



**Review:**

**Healthcare Data Analytics on the Cloud**

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**Citation:** Bhattacharya I, Ramachandran A, Jha BK. Healthcare Analytics on the Cloud. *Online J Health Allied Scs.* 2012;11(1):1

**URL:** <http://www.ojhas.org/issue41/2012-1-1.htm>

**Open Access Archives:** <http://cogprints.org/view/subjects/OJHAS.html> and <http://openmed.nic.in/view/subjects/ojhas.html>

Submitted: Feb 23, 2012; Accepted: Mar 25, 2012; Published: Apr 15, 2012

**Abstract::** Meaningful analysis of voluminous health information has always been a challenge in most healthcare organizations. Accurate and timely information required by the management to lead a healthcare organization through the challenges found in the industry can be obtained using business intelligence (BI) or business analytics tools. However, these require large capital investments to implement and support the large volumes of data that needs to be analyzed to identify trends. They also require enormous processing power which places pressure on the business resources in addition to the dynamic changes in the digital technology. This paper evaluates the various nuances of business analytics of healthcare hosted on the cloud computing environment. The paper explores BI being offered as Software as a Service (SaaS) solution towards offering meaningful use of information for improving functions in healthcare enterprise. It also attempts to identify the challenges that healthcare enterprises face when making use of a BI SaaS solution.

**Key Words:** Business Analytics; Business Intelligence (BI); Cloud computing; healthcare industry; Software as a service (SaaS).

**Introduction:**

Healthcare industry is undergoing tremendous transformation in today's world. It is a common occurrence to come across amazing advancement in clinical, surgical and healthcare delivery areas like robotic surgery, non invasive laser procedures etc. The healthcare industry though lagging so far compared to other industries in utilizing information technology (IT) has made tremendous adjustments in leap and bounds to adopt IT in all its functions. Because each healthcare provider environment has its own vision, demographics, medical staff, and other factors, we find ourselves unique in the healthcare industry and require an individual approach when striving for success. This has created a large reservoir of healthcare data overflowing in databases and data warehouses. But this pool of data has no value without a program in place to target, gather, deliver and analyze the most relevant data.

Health care organizations are also facing financial crunches and management problems due to ever escalating costs, inconsistent quality, a critical shortage of skilled workers and an increasing demand for services. Following up on the report "To Err is Human: Building A Safer Health System"[1], the Institute of Medicine (IOM) set the stage for measuring healthcare quality with its 2001 report, "Crossing the Quality Chasm". This report underlined the challenges for health care delivery organiz-

ations in improving quality. This report laid the foundation for Timeliness, Patient –centeredness, Equitability, Effectiveness, Efficiency and Safety to be considered as main focal points while developing healthcare systems by many public and private groups. Both healthcare providers and payers of care are looking for innovative ways to increase operating margins, reduce costs and improve quality and safety while increasing access to care. The challenge can be tackled by leveraging the performance management capabilities by conversion of data to meaningful information, using appropriate business intelligence (BI) tools for real time analysis and reporting and on demand analytics for knowledge management and intelligent decision making in fierce competitive environment.[2] They combine various data sources like data warehouses and various databases for analyzing and retrieving valuable information from them.[3] In this regard the term BI is interchanged with Business Analytics. BI allows the business to allocate limited resources for optimal advantage, including budget, staff and IT systems.[4] The various sections or services of a healthcare enterprise need to align their activities towards fulfilling the objective of the organization by addressing the sectional needs and methods with the organizational goal.

In order to have a good BI an appropriate infrastructure with the following components are required:

- Structured or Unstructured Data
- Data Quality and Integration (for converting data into a format readable by the database)
- Healthcare Data Warehouse (for storing data used by BI)
- Healthcare Business Intelligence & Analytics Engine
- Healthcare Portal (for display of data for healthcare customers)

Healthcare providers are leading the pack in healthcare domain in using predictive analytics form disease prediction to fraud and risk prevention. Such BI solutions are a complicated and their implementation is a time consuming costly affair with healthcare industry undergoing accelerated changes. In order to be agile in such an environment, the organizations should look for effective method to implement BI solutions. Organizations with information, analytics and technology enabled agility will be able to adapt and thrive. The IT technology should be able to manage all resources in a flexible manner, easy to configure, connect, collaborate and innovate. Even though BI solutions can be offered on premise, there is an increasing trend towards combining BI with cloud computing.

The National Institute of Standards and Technology (NIST), defines cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.[5] Cloud offers innovative ways to capture, manage, store, and share information with potential cost savings in IT infrastructure and staff. Cloud computing can be defined as ‘a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet’.[6] Cloud computing is enabled by many technologies, but key among them is virtualization technology, which allows entire operating systems to run independently of the underlying hardware.[7] In most cloud computing systems, the user is given access to what appears to be a typical server computer. However, the server is really just a virtual ‘instance’ running at any one point on a large underlying hardware architecture, which is made up of many independent CPUs and storage devices. Some of its applications in healthcare organization are similar to IT optimization in any business enterprise, and others address the current, unique needs of health care. For example, healthcare finance executives can use cloud computing to help innovate their organizations in several ways: Ad-hoc analytics on self-service, real-time, on-demand and high performance exploration functionality with plug-ability, scalability & security today is possible through cloud services in both Software As a Service (SaaS) model and on-premise model.

Integrating patient health and clinical outcome with genomic data through translational bioinformatics in cloud has been seen as a affordable alternative compared to local computing clusters.[8] Google and Microsoft are two prominent examples of organizations using cloud to offer their medical services in form of Google Health and Health Vault. According to the Certification Commission for Healthcare Information Technology (CCHIT), greater number of vendors are offering some variance of electronic medical records — some “in the cloud,” some locally, and some in both. Some of the benefits of adopting cloud computing to healthcare include:

- Supply chain Management and Capacity building
- Scalable Infrastructure
- Collaboration with companies offering similar services
- Accessing Insurance details
- Fast and Easy access of health records
- Standard Integration
- Report generation using dashboards and KPI
- Increased Customer Service Quality

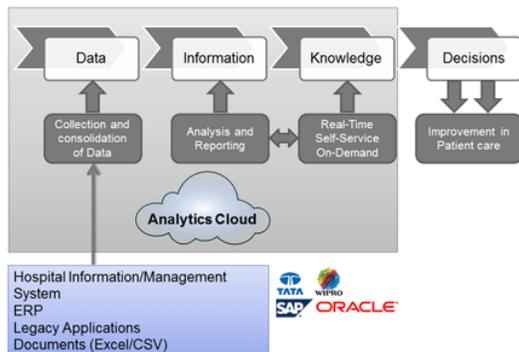


Fig. 1: Business Intelligence on Demand [Source: Ref.13]

Cloud computing allows for scaling up and down as capacity is required by the business and this is paid incrementally to the cloud computing vendor.[9]

By making use of a cloud based BI solution (BI Software as a Service (SaaS) the financial burden for the business shifts from an upfront capital expense to an on-going operating expense. [10] With this the business pays for the service as it is required, rather than a large upfront investment.[11] There is a lower financial risk to the business because the business only pays for what they use and can terminate the contract at any time. With on-premise solutions, the business needs to spend money upfront for hardware and software with an uncertain payoff.[12]

### Business Intelligence (BI) on SaaS

What is a BI or Business Analytics on SaaS?. It is a delivery model for business intelligence in which applications are typically deployed outside of a company’s firewall at a hosted location and accessed by an end user with a secure Internet connection. The vendors provide it either on subscription or on pay - as - you - go model (<http://www.saas-showplace.com>). Integration of a BI solution involves a large human and financial capital, for many small and medium-sized organizations this represents an objective to be attained and not a reality.[5] Advanced business analytics tools hosted on cloud feature unique multi-dimensional and multi-fact based web interface, with a responsive user interface to filter, drill-down and roll-up. Dynamic layout provisioning according to user’s preference could be seen. The base view offers an array of dynamic visualizations in forms of various charts and contingency tables. The view specific configurations allow one to switch between aggregation operations on the fly. BI tools on SaaS are found to offer export facility to export the reports in a variety of formats as well as capability to record complex view configuration for the purpose of arriving at those views with single click later on. They have the capability of defining criteria based fact slabs for gauge visualizations as well as criteria based fact targets for target visualizations.[14] They have the ability to define calculations over aggregations with expression language, along with editor support besides ability to define custom behavior (like semantics of sorting) for special categorical data.

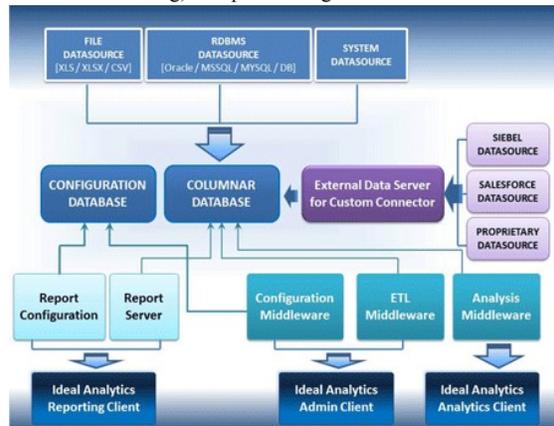


Fig. 2: On-Demand BI Architecture on Cloud [Source: Ideal Analytics, 2012; Ref. 13]

These tools also have the capability to handle huge volumes of data in the web interface and ability to create organization-wide dashboard and user specific dashboards, with complete control over layout design. The property of one-click externalization of dashboard items for embedding in proprietary applications or in web-sites or in live documents is impressive and allows forecasting and trend analysis over time-series data.

### Business Analytics for Healthcare enterprise on Cloud

In a typical healthcare enterprise, information comes from various sources in different formats. Each function or service records data in their own format that are normally in practice. The challenge is to bring out a uniform analysis from this heterogeneous information. The response of this challenge can be met by forming a tool to organize this information towards visualizing, analyzing decision enabling and making right predictions with appropriate futuristic vision. Data should be collected from various sources in different formats such as Excel, XML, CSV, database web service or applications such as sales force or ERP into a unified source from where the tool can analyze data. The data in the source can then be reorganized and classified within the tool, as per the need of the user and then stored with necessary derived dimensions and aggregations. One can instantaneously visualize 'data on the fly' based on one's selected criteria. It is then easy to interpret the business performance display using graphics. It is also possible to drill down to find out inner meanings, bases, hidden correlations available and suggest alternative solution space for all of them. Subsequently, the aggregate information can be figured out, the trends extrapolated to see the possibilities.

The cloud business analytics applications enables an analysis which is possible anywhere, anytime in any platform with utmost ease. Every change of data is captured and automatically updated on the dash board in real time basis.



Fig. 3: Snapshot of a BI Analytics

Business Analytics for healthcare enterprise hosted on cloud[13] can be an appropriate tool that combines simplicity with power of convergence and a perfect leadership tool kit that helps to lead and direct the state of art information and bottom-line advice.



Fig. 4: Real-time KPI Scorecard [MGMA, 2008]

The following attributes are considered as chief characteristics that define a good and effective BI:

**Visibility** - This refers to different faces of the same data i.e., views of the data from various angles, needs and aspects.

**Granularity** refers to the capacity to deep dive into the data i.e., possibility to drill down, roll up, slice and dice, group and find hidden correlations.

**Availability** refers to availability of any data, any time anywhere to the authorized user.

**Simplicity** refers to the fact that the BI should be easy to use even by non-technical person, wherein data, information and knowledge at the disposal of the user should be made use of instantly without any special training.

**Flexibility** refers to integration and externalization by cut n slice, ship out chunk, integrate, cube it and show it selectively.

**Predictability** refers to forecast and trend analysis on viewing future scenarios with little changes too.

Not everything is smooth sailing as far as BI on cloud is considered. There are many challenges that should be overcome. First there are technological challenges associated to moving to the cloud. There are escalating costs when one considers private cloud.[15] Simultaneously there is a security concern, of data overflowing outside the organization boundary in a public cloud. Lack of trained staff is another major concern. There are many enterprises like IBM, Oracle, Microsoft etc experimenting with newer models of BI on cloud that could address these concerns. The focus on a BI strategy should be on quick and continuous wins for the customer in the form of new and timely information.

### Conclusion

The key differentiators of hosting Business Analytics or BI on cloud would be factors such as on-demand self-serving analytics, possibility of large data handling, performance, data load and viewing updation strategy, vertical specific adapter architecture, enterprise scalability, flexibility in analysis, externalisation, implementation time and cost benefits. Above all the transactions should be in a secured environment to ensure confidentiality of medical records.

Though cloud computing still exists mostly in theory for Indian healthcare industry, a couple of implementations of BI on cloud, views of IT heads of many software organizations and hospitals and forecasts of health care industry analysts all highlight the general opinion that Indian healthcare industry is rapidly aligning itself to BI on cloud.

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