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Perspective Approach towards Business Intelligence Framework in Healthcare

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Abstract

Healthcare is highly complex industry driven by knowledge with rising cost and increasing demands for healthcare quality services. Healthcare providers are forced to focus on care quality while minimizing the cost through better healthcare resource management. However the abundant data from different sources such as clinical processes, business processes, and operational processes, causing remarkable issues and challenges are not resolved, through traditional technologies. Thus the Healthcare providers in effort to improve care quality and reduce cost are turning towards advanced and flexible IT -enabled business strategies. This paper is focused towards designing a Business Intelligence (BI) framework in Healthcare with an aim to overcome the issues and challenges in healthcare. This paper also attempts to illustrate the BI approaches incorporated with data mining techniques appropriate in the healthcare domain to overcome the issues and challenges more efficiently. Here emphasis is given on the main BI healthcare processes, benefits of using BI strategies in terms of efficiency, care quality and patient satisfaction.

Keywords: Business Intelligence, BI Healthcare processes, BI Solutions, BI adoption, BI framework, Data mining

1. Introduction

The Healthcare industry being complex and knowledge based is more concerned about the quality of care with lesser cost. The fundamental need of health care is to achieve high care quality at lowered cost. The health care organization are forced to provide access to data from multiple domains such as clinical, financial, quality, and patient experience information[1]. This data needs to be integrated to clearly define the relationship between outcome and the cost [2][3]. Healthcare providers in effort to improve care quality and reduce cost, are increasingly turning to advanced IT-enabled business strategies. For many years Business Intelligence has been adopted in large enterprises, particularly from the business sector and the banking sector. However, Healthcare industry is still deprived of flexible approaches of Business Intelligence technology that can be proved as a valuable tool to overcome the healthcare issues in terms of data integration, service quality and efficiency. Hence the research on the possibilities of using Business Intelligence in Healthcare has been strengthened but BI being a relatively new idea to healthcare is a biggest challenge. The need

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for a more systematic and deliberate study on Business Intelligence and the factors that allow for success in BI initiatives in healthcare organizations is crucial [4]. In terms of tools, general BI tools are used in healthcare industry, but people experienced in both healthcare data and Business Intelligence can be helpful in building custom data models to suit the needs of healthcare organization [5]. This paper focuses on how the issues in Healthcare can be targeted and overcome by more efficient and flexible BI approaches and understands the Business Intelligence Healthcare processes.

This paper is structured as follows. The section 2 introduces research methodology. Section3, presents the literature review. Section 4, perform the analysis, and Section 5 presents the evaluation of research questions. Finally, the paper is concluded.

2. Research methodology

The base of Methodology for Research adopted here the literature review conducted on the relevant researches. The objective of this paper is to present a cognitive review related to the research area. The research methodology included all journals and research papers relevant to the field of research and is examined at different levels to target the objective. While planning the review methodology the requirements for writing the review are elucidated, and then the appropriate research questions are framed. While conducting the literature review, the initial researches are identified, then data is abstracted, analyzed and evaluated for its relevance and review report is presented. This review considered the research papers, articles, reports from2002-2016 (till date) based on the availability of more research work during these years.

2.1. Research questions on BI framework in healthcare

Two research question related to the problem were framed based on the reviewed literature. RQ1: How can a Healthcare organization use the power of BI to overcome the issues and challenges in Healthcare?

RQ2: How can a BI set up be developed that provides an impact across the organization? These research questions help to find the research gaps in previous and present research work related to Business Intelligence in Healthcare The review is conducted in more conventional and systematic manner by considering relevant researches related to the technical support, working papers, articles and PhD thesis.

2.2. The strategy for primary search

Digital libraries, white papers and other online articles were considered as a source of primary search. In the initial stage, various keywords related to Healthcare, Business Intelligence, BI frameworks were used frequently for searching relevant material.

2.3. Inclusion and exclusion strategies

While conducting the review process, the papers from 2002-2016(till date) were included based on the availability of relevant work. To identify the required material from the study, notes were prepared from each paper. These records include title, abstract and findings from the study. Then at the next stage, only those notes were included which were relevant to our study. In this review process 31 research papers were selected relevant to the specified research work. Before 2002 not much significant work is discovered and however, no work is discovered in 2016 till date.

3. Literature review

Business Intelligence in healthcare has become a subject of interest to the researcher due to rising demand of improvement in healthcare service quality, patient satisfaction and safety and organizational efficiency. The stakeholders of healthcare support the adoption of advanced technology to enhance the service quality, availability of real time information and support to economic activities [6].

3.1. The Significance of business intelligence

BI is a wide combination of technologies, applications and processes for integration and analysis of data being beneficial to the stakeholders of healthcare organizations in making effective decision support system [7][8]. BI has been considered to be valuable tool by many business organizations to reach their strategic goals, increase profitability and improve customer satisfaction [9]. The role of business intelligence is to deliver right information at right time and right location to improve the decision support process [10].

3.2. Business intelligence in healthcare

Discovering actionable information from huge amount of data is a complex task faced by healthcare providers today. A healthcare organization should be aimed at treating patient up to their level of satisfaction as well as achieving desired management outcomes. Two different approaches exist for Business Intelligence in Healthcare: data centric approach and process centric approach [11]. The data-centric approach combine operational data with OLAP tools to achieve effective decision making support by improving the quality of inputs to the decision process at reduced access time[12] which allows the firm to better understand its own capabilities [13]. The process-centric approach focuses more on the organizational processes helping in understanding the organizational capabilities through the integration of discovered knowledge with the organizational processes. The healthcare organization need to enhance its organizational capacity, standardization of business processes and improvement in the patient's treatment and care quality by implementing some effective solutions based on BI technologies [14].

3.3. BI approaches

So, far we have been discussing about the traditional BI approach that has been struggling since a decade to satisfy the needs of Healthcare sector. However, the healthcare sector has gained lot of benefits by the adoption of BI technology but due to dynamically changing needs and complexities, the requirement arise for more efficient and flexible BI approaches among which the most commonly used are Cloud based BI and Mobile based BI.Cloud based BI applications are hosted by virtual network i.e., internet. They provide access to BI related data through clouds with no need for BI installation and data warehouse and thus, can be deployed in less time. It provides easy access, with less administrative tasks related to data management and is scalable. Cloud based BI can perform all the functions provided by traditional BI more efficiently and lesser cost [15].

Mobile based BI is advancement over traditional and cloud BI that provide access to BI related data on Mobile devices. Mobile BI is capable of handling the use case of mobile users that need remote access to critical business, clinical and financial information. The developers of smart phones have provided the platform for development of mobile based BI applications [16]. Due to advancement in mobile technologies and devices healthcare organizations are

looking for adoption of Mobile BI for real time analytics, better visualization with affordable resources at lower cost. Data collected by organizations can be converted into useful knowledge due to the use of advanced data warehousing and analytics tools [17]. The difficulties arising in adoption of Mobile BI adoption today are: Lack of technical skills, complexity of mobile based IT systems, future uncertainties, rising cost in technology transformation, patient privacy. Moreover the Mobile BI is more beneficial from patients view point enabling the patients to: enhance awareness and participation in care, improved access to preventive healthcare information, enhance communication with healthcare providers, reduction in healthcare delivery cost [18].

3.4. Available BI solutions and their adoption

In healthcare organizations, the factors responsible for organization performance and efficiency are changing rapidly with the changes in the needs of healthcare sector and advancement in technology [19]. Business Intelligence is capable of providing one solution to multiple problems related to managing data, quality, handling organizational processes, monitoring performance, and many others. BI solutions are tools for analysis and monitoring of organizational performance [20]. There are many BI solutions developed with their unique functionality and technology. Choosing the appropriate BI solution that can provide a feasible method to deals the upcoming challenges in the healthcare domain is a crucial task. As per the Business intelligence market analysis report the major contribution is in North America by U.S, followed by Asian countries including India, China, Singapore, Malaysia, etc, the European countries are less competitive due to some barriers to BI adoption [21]. Other countries are performing better as compared to European countries. This study is focused towards the BI technology used and the functionality provided by the BI solutions. There are approximately 20 business intelligence solutions developed for healthcare that are performing well in terms of managing and integrating data, interoperability of processes ,reporting and visualization, performance management [18]. However, these solutions are competing for enhancing the performance and efficiency of the organization but less focused towards patient oriented needs. The organizations adopting BI are gaining benefits such as: improved performance, increased analytical and visualization capabilities, effective and flexible business processes with efficient decision making [22][23].

3.5. BI maturity models

Maturity Models provide a systematic framework to identify the strengths and weaknesses of an organization and enable continuous enhancement in the efficiency of an organization to achieve strategic goals [24][25][26]. BI maturity Models provide strategic guidelines to enhance efficiency and assessment criteria for data standards and quality services [27][28][29]. A number of maturity models exist in the literature which are targeting Business sector, banking sector, enterprises, but none of them are targeting to the current needs of healthcare sector.

3.6. BI frameworks in healthcare

In the period from 2002-2015, a few research related to BI framework in Healthcare has been discovered. One of the studies implementing BI to assist decision making in Healthcare proposes three key areas for development: Quality of patient care, quality of information system and improved financial controls. Hospitals can adopt BI systems to enhance the care quality, patient satisfaction and operational efficiency in terms of medical and business [30].

Clinical Research using BI framework can optimize the transformation of data into knowledge and clinical research process [31].

3.7. Data mining for business intelligence in healthcare

Data mining technology introduces a variety of techniques to determine relationship among data, finding hidden patterns in huge data, make interpretations to predict future trends and support effective decision making. The data mining techniques being elements of statistics, machine learning, regression models; help organizations to understand and identify trends within the huge data [32]. Data mining plays a vital role in knowledge discovery process (KDD) in databases and refers to algorithms used to discover valuable information that can be applied to achieve strategic goals. The algorithms can be applied with their suitability depending on the application domain [33].

4. Analysis

4.1. Healthcare BI processes

Healthcare organizations are composed of a variety of integrated processes that needs operational support. In relation to BI, Healthcare organizational processes can be differentiated in three categories [34]: Clinical Processes, Business Processes, and Operational Processes.

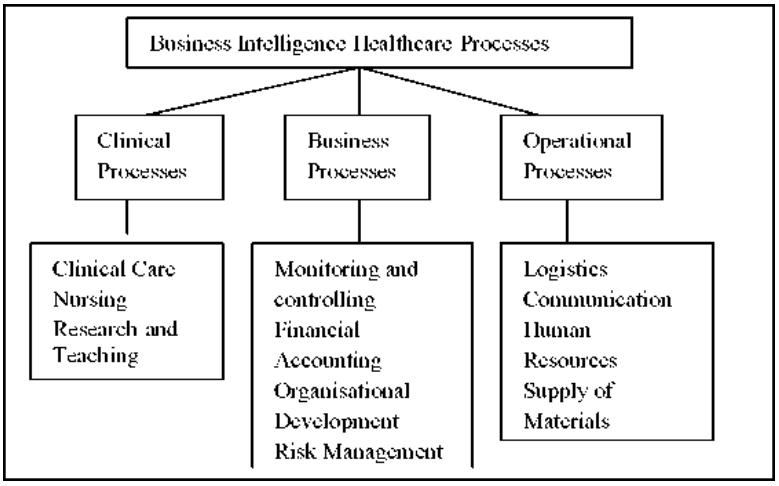

Figure 1. Healthcare BI processes

4.2. BI approaches: Comparison

BI technology is used now days in more advanced forms to meet the needs of current healthcare sector. The use of BI at initial stage began with traditional BI solutions that are powerful and supported by well-established software companies. Traditional BI solutions were built to serve the needs of handling massive amount of data, large amount of users, developing reports, use cases, and performance management. But using traditional BI systems require high level technical skills, IT infrastructure equipped with SQL servers that pushes up the cost and time consuming deployment of the solution. Also in spite of being powerful these

systems are static, based on historical data and trained professionals for their effective use. Since many years, cloud BI is developing its importance as an alternative to traditional BI solutions. The cloud BI is in demand and in use due to its easy to use features. But now days due to advancement in mobile computing and mobile devices there is a need for lightweight version of BI i.e. Mobile BI. Healthcare organizations are looking for adoption of Mobile BI for real time analytics, better visualization with affordable resources at lower cost.

4.3. Healthcare issues and challenges

The healthcare industry is forced to meet the needs of discovering real time information from huge varied data sources. Healthcare executives are moving towards implementing BI approaches to focus on quality aspects, handle the various processes throughout the organization to enhance its efficiency, patient satisfaction and safety. However, on the basis of review, in terms of BI implementation the healthcare sector face the following challenges:

- Challenges for quick access to integrated information.
- Challenges for advanced and complex mobile technology.
- Challenges for care and service quality.
- Challenges for patient satisfaction and safety.

For BI to be successful in healthcare sector, it is necessary to understand the complexities and challenges of Healthcare and how BI can be impacted.

4.4. BI solutions -analysis

The needs of healthcare organizations have changed during the years and became more complex in competitive environment. There are a number of BI solutions exist that began using traditional BI approach to overcome the needs in healthcare sector. The BI solutions are performing well in terms of analytics, reporting, data warehousing, and performance management focusing on all financial, clinical and operational process of an organization but there is less consideration towards care service quality, patient satisfaction and safety. Due to technical complexities in Traditional BI, the providers are turning towards the alternative flexible approaches. Many of BI solutions are using cloud based BI as an alternative to traditional BI but only few have incorporated the Mobile BI to deal with wireless world and smart phones.

5. Result

This paper is intended towards analyzing the challenges in Healthcare industry and how these challenges can be overcome by using intelligent mobile based BI framework in healthcare. This section shows evaluation of solution of the research questions framed.RQ1: How can a Healthcare organization use the power of BI to overcome the issues and challenges in Healthcare?

After performing the analysis of various researches published, it can be indicated that the research in this area is not satisfactory in terms of healthcare needs and thus needs more efforts. From 2002-2016 the related research works on Healthcare needs targeted by BI is shown in Fig2. Graph indicates the research work in related area so far in 15 years.

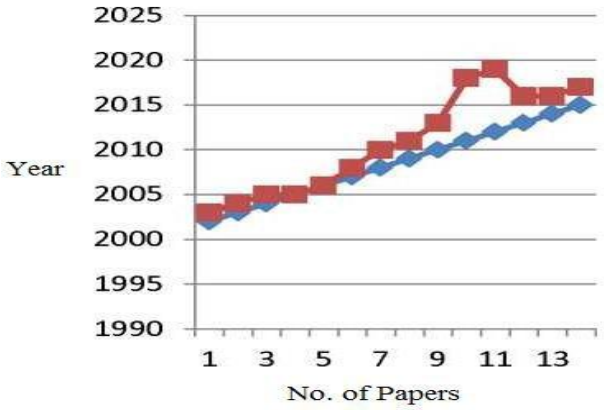

Figure 2. Literature review analysis (2002-2016)

RQ2: How can a BI set up be developed that provides an impact across the organization? While going through various research papers for BI frameworks or models developed during the 15 years, it can be analyzed that there is sufficient use of BI and its approaches for resolving issues in healthcare some are using traditional BI approach, cloud BI, Mobile BI. From the fig3 below, it can be deducted that only few BI solutions in healthcare has adopted Mobile BI. Thus, future research can be carried with Mobile BI platform to resolve the issues in healthcare sector with more benefits at lesser cost.

BI approaches for resolving healthcare issues
■ Traditional BI ■Cloud BI ■ Mobile
BI 23% 31%
46%

Figure 3. BI approaches in healthcare

6. Conclusion

After analyzing the review, it can be stated that healthcare organizations are achieving a lot of benefits using Business Intelligence systems. Business Intelligence systems provide reliable and consistent information from all the areas of organization activity. Data collected by organizations can be converted into useful knowledge due to the use of advanced data warehousing and analytics tools incorporated with data mining techniques. Nowadays, BI systems have been proved to be crucial in developing effective decision support systems that will help improve patient's clinical outcomes and the quality of medical services. But the traditional BI being more rigid and complex, there is need to move more advanced and flexible BI approaches with more focus towards mobile BI. From the review it can be analyzed that Mobile BI is performing better to satisfy the need for higher efficiency by accessing real time data quickly and at less cost for making real time decisions. Moreover, BI solutions in India are more focused towards performance monitoring functionalities but less diverted to person needs. This research will be more directed towards patient oriented framework focused towards care quality, patient satisfaction, and information quality. The proposed BI framework will provide a BI implementation strategy based on mobile BI by providing support for the critical processes needed to reach desired strategic goals and improved care quality. By adopting proposed BI framework, healthcare efficiency can be

enhanced by extracting valuable information remotely, with improved service quality, patient satisfaction and safety.

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