

Knowledge Management Approaches for Business Intelligence in Healthcare

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Abstract - Knowledge management (KM) is an intelligent process by which the gathered raw data is transformed into knowledge. KM have become an efficient approach for building practical and intelligent decision support systems in medical and healthcare domains. Business intelligence (BI) is a structured approach to preparing and using information to drive business activity and it is instrumental in turning raw data into knowledge that can be used to derive value. It can be described as a value proposition that helps organizations in their decision making processes. This paper discusses two important knowledge management approaches that are used for business intelligence in the context of healthcare domain, namely; expert systems and data mining techniques.

Keywords - Business intelligence, Data mining, Expert systems, Healthcare, Knowledge management.

I. INTRODUCTION

During recent decades, knowledge is the aspiring elementary resource mandatorily required by all intelligent information processing systems. Knowledge engineers use artificial intelligence concepts and techniques to knowledge-based decision support systems. Knowledge management (KM) is emerging as the new discipline that provides the mechanisms for systematically managing the knowledge that evolves with the enterprise. Most large organizations have been experimenting with knowledge management with a view to improving profits, being competitively innovative, or simply to survive [1, 2]. Furthermore, exploiting technology enables organizations to derive knowledge from data and information collected as the business proceeds. It then may be exploited in decision making, product development, human resourcing, customer relationships, the supply chain and so on. Clearly, knowledge management needs to infiltrate every aspect of the enterprise to improve business efficiency. Most literature on KM classifies knowledge into two main categories: explicit knowledge and tacit knowledge. Explicit knowledge can be defined as things that are clearly stated or defined, while tacit knowledge can be defined as things that are not expressed openly, but implied [3, 4].

Business Intelligence (BI) is an umbrella term for various business managing approaches based on well-informed decisions, which lead to a high performance level within organizations. The Data Warehouse Institute defines BI as “a set of concepts and methodologies to improve decision making in business through the use of facts and fact-based systems”[5]. BI can be thought of as getting the

right information to the right people at the right time and place to enable fact-based decisions. Recently two distinct understandings of the term BI (respectively BI system) exist – a data-centric and a process-centric. The data-centric position uses BI systems to combine operational data with analytical tools to present complex and competitive information to planners and decision makers. The objective is to improve the timeliness and quality of inputs to the decision process [6]. BI is therefore mainly used to understand the capabilities available in the organization [7]. The process-centric position notes a major shortcoming in this inherent data-centricity. Because the collection, transformation, and integration of data as well as information supply and analysis are commonly isolated from business process execution, a great part of the information that intrinsically exists within an organization remains either unused or is at most partially used but deprived of its interpretation context [8]. As they see an organization as a set of well-integrated processes [9], BI therefore should be used to integrate the information world with the process world in order to facilitate decision making with an all-embracing information basis.

In the context of BI, knowledge management techniques can be seen as enabler for managing, storing, analyzing, visualizing, and giving access to a great amount of data. For this purpose, a wide range of intelligent technologies (e.g. expert systems, online analytical processing, data mining and knowledge discovery, grid computing, cloud computing) are used in developing of a BI systems. Technology is required to provide an integrated view of both, internal and external data (for example by means of a data warehouse). It is therefore the base for BI. The aim of this study was to discuss the benefits of the well known knowledge management approaches, namely; expert systems (ESs) and data mining (DM) from the business intelligence point of view in the context of healthcare domain.

II. BUSINESS INTELLIGENCE APPROACH IN HEALTHCARE ENVIRONMENT

From the BI perspective, we have the following three the main healthcare processes; (a) **Medical processes**, (b) **Business processes**, and (c) **Support processes**.

(a) **Medical processes** are those activities and work practices within a health care organization which are mainly

focused on the health services delivery ,e.g.; diagnostic and therapy , research and teaching , and nurse care.

(b) Business processes comprise activities that are needed to effectively run the health care organization and may not be, or only partially sector specific ,e.g; monitoring and controlling , financial accounting , compliance and risk management , and Organizational Development .

(c) Support processes are used from both kinds of processes but only have an indirect impact on medical and business activities, e.g; communication ,human resources and logistics and supply

Based on our analysis for the recent publications during the last five years, one can conclude that, the BI serves an increasingly wide variety of departments in the provider market with an assortment of unique reporting and analysis applications. A robust BI environment offers healthcare organizations a host of business benefits including:

1. The ability to optimize resources (including physical space, equipment and devices, staff and supplies) in individual departments such as Surgical Services.
2. The ability to develop and monitor key performance indicators and clinical indicators to improve performance and quality.
3. The ability to conduct planning, budgeting, and forecasting more efficiently and accurately across large organizations.
4. The ability to effectively understand and manage the supply chain and logistics to contain costs and ensure consistent supply.
5. The ability to better ensure patient safety through efficient diagnostics and the identification and enforcement of best practice treatment protocols.
6. The ability to contain costs and improve performance and quality through human resources management and physician profiling

III. EXPERT SYSTEMS APPROACH IN THE CONTEXT OF BUSINESS INTELLIGENCE IN HEALTHCARE

Expert system (ES) is a consultation intelligent system that contains the knowledge and experience of one or more experts in a specific domain that anyone can tap as an aid in solving problems [10]. The most commonly systems are rule-based expert systems (RES) and case-based expert systems (CES). In RES the knowledge base stores the knowledge in the form of production rules (if-then statements). The inference engine contains a set of formal logic relationships which may or may not resemble the way that real human expert reach conclusions. CES uses case-based reasoning (CBR) methodology in which the system can reason from analogy from the past cases. This system contains what is called “case-memory” which contains the knowledge in the form of old cases (experiences). CES solves new problems by adapting solutions that were used for previous and similar problems [11]. The technology of CBR directly addresses the problems found in rule-based technology, namely: knowledge acquisition, performance, adaptive solution, maintenance.

In the last years various machine learning (ML) techniques have been proposed by the researchers in order to develop efficient biomedical knowledge-based systems[12,13].ML is an intelligent technique that tries to find a mathematical model that maps between inputs and outputs of a domain problem. There are two stages of using ML techniques. These are creating the mathematical model by learning mappings between given input and output. The second stage is using the model to predict an output, given unseen input.ML techniques offer a robust computational intelligence methods and algorithms that can help solving management problems in healthcare domains.

Based on our analysis of the recent publications during the last five years, one can summarized the benefits of the ESs technology to healthcare sector in the following;

- a) Treatment choice – may be easier with the use of if-then rules of an expert system; Following the rules, a physician is able to infer treatment adequate to symptoms and/or to a specific illness;
- b) Diagnosis support – this comes both from rule-based systems as well from case based ones. If-then rules enable encoding of knowledge linking symptoms to illnesses, while case-based reasoning enables finding the illness by comparing patients’ symptoms to these stored in case-based knowledge base;
- c) Analysis of treatment options – rule-based knowledge enables a so-called what-if analysis: what is probable to happen if we use a specific treatment?
- d) Keeping medical history – is easy with case-based expert systems, where individual patients’ cases may be stored both for statistical purposes and for case-based reasoning.

IV. INTELLIGENT DATA MINING APPROACH AS A BUSINESS INTELLIGENCE VALUE CHAIN

Data mining approach is a complex process of using historical databases to improve subsequent decision making.DM methodology aims to extract useful knowledge and discover some hidden patterns from huge amount of databases which statistical approaches cannot discover [14]. Knowledge discovery in databases (KDD) process involves the following processes; (a) using the database along with any required selection, preprocessing, sub-sampling, and transformations of it, (b) applying data mining methods to enumerate patterns from it, and (c) evaluating the products of data mining to identify the subset of the enumerated patterns deemed knowledge. The data mining components of the KDD process is concerned with the algorithmic means by which patterns are extracted and enumerated from data (e.g. rough sets, fuzzy logic, neural networks).Data mining is supported by a host that captures the character of data in several different ways ,e.g. clustering, regression models, classification, summarization, link analysis and sequence analysis [15].

Fig. 1 shows the main functional phases of the medical knowledge discovery process[16,17].The preprocessing phase is often referred to as data cleaning. The cleaned data are stored in the warehouse. This is followed by data mining phase and its results are provided to an output generator (visualization) producing reports, action lists, or monitor reports. Each phase is supported by different methodologies. Data mining itself exhibits a plethora of algorithmic tools such as statistics, regression models, neural networks, fuzzy sets and evolutionary model. From fig. 1, it can be seen that, the knowledge discovery process is dynamic, highly interactive, iterative, and fully visualize able. Its main goals are to: (a) extract useful reports (b) spot interesting events and trends (c) support decision-making processes (d) exploit the data to achieve scientific, business, or operational goals.

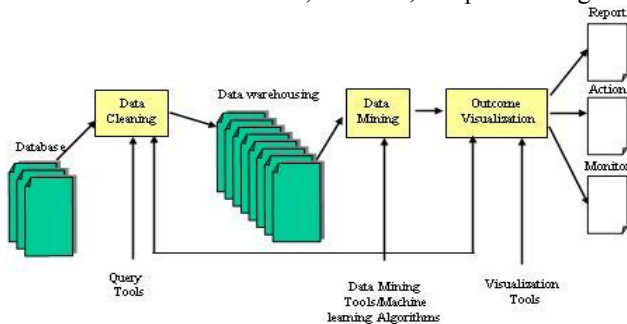


Fig 1: knowledge discovery process.

Data mining is supported by a host that captures the character of data in many different ways ,e.g. Classification, Clustering, Link analysis, Sequence Analysis, Regression Models, and Summarization. So, based on these intelligent techniques, data mining approach can performs and provides several tasks and benefits for the healthcare sector, e. g;

- (a) Clustering and classification tasks are useful for statistical purposes,
- (b) Link analysis – may support accurate diagnosis (by showing links between symptoms and illnesses) and efficient treatment – by revealing links between illnesses and medical drugs,
- (c) Storing medical history in a warehouse may be useful for statistical analyses, and
- (d) Discovering patterns and trends – used for diagnosis and reporting purposes.

V. DISCUSSION

Business Intelligence paradigm can be described as a value proposition that helps organizations in their decision-making processes [18]. Following to Porter [19], a value chain is a systematic approach to examine the development of competitive advantage, consisting of a series of activities that create and build value. All the stages and relationships in this approach will add value to the decision support process. Based on the introduced value chain, tasks like business analysis, enterprise reporting and performance management are possible.

Healthcare organization uses the business intelligence solution not only for analysis but also to change business processes and drive toward the value-driven healthcare vision. Business intelligence provides an integrated view of

data that can be used to monitor key performance indicators, identify hidden patterns in diagnosis, illuminate anomalies in processes, and identify variations in cost factors, all of which facilitate accountability and visibility and can drive an organization towards efficiency.

From the technical point of view, healthcare-based business intelligence systems are complex to build, maintain and face the knowledge-acquisition difficulty. Efficiency of such systems is determined by the efficiency of the knowledge management techniques and methodologies. Knowledge management techniques provide an effective knowledge computing methods and robust environment for business intelligence in the healthcare decision making domain.

VI. CONCLUSION

This paper discusses two important knowledge management approaches that are used for business intelligence in the context of healthcare domain, namely; expert systems and data mining techniques. Both techniques can be seen as enabler for managing, storing, analyzing, visualizing, and giving access to a great amount of data .Intelligent data mining approach fits the “ Value Chain” model of business intelligence “From DATA To PROFIT“ approach .Biomedical data is transformed into relevant and useful information. Further, the obtained valuable knowledge supports any decision-making processes in order to achieve profit. Successful BI initiatives are possible with the support of intelligent technologies, tools and knowledge-based systems that are capable to sustain the introduced value chain.

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