a way (how), place (where) and time (when) to provide services to the patients. The shortcoming of current healthcare system in Poland are:

- Health information poor quality
- Not able to access health information on time and place where it is needed
- Inadequate procedures - implementation of information systems not related to the relevant organizational changes
- Lack of co-operation of information systems i.e. it 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.

Poland is one of the worst ranking countries of Europe with respect to healthcare facility. It ranks on 25<sup>th</sup> position out of 31. Healthcare sector is facing many problems such as handling the data and quick access to the required data. One of the solutions discussed is Healthcare Information Technology (HIT).

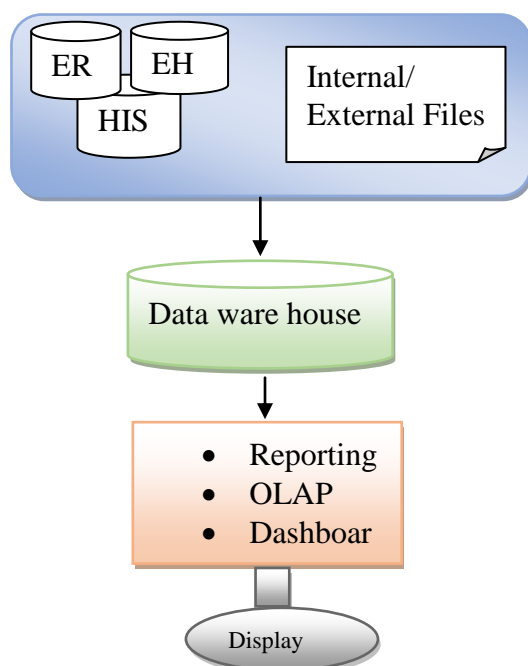


Fig. 1. The schema of BI for Healthcare organization

A well-developed Health Information System provides many benefits such as that includes the quality of patient treatment and care as well as better financial management and many more. One of the most appreciable HIS 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 Kamssoft).

In Poland, most of the patient's information i.e. medical records are collected in paper form or with the paper placed on the computer i.e. by scanning. But the storage, retrieval and access of data in such case becomes difficult. This has been overcome by using electronic records to store these records such as EHR (Electronic Health Record), EPR (Electronic Patient Record) and EMR (Electronic Medical Records). The schema of healthcare organization is shown in Fig. 1 [1].

#### B. Application of BI in healthcare in Poland and its challenges

The BI system uses set of integrated tools that include various components such as:

- ETL tools
- Data ware house
- Analyzing, reporting and presentation tools
- Dashboards

Two BI systems viz. Simple BI and Comarch BI are discussed.

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 [1].

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 [1].

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

1. Challenges for quality and data standards
2. Challenges for selection of information
3. Challenges for healthcare organizations personnel (especially medical staff) for handling information systems.

#### C. Benefits of using Business Intelligence in Poland

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

- Consolidation and protection of data.
- Efficiency improvement.
- Increase revenues and reduce costs.
- Improved margins.
- Improved patient satisfaction by using BI and analytic tools.
- Improved patient treatment and care.
- Reduction of medical errors and improved patient's safety.

- Improved decision-making in the area of comprehensive health care policy by the authorities of the organization of the health sector.
- It helps to see the overall picture of the hospital.
- Improved monitoring.

**IV. USING A BUSINESS INTELLIGENCE IN HEALTHCARE FOR IMPROVING HIP FRACTURE CARE PROCESSES IN A REGIONAL REHABILITATION SYSTEM**

Osama Ali, Pete Crvenkovski, Helen Johnson proposed a research methodology to improve the healthcare organization care process for hip fracture in a regional rehabilitation system in Ontario. Hip fracture is well known health condition in adults. Accurate data on volumes of patients with hip fracture, discharge dispositions, and patient outcomes can be challenging to obtain for system evaluation and directing quality improvement [2].

The Bone and Joint Canada National Hip Fracture Toolkit outlines suggested best practices, such as targets for timely surgery and access to appropriate rehabilitative care, to improve outcomes and return more patients home.

**A. Hip fracture patient flow framework**

According to the system proposed by Osama Ali, Pete Crvenkovski, Helen Johnson, patients should be admitted to hospital from the Emergency Department within four hours and 90% of patients should receive surgical repair of the fracture within 48 hours. The mean target length of stay in the acute care setting is seven days, after which discharge planning and expedited transitions should occur either to home or another post-acute setting for ongoing rehabilitation, as shown in Fig. 2 [2].

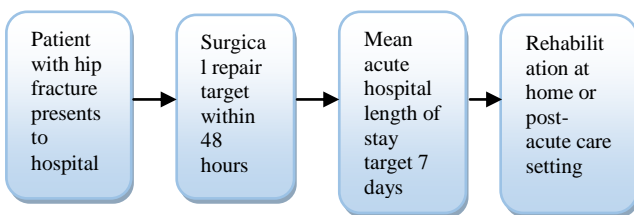


Fig. 2. General process flow map for patient with hip fracture [2]

The research conducted by Osama Ali, Pete Crvenkovski, Helen Johnson was developed to improve data management and allow data analysis considering different perspectives. The most challenging part of this project was to build the data warehouse using star schema, constructing the cube and determining Key Performance Indicators (KPI).

**B. Technology used for design and implementation:**

- For Data Mart Building: Microsoft SQL Server 2008 R2 Management Studio.
- For Data Transformation (ETL): SQL Server Integration Service (SSIS) packages (using Business

Intelligence Development Studio with Visual Studio 2008).

- For building Multidimensional Cube (OLAP): SQL Server Analysis Service (SSAS) solution by using Business Intelligence Development Studio with Visual Studio 2008.
- For Reporting: SQL Server Reporting Service (SSRS) or MS Excel 2010.
- For Online Scorecard and Dashboard: Web application based on ASP.NET and C#.NET [2].

**C. Project Methodology:**

The BI research in healthcare which was conducted in Ontario discusses the methodology phases in development of BI as follows:

1. Design the data warehouse using SQL Server Management Studio i.e. design of facts and dimension tables in the data warehouse.
2. Design the ETL packages via using SQL Server Integration Services project.
3. Design of a Multidimensional Cube for Hip Fracture by using Analysis Service project within VS 2008 SSAS.
4. Build required reports by using SSRS or Excel 2010 pivot table.

**D. Results:**

According to the BI solution generated data, a number of collaborative initiatives were undertaken by health service provider partners following the regional forum. Some of these initiatives included:

1. Improving time to surgery
2. Improving access to inpatient rehabilitation
3. Improvements to total acute care length of stay (LOS)

**V. APPLYING “BIG DATA” AND BUSINESS INTELLIGENCE INSIGHTS TO IMPROVING CLINICAL CARE FOR CANCER**

John Lewis, Prof Siaw-Teng Liaw and Pradeep Ray proposed a research methodology that explores ways to improve clinical outcomes by linking different multiple datasets held in a diverse set of clinical, research and other repositories in many different organizations. This research aims to realize this potential by identifying the most effective ways to utilize the growing amount of data generated by cancer care information systems through improved data linkage and application of big data and emerging business intelligence applications [3].

**A. Objectives:**

The main objective of the research conducted by John Lewis, Prof Siaw-Teng Liaw and Pradeep Ray is to focus on effective delivery of information and improve the clinical decision making in cancer care. In Australia, there are multiple datasets held in a diverse set of clinical, research and other repositories in many different organizations. There is much scope to improve clinical

outcomes by linking the different operational datasets as well as linking operational real time data with available retrospective data [3].

The assumption is that clinical decision-making and results in cancer care can be improved by combining datasets from real-time clinical information systems with historical datasets from clinical trials and the subsequent application of big data and Business Intelligence techniques. Clinical decision-making and outcome improvements is measured by clinician and patient feedback on usage, interference changes and outcomes using structured interviews and surveys, improved by changes in survival rates and patient wellbeing [3].

#### B. Methodology used:

The design and methodology of the research for improving clinical care for cancer conducted in Australia comprises of:

1. A Literature Review: It studies about the current decision making process of cancer care. It involves taking reviews that would help in improving data quality and provide easy access to data.
2. A Conceptual Framework: It is the framework that focuses on recognizing the interaction between human and the technology in health workplace. It will use a combination of quantitative and qualitative methods.
3. A Qualitative Research Phase: Quantitative measures of data entry effort, data quality, timeliness and extent of use by clinicians would enhance the qualitative methods [3].
4. Combined Data Sets: It studies the difference between the combined datasets and the existing datasets.
5. Analytics Applications: comparative study to identify differences in utility for clinical decision-making of different analytics techniques and applications [3].

#### C. Barriers in combining the datasets:

There are significant barriers to be overcome in combining unrelated datasets if the end result is to be valid. The barriers include:

1. Different purposes
2. Different patient populations
3. Different primary keys
4. Different data model
5. Ensuring Privacy
6. Proprietary issues

#### D. Research priorities discussion:

Translational Research offers opportunities to operationalize the insights such as managing large amount of data. Translational Research is still rapidly evolving.

This has led research project to focus less on combining clinical trials datasets with operational datasets and more on the knowledge gained from combining operational datasets can be actually applied to patient care.

## VI. CONCLUSION

The purpose of this review was to study and understand the different research methodologies in use of Business Intelligence in the healthcare sector. Three different aspects of providing better solutions for business intelligence in healthcare are discussed as follows:

The authors Celina M. Olszak Kornelia Batko, "The Use of Business Intelligence Systems in Healthcare Organizations in Poland," have accomplished that the success of BI system is based on historical data collected from different sectors such as financial, operational and clinical system. Also, currently BI focusses on reducing cost, instead of the further improvement of medical necessity. [1] The authors Osama Ali, Pete Crvenkovski, Helen Johnson "Using a Business Intelligence Data Analytics Solution in Healthcare" have accomplished that enhancement effort in building an integrated regional rehabilitation system for patients with hip fracture has resulted in improved time to surgery, access to rehabilitation, and shortened length of hospital stay. Also, the data warehouse and OLAP cubes have improved the ability to visualize system data in timely ways. [2]

The authors John Lewis, Prof Siaw-Teng Liaw and Pradeep Ray, "Applying Big Data and Business Intelligence Insights to Improving Clinical Care for Cancer," accomplished that the use of translational research principles to implement the Colon Cancer Survivorship Care Plan will improve compliance with guidelines and encourage healthier life style, wellness. [3]

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### BIOGRAPHIES



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