International Journal of Enterprise Computing and Business Systems
ISSN (Online) : 2230-8849
Volume 12 Issue 2 July - December 2022
International Manuscript ID : 22308849122022-04

Business Intelligence and its use in the Healthcare Sector primarily in Hospitals

A. Dharmadhikari[1], A. Shinde[2], Dr. K.S. Thakre[3], I. Phadke[4] and T. Shiyekar[5]

[1,2,3,4,5] Department of Computer Engineering (MMCOE), SPPU.

Abstract- In today's arduous business environment, it is vital for organizations to access useful information, knowledge and relevant data. Business Intelligence (BI) is a collective concept for tools, techniques and solutions that helps business admins and managers to understand business situations and BI tools can support informational knowledge needs of organizations. Subsequently, Business intelligence comprises the strategies and technologies used by enterprises for the data analysis and management of business information. Therefore, with respect to the increasing trend of BI research in BI concepts and applications, in this paper, recent research and papers of academic journals in this field are reviewed to classify and prioritize the concepts and approaches of business intelligence.

Keywords- *Data warehousing, Business Intelligence, Business Intelligence for Hospitals, Data Marts, Healthcare Management, Cloud Business Intelligence and Analytics*.

1 INTRODUCTION

AN overview of various application areas in healthcare is given that leverages such techniques from security and privacy point of view and present associated challenges. In a recent paper, some light is shed on potential methods to ensure secure and privacy-preserving ML for healthcare applications and also provide insight into the current research challenges and promising directions for future research.[3] This system will allow the admin to track the resources that will be used to conduct a certain procedure. A procedure involves a doctor, a patient and the hospital. This procedure can involve different processes that have been defined by the hospital or the government and the hospital has to abide by it strictly. For example, if someone has gone for a knee replacement surgery then the procedures required for that are lab tests, diagnosis, treatment etc. This procedure is defined by the hospital or the government and the hospital has to follow it. To build a system for the hospital that will take into account some parameters and then calculate a certain budget. This budget will include staff allocation, doc allocation etc basically an estimated amount the hospital will have to spend in order to carry out a procedure.

The main objective is to combat the increasing costs and provide quality care for the patients. With all the data available at one place like a data warehouse, tasks like costing and billing become free of errors and variables can also be easily calculated. HCOs with an emphasis on organizational memory capacities were searching for a reliable database that would enable them to preserve their historical data and manage it more effectively. The information integration capabilities of BI were the topic of some other studies that attempted to have a special data warehouse that enables them to have easier and quicker access to all forms of data from various time points.

Business Intelligence

It is the act of using data and evaluating it to support decision-making. It uses a variety of techniques to assist enterprises in forecasting the behavior of rival companies, suppliers, clients, and the environment in order to stay afloat and survive in the global economy. Additionally, leveraging tools like data mining and data warehousing facilitates decision-making and creates a competitive edge. Coordination of individual and organizational goals also results in increased performance. There are three methods for using BI, depending on the objective and desired level of emphasis. These methods are:

1. Managerial strategy aimed at enhancing management decision-making.

2. Using a technical approach and concentrating on the instruments that assist the procedures connected to intelligence in management.

International Journal of Enterprise Computing and Business Systems
ISSN (Online) : 2230-8849
Volume 12 Issue 2 July - December 2022
International Manuscript ID : 22308849122022-04

3. Using an enabling strategy that emphasizes information support capabilities with value added.

A data-driven DSS known as a business intelligence system primarily allows historical database querying and the creation of periodic summary reports. Throughout the years, data-driven DSS have gone by a number of names, including data-oriented DSS [(Alter, 1980), retrieval-only DSS (Bonczek, Holsapple, & Whinston, 1981)], Executive Information Systems, OLAP systems, and Business Intelligence systems. Business intelligence (BI) is a collection of skills, resources, methods, and solutions that aid managers in comprehending the state of their companies' operations. People can view past, present, and future conditions thanks to BI technologies. Managers need information at every level and whenever it is acquired with high quality, and with the implementation of BI approaches, the current contact information gap between top managers and middle managers will vanish. Experts and analysts can also improve their activities with straightforward tools and produce better results.

By first recognising the information and then processing it into concise and practical managerial knowledge and intelligence, business intelligence (BI) aims to assist in handling the massive flow of business information inside and outside of organizations. The BI job, which is one of the fundamental management tools, analyzes the complicated business environment in order to help decision-makers. As a result, it covers both new themes and very old managing challenges.

The BI literature indicates that there are numerous advantages to employing BI (Thomas, 2001). However, implementing BI requires resources, and the advantages that materialize in practice are not always obvious. In companies, measuring business success has a long history. Although BI measurement has been cited as a crucial activity in the literature (Solomon, 1996; Viva Business Intelligence Inc., 2000), researchers generally agree that it is challenging to implement (Gartz, 2004; Hannula & Pirttimäki, 2003; Simon, 1998). Only a small number of firms, according to a recent poll, have any measures in place to gauge the value of BI. (2004) Marin and Poulter.

1.1 OBJECTIVES

In this study, the literature on BI applications in the HC area, particularly in hospitals, will be analyzed. As a starting point for determining the general research trends in the field, it specifically aims to study the unique nature of the BI systems now in use and the outcomes gained. The results will point to possible directions for future investigation. The study's precise aims are as follows:

1. Identifying HCO objectives that encourage service providers in this field to use BI as a strategic tool.

2. Recognizing the characteristics of the BI solutions used in the HC domain.

3. BI use's effects are evaluated by identifying its outcomes and, more crucially, by interpreting their relationships to various end-users and beneficiaries, particularly patients and healthcare providers/hospitals.

4. By identifying research problems and alerting HC Informatics of possible study fields, the research gaps are eliminated.

2 LITERATURE SURVEY

For seamless transfer of data we will be using layered architecture owing to the privacy constraints to further drawout data marts. The authors present a comprehensive and integrated framework consisting of a layered architecture with components placed strategically to allow seamless and privacy compliant acquisition and transmission of EHR data of public health interest at all levels of health care delivery system. Multiple data marts are spawned out from the underlying consolidated population database to support regional and national programs running under different public health departments [1]. ETL stands for Extract, Transform, and Load and is a Data Warehousing method. Data is extracted from various data source systems using an ETL tool, transformed in the staging area, and then loaded into the Data Warehouse system. Traditionally, requirements are met with information processed into a data warehouse and data marts constructed for analysis as data comes from outside the enterprise and often is in its unprocessed forms. And then the data is processed according to the requirements. To automate this process, what is required is a sufficiently robust extract–transform–load process; external sources are mapped to some form of ontology, and an integration process to merge the specific data sources [2].

A conceptual framework for an archival system devoted to long-term preservation and access to digital content is the Open Archival Information System (OAIS) reference model. The reference model aims to: clarify terminology and concepts for describing and comparing data models and archival architectures; create a framework to guide the identification and development of data marts. In order to manage clinical data, medical professionals, and patients effectively, care centers and medical systems have already embraced the Open Archive Information System (OAIS), a reference model for allocating people and resources within a system. Systems for archival storage are typically employing conventional relational database technologies for implementation; the relation-oriented technology, however, severely restricts the efficiency in the care of a large number of patients' healthcare data, particularly with newly developed cloud-based disperses. Presenting an Open Archive Information System (OAIS) healthcare system in this research. The architecture is helpful for

scalable management of a large number of HL7 clinical documents. It is specifically based on a Database Management System that uses columns and NoSQL installed in the cloud, allowing for the use of large tables and accessible in broad rows spanning.[4]

Data transformation involves changing data to be compatible with the destination system, such as a database, to make data loading easier. Data processing can be streamlined by using the built-in transformations that data warehouse management technologies provide. High Dimensionality is of great concern in the domain of big data. In this research,an information theory is proposed based on a feature selection method using various state of the art algorithms like JMI. It is then followed by columnar transformation algorithm implementation in order to benefit from data locality. The author's distributed approach has consistently outperformed the traditional sequential approach. In discussing the problem of processing big data, especially from the perspective of dimensionality, the impact of correctly identifying relevant features in datasets and the corresponding difficulties caused by the combinatorial effects of incoming data growing in terms of both instances and features is highlighted [5].

Many firms are deploying a traditional ETL procedure in lieu of data lakes and other technologies like cloud computing. ETL is mostly employed in technologies like cloud computing and data lakes, which house vast amounts of unstructured data. Without much organization or preparation, data is spilled into the data lake. Then, using BI tools, analysts locate pertinent data, pull it from the data lake, convert it to fit their analysis, and then examine it. In order to use the data produced in the development process of the EPC system network reasonably, Cloud Computing (CC) and the related technologies are presented, and the conception and architecture of Business Intelligence (BI) are Introduced. This is done in order to use the data generated in the development process of the EPC system network reasonably. The platform architecture of BI based on CC technology, also known as the platform architecture of "CC & BI," is then presented and contrasted with traditional BI in order to demonstrate the benefits of the "CC & BI" architecture.[6]

Business intelligence tools are fundamentally data-driven decision support systems (DSS). Executive information systems, report and query tools, and briefing books are all terms that are occasionally used interchangeably with BI. Instead of waiting for IT to run complicated reports, business people can now begin examining the data themselves thanks to these technologies. This information access enables users to support business decisions with data instead of emotions and stories. It could be best to investigate its applications for your company to keep ahead of the curve given that 54% of businesses claim that cloud BI has become essential to their operations. More specifically, the BI&A literature was found to be lacking in studies that focus on the purpose of BI&A components to assess SMEs' readiness for BI&A projects; the benefits evaluation, assessment, and realization of BI&A; factors such as return on investment, total cost of ownership, and security and privacy issues that influence BI&A adoption and implementation; how BI&A are used for decision-making; and different usage of BI&A in various business fields and industries. Further, cloud and mobile-based BI&A solutions are promising areas of application for SMEs. Most of the literature is focused on proposing frameworks, architecture, models, critical success factors, determinants, antecedents, and barriers that influence business intelligence and analytics implementation and adoption. For BI&A vendors, this literature can help them improve upon their BI&A solutions, for example, by offering improved usability, integration into other systems, and ease of deployment.[7]

Testing GP-tSNE versus baseline techniques on a range of datasets demonstrates its unmistakable ability to enable deeper data understanding than that offered by current visualization techniques. With the help of a thorough examination of a candidate front, which demonstrates how various models may be examined collectively to provide more insight into the dataset, we further illustrate the advantages of a multi-objective approach. Even though the visualization process isn't entirely automatic, manual visual creation is not necessary. In general, you can utilize templates on any BI interfaces. By putting up the necessary data characteristics, these can be changed and altered. In some circumstances, graphics can react to changes in data and display these changes by automatically changing graphs and tables. Numerous visualization techniques have been suggested, including the cutting-edge t-distributed stochastic neighbor embedding technique. The most effective visualization techniques do, however, have a big drawback: they are fully opaque about how they derive their visualization from the dataset's original attributes. The necessity for effective visualization techniques that make use of intelligible models arises from the fact that many areas call for a comprehension of the data in terms of its original qualities. A multi-objective approach is created that generates a number of visualizations in a single run with various visual quality and model complexity trade-offs.[8]

Many data analytics tools have been developed for both research and practice to assist in specifying, integrating and deploying data analytics applications. However, delivering such big data analytics applications requires a capable team with different skill sets including data scientists, software engineers and domain experts. Such teams and skill sets usually take a long time to build and have high running costs. An alternative is to provide domain experts and data scientists and the end users with

International Journal of Enterprise Computing and Business Systems
ISSN (Online) : 2230-8849
Volume 12 Issue 2 July - December 2022
International Manuscript ID : 22308849122022-04

tools they can use to create and deploy complex data analytics application solutions directly with less technical skills required. [9]

The prospects for analytics come with new difficulties in processing and managing avalanches of data that are continuously produced by millions of medical sensing devices. The ability to seamlessly combine disparate data sets into a reliable, accurate, and meaningful representation—also known as data fusion. In order to provide a more accurate description than any of the individual data sources alone and reduce uncertainty, data fusion aims to merge pertinent information from various data sources into a single one. It integrates physical space and information space to network and inform people's living environments. The medical resources are dispersed in a very unbalanced manner. Large cities have a wealth of top-notch medical resources. Due to the limited resources of small and medium-sized communities, patients must seek medical care in large city hospitals, which contributes to hospital overpopulation. Excellent medical resources are wasted by intelligent telemedicine systems. The top-notch medical facilities of the nearby large-city hospitals are available to patients as well. Therefore, the construction of intelligent telemedicine systems, the employment of modern networks, science, and technology, and the integration of information and medical technology would undoubtedly optimize the hospital business process. In order to increase resource utilization, work efficiency, and hospital hierarchical data creation, this study suggests research on multi-level data fusion under intelligent medical monitoring. Innovative applications of Internet of Things technology encourage hospital-to-hospital academic exchanges, raising hospital medical standards and enhancing doctors' technical proficiency. The growth of the Internet of Things has a big impact on how medical business develops.[10]

Effects of using BI Based on our knowledge from analyses, we made a distinction between the effects of BI solutions on HCOs and patients in order to better understand the implications of BI. On one hand, they were divided into 6 categories from an organizational point of view: data management, cost, decision-making, collaborations, efficiency, and quality and quantity of HC services. In general, BI implementation in HCOs frequently enhances data management and decision-making. Access to data might be made simpler, quicker, and more accurate for HCOs. It aids businesses in enhancing the caliber of their operations and services, lowers the expense of duplication of effort and errors, and aids in more effective resource usage.[11]

Business intelligence is not completely error proof however, it has its own set of advantages and applications in healthcare.

1) Patient Care -'BI software can assist health care providers in making important decisions ranging from patient care. A high satisfaction score is an indication that healthcare organizations have gotten it right with the patient experience from start to finish. Most importantly, business intelligence can provide an immense amount of data to aid in improving patient outcomes.

2) Financial Analysis- BI tools can help healthcare organizations make better financial decisions through budget management, tracking inventory and supply costs, and monitoring other key metrics.BI software can monitor revenue, and provide numbers on performance at any level. Key Performance Indicators and financial goals can easily be tracked, like return on net assets or profitability. Insights can then be visualized for busy decision makers in easy-to-understand dashboards.

3) Patient Flow and Utilization - Healthcare providers are often extremely concerned with making sure that a patient receives an appointment that they will keep, which means that providers usually run off their feet during certain popular times of day. Using a business intelligence tool to understand these utilization patterns and allocate staff accordingly could result in shorter waiting times and more efficient use of resources.

4) Better Cost Management - BI tools in terms of data analytics is to give healthcare organizations the scope of managing their expenses better, allocating them across departments more accurately, and reducing wastage. With all the data available at one place like a data warehouse, tasks like costing and billing become free of errors and variables can also be easily calculated.

5) Clinical Analysis - Besides predictive analysis, BI tools can help organizations analyze clinical data such as measuring lab test results, rate of unfilled prescriptions, etc. It can also help municipal committees to understand which areas need more resources.

6) Data Mining for Better Treatment - Data mining can help organizations understand exactly where treatment is falling short. BI tools can be used to analyze the exact treatment procedure and the outcomes. This can help organizations understand areas of deficit, as well as arrive upon successful treatment methods and paths for future cases.

3. RESEARCH GAP

A platform that will provide hospital admins to better manage their staff, resources, patients and provide real time metrics on patient data to provide better services to the patient and at the same time keep a track of its revenue. The key to BI success is enhancing the performance of the key business-critical operations. If you

International Journal of Enterprise Computing and Business Systems
ISSN (Online) : 2230-8849
Volume 12 Issue 2 July - December 2022
International Manuscript ID : 22308849122022-04

stop to think about it, a company cannot profit from a BI investment unless it results in greater sales, decreased costs, or both. It might be called elementary, yet many businesses are satisfied with BI value propositions that aren't explicitly connected to their company strategies and crucial business processes.

4. PROPOSED METHODOLOGY AND SYSTEM ARCHITECTURE

4.1 System Architecture

The user will interact with the UI to log in to the system, set parameters and provide input to the algorithm.

• The Client Database is accessed under primary circumstances.Under the Client database all the factual and dimensional tables are retrieved and the data is accessed.

• As the next step all the metadata is added to the existing data and is important for data warehousing.

• The required data is extracted and transformed to obtain required data and features only. That is the ETL process is performed on the data.

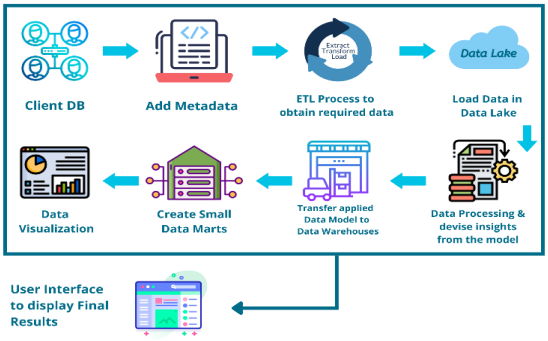
• Now after the ETL process ,the data is now loaded into the data lake for further processing.

• The pre-processing tasks are done on the data and a data model is developed.

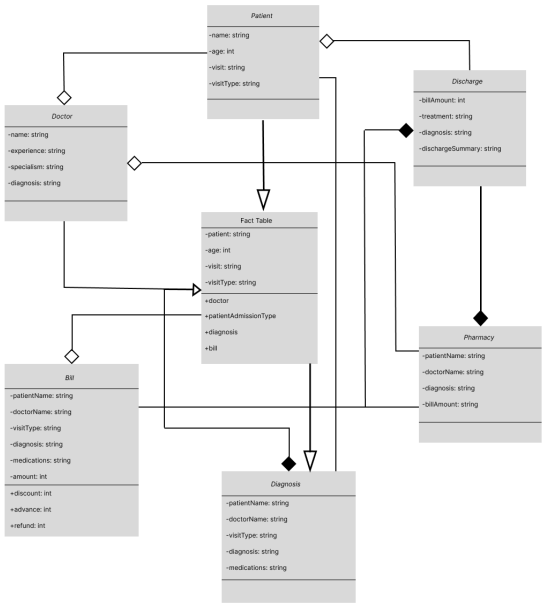
• The developed data models are transferred to data warehouses to get insights from the data already stored in the warehouses.

• Small data marts are created from the data in the warehouse for further data visualization.

• All the results will be displayed on the user interface which will be responsive and interactive.



4.2 UML Class Diagram



5. CONCLUSION

There is no doubt BI currently plays and will continue to play a crucial role in the future of the healthcare industry. It can also help healthcare providers be agile and responsive by supporting fast and critical decision-making and driving collaboration across departments.

With the healthcare BI platform market expected to exceed USD$3.9bn by 2023 growing at a CAGR of more than 11% in the given forecast period 2015 to 2023, there's no doubt that more and more businesses will continue to adopt BI to build a reputation around optimal patient care. Analysis of this business will help in achieving that goal. This healthcare BI platform based on the metrics and trends of the market will help the hospital (and hospital chain) to track their overall proceedings and make the necessary changes if at all the graph of growth rate is stagnant.

These departments are independent though their revenue is interlinked with the annual proceedings of the hospital, independent analysis of their respective earnings is imperative as some departments might have taken a hit in their annual revenue and therefore affect the total income of the hospital. This is applicable to all the branches of the hospital chain (if any) at different locations.

6. REFERENCES

[1] - F. Khalique, S. A. Khan and I. Nosheen, "A Framework for Public Health Monitoring, Analytics and Research," in IEEE Access, vol. 7, pp. 101309-101326, 2019.

[2] M. Scriney, S. McCarthy, A. McCarren, P. Cappellari and M. Roantree, "Automating Data Mart Construction from Semi-structured Data Sources," in The Computer Journal, vol. 62, no. 3, pp. 394-413, March 2019.

[3] A. Qayyum, J. Qadir, M. Bilal and A. Al-Fuqaha, "Secure and Robust Machine Learning for Healthcare: A Survey," in IEEE Reviews in Biomedical Engineering, vol. 14, pp. 156-180, 2021.

[4] A. Celesti, M. Fazio, A. Romano, A. Bramanti, P. Bramanti and M. Villari, "An OAIS-Based Hospital Information System on the Cloud: Analysis of a NoSQL Column-Oriented Approach," in IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 3, pp. 912-918, May 2018.

[5] S. Ramírez-Gallego et al., "An Information Theory-Based Feature Selection Framework for Big Data Under Apache Spark," in IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 48, no. 9, pp. 1441-1453, Sept. 2018.

[6] F. Wang, A. Yan and L. Yang, "Combined application of cloud computation technology and Business Intelligence," 2011 International Conference on Electrical and Control Engineering, 2011.

[7] Llave, Marilex. (2019). A Review of Business Intelligence and Analytics in Small and Medium-Sized Enterprises. International Journal of Business Intelligence Research. 10. 19-41. 10.4018/IJBIR.2019010102.

[8] A. Lensen, B. Xue and M. Zhang, "Genetic Programming for Evolving a Front of Interpretable Models for Data Visualization," in IEEE Transactions on Cybernetics, vol. 51, no. 11, pp. 5468-5482, Nov. 2021.

[9] H. Khalajzadeh, M. Abdelrazek, J. Grundy, J. Hosking and Q. He, "Survey and Analysis of Current End-User Data Analytics Tool Support," in IEEE Transactions on Big Data, vol. 8, no. 1, pp. 152-165, 1 Feb. 2022, doi: 10.1109/TBDATA.2019.2921774.

[10] W. Lian, T. Xue, Y. Lu, M. Wang and W. Deng, "Research on Hierarchical Data Fusion of Intelligent Medical Monitoring," in IEEE Access, vol. 8, pp. 38355-38367, 2020, doi: 10.1109/ACCESS.2019.2958854.

[11] Isazad, Mona & Ojo, Adegboyega & Sullivan, Francis. (2019). Analysis of Business Intelligence Applications in Healthcare Organizations. 10.24251/HICSS.2019.503.

[12] 2. L. Sautot, S. Bimonte and L. Journaux, "A Semi-Automatic Design Methodology for (Big) Data Warehouse Transforming Facts into Dimensions," in IEEE Transactions on Knowledge and Data Engineering, vol. 33, no. 1, pp. 28-42, 1 Jan. 2021.