![eInfochips logo] The Solutions People

REVOLUTIONIZING THE HEALTHCARE INDUSTRY WITH BIG DATA, ANALYTICS AND VISUALIZATION

4 KEY TAKEAWAYS

• Big Data, Analytics and Visualization and what it means for the healthcare industry

• Major challenges in implementing analytics/BI in healthcare and how eInfochips addresses them

• eInfochips Case Study in Analytics/BI

• Data Visualization: A Live Example from the Healthcare Insurance Industry

SUMMARY

In recent times, the global healthcare industry valued at US$9.59 trillion (PwC Report, 2015) has undergone sweeping changes in every aspect of its business. These include massive adoption of electronic health records (EHR) by governments, hospitals and physicians to full digitization of research databases and billions of patient records belonging to pharmaceutical and insurance companies respectively. The onset of mobile health apps, wearable medical devices, telemedicine and automated medicine dispensers that work like ATMs portend a smart, digital-driven future. Furthermore, there is industry wide focus on healthcare compliance as per stringent regulatory norms along with meeting consumer demand for affordable medical care through innovative business models like the Healthcare Alliance. If there is one single factor which unifies all these healthcare trends, it is Big Data - the huge gaps faced by the industry in converting unstructured information bytes into meaningful business intelligence.

Healthcare data analytics, a market expected to grow to US$18.7 Billion by 2020, sits at the heart of various transformations shaping the healthcare industry. This white paper by eInfochips aims to showcase our unique capabilities in the data analytics and visualization space as a common service partner for healthcare players across all stages of the data lifecycle, with multi-project experience across all leading BI/analytics platforms including Tableau, Microsoft BI, Jaspersoft, Oracle, MongoDB and Hadoop. Through use cases and examples and our experience as an end-to-end product engineering services partner for healthcare companies, it will be shown how eInfochips integrates data from all sources – applications, sensors and IoT smart devices to address the entire spectrum of healthcare client needs including remodeling applications for modern BI, pushing device data to applications and delivering interactive dashboards over web, mobile and cloud.

DID YOU KNOW?

A total of 2.5 quintillion terabytes of data were being generated every day in 2012: insurance claims, physician notes within the medical record, images from patient scans, conversations about health in social media, and information from wearables and other monitoring devices (Source: HBR, 2014)

BACKGROUND: THE NEED FOR DATA ANALYTICS AND VISUALIZATION

Spreadsheets have been around long before BI and analytical tools took off in such a big way. Using in-built charts and pictorial representations, visualizing data is not exactly rocket science but considering the business demands of today, the limitations of spreadsheet visualizations can no longer be ignored. These limitations mentioned below, necessitate the rapid inclusion of BI/analytical tools in the corporate decision-making landscape:

• The problem of data in motion:

So far, healthcare corporations were used to dealing with static, stored data which could be collected from various sources before they were analyzed and interpreted for visual results. However, the rapid onset of large data volumes – log files, EHR data, patient readings, social media sentiments, clickstream information ("customer clicks on the website") means datasets are no longer expected to reside within a central server or within a fixed place in the

Cloud. In fact, the very nature of big data refers to business information that is streaming in across hundreds of thousands of disconnected sources, rapidly evolving by the minute making it nearly impossible for healthcare organizations to keep track of spontaneous information bytes. Traditional methods to analyze these information patterns is adequate giving rise to tools like MongoDB which can process and store billions of bytes of real time data, with hundreds of thousands of transactions per second.

• The problem of unstructured data:

Analyzing data is a rather simple affair when all data sources collect information based on unified file formats. However, the biggest challenge facing enterprises is the undefined and unpredictable nature of data emerging in multiple formats. Unstructured data can fall into any one of these categories - textual, non-textual, audio, video, presentations, pictures and .rar files. Going hand in hand with the problem of data in motion, it's

nearly impossible to keep track of information formats emerging from multiple sources.

• Aesthetics – the need for interactive visualization:

Converting unstructured data into structured formats is only half the battle won. An informed business decision can only be taken when the data can be readily converted into relevant charts and pictorial depictions that enable "real sense" of all the information pouring in. The sensory creatures that human beings are, accurate, aesthetically-pleasing visuals go a long way in understanding the value of the business data and "consume" it for business decision-making. Data visualization tools like Tableau, Spotfire, etc. have rapidly emerged to address this market need.

EXISTING CHALLENGES IN IMPLEMENTING BUSINESS ANALYTICS ACROSS HEALTHCARE ORGANIZATIONS
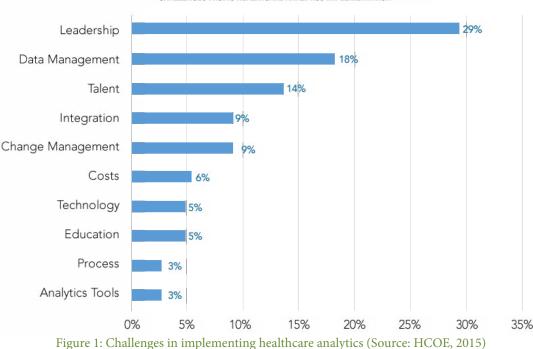
Healthcare organizations including hospitals, medical councils, pharmacies, health insurance providers and associated agencies have access to an enormous number of data records which cover every aspect of their business. Despite the widespread availability of highly relevant patient records, it has been found that the very unstructured nature of available data poses the single biggest hurdle in creating viable business outcomes. In a PwC study, 95% of healthcare CEOs said they were exploring better ways to harness and manage big data.

In a related survey by Healthcare Center of Excellence, the top challenges facing healthcare analytics implementation have been identified as leadership, data management, talent and integration capabilities (Fig 1.) Leadership includes not only factors such as a lack of "vision" and

"priority" but also "siloed systems" and "teams not talking to each other".

Data management, the second biggest challenge in implementing business analytics, consists of variables such as "lack of data standardization", "the quality of data" and "data location factors". Talent, another major challenge, refers to "lack of skills" and "lack of adequate analytics talent" in achieving proper data visualization of disparate results. Also lack of integration capabilities between organization-wide IT systems and intra-software tools (e.g. between MongoDB and Tableau) poses serious challenges for enterprises that wish to scale up analytics to achieve real time results.

Other significant factors that prevent healthcare organizations from seeking proper utilization of their data include change management,

costs and lack of access to and awareness ("education") of relevant technologies. Some healthcare organizations that can afford it, have started investing millions of dollars in their own in-house analytics/BI teams employing system engineers, data architects, programmers, visualization experts and experienced consultants. Presently, standalone approaches like these fail to deliver intended results since most organizations, not just in healthcare but other verticals as well, are relatively inexperienced in handling the sheer volume and velocity of Big Data. Even with all analytics/visualization tools at their disposal, making sense of Big Data numbers can be a frustrating experience. As business requirements become more complex in future, the demand for analytics capabilities would continue to rise and time-to-market would continue to suffer.

CHALLENGES FACING HEALTHCARE ANALYTICS IMPLEMENTATION

Challenge	Percentage
Leadership	29%
Data Management	18%
Talent	14%
Integration	9%
Change Management	9%
Costs	6%
Technology	5%
Education	5%
Process	3%
Analytics Tools	3%

Figure 1: Challenges in implementing healthcare analytics (Source: HCOE, 2015)

THE eInfochips DIFFERENCE

At eInfochips, our analytics and data visualization expertise can be summed by our huge experience in combining powerful, end-to-end systems to help healthcare providers make informed business decisions in the fastest possible time even when there are multiple, large data sources. With than 100+ certified consultants having hands-on experience in the healthcare industry and constant exposure to regular trainings on new features and updates, eInfochips offers unmatched skills in extracting maximum performance out of healthcare data with reduced time-to-market.
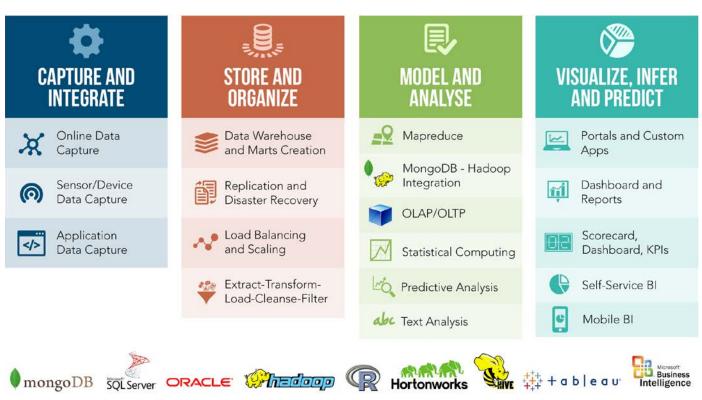
eInfochips is uniquely positioned to offer services in healthcare analytics work seamlessly to enable better clinical decision-making, improve member care, manage risk and drive better market access. The differentiation offered by eInfochips can be summarized as:

End-to-end Service Capabilities

eInfochips' comprehensive BI/ Analytics platform (see figure) consists of back-end processes - data capture, data storage/warehousing, disaster recovery and load balancing/ scaling, centralized processes - extract-transform-load (ETL) techniques, MapReduce, MongoDB-Hadoop integration, setup of OLAP/ OLTP systems, statistical computing and predictive analytics and front-end systems – portals and custom apps, dashboards and reports, self-service BI and mobile BI enabling multi-dimensional and unified views.

On the whole, eInfochips offers a broad platform of services for data analytics and visualization across all stages of the data lifecycle which can be further customized as per individual client needs. Our services stack have been built on the back of successful software partnerships with leading players in the BI/ Analytics space such as Hortonworks, Jaspersoft, Microsoft BI, Hadoop, R, MongoDB and Tableau.

BI/ANALYTICS PLATFORM

Healthcare clients benefit from eInfochips' strong legacy in working with medical service providers across future-ready applications including telemedicine, clinical inventory management systems, remote patient monitoring and homecare applications.

The full range of BI/analytical services offered by eInfochips can be applied across:

• Physicians and ambulatory care centers
• Hospitals and health systems
• Managed care plans and HMOs
• Accountable care organizations (ACOs)

STRONG, EXPERIENCED POOL OF ANALYTICS EXPERTS

eInfochips has a sizeable team of innovative product managers with experience in healthcare industry who can easily identify which best practices lead to improved outcomes. Our experts encompass a broad range of technologies including MongoDB, Tableau, Jaspersoft and more.

GEOHASHING

eInfochips uniquely differentiates itself as a service provider for the healthcare industry by offering a granular and customer-centric data capture, analysis and visualization capabilities independent of user location, technology used (wearable etc.) or device. This lends itself well in application areas including remote care, telemedicine, remote diagnostics, e-prescriptions and automated dispensation of medicines like ATM devices.

INTEROPERABILITY, AGILITY AND TIME-TO-MARKET

eInfochips experts have the capability to speedily integrate the different software, products and enterprise IT systems being used across all stages of the data cycle. This ensures quickest response time and faster conversion of unstructured data into actionable intelligence through visualization tools.

CASE STUDIES FOR NEXT-GENERATION DATA ANALYTICS AND VISUALIZATION

eInfochips has vast experience in managing healthcare analytics for the entire data cycle. The following case studies reflect its broad expertise.

DEVELOPING AN EARLY WARNING SYSTEM TO PREVENT UNCONTROLLED ICU ADMISSION FOR NEW HAMPSHIRE-BASED MEDICAL CENTER:

The hospital needed an early warning system to prevent sudden rush to its 11-bed ICU. The EWS developed by eInfochips was embedded within Cerner Soarian® Clinicals system.

It measures and calculates an early warning score using physiologic parameters such as respiratory rate, heart rate and blood pressure. It promote early recognition of patient deterioration and initiate early interventions with the goal of avoiding the need for unplanned transfers to the ICU. In just two years, the EWS and associated workflow reduced unplanned ICU admissions by 20.4 percent.

DATA INTEGRATION AND MANAGEMENT FOR MEDICAL EQUIPMENT MAKER.

A leading Medical equipment maker was addressing the market for more than 30 diseases. Its NoSQL database had potential to help meet ever-changing data requirements.

It was serving 9 million patients while collecting more than 30 million data samples every day. The objective was to find the complete history for a component with a very simple query quickly. Since the device data could last anything between 10 to 30 years, the company had to deal with information spread across a multitude of obscure database systems, in a wide variety of formats. eInfochips used the NoSQL capabilities of MongoDB and its expertise to capture 40% of available data in 2 years alone.

HEALTHCARE ASSET TRACKING AND MANAGEMENT FOR HOSPITAL:

A hospital was facing challenges due to non-availability of medical equipment during emergencies, high inventory costs and increasing patient dissatisfaction. eInfochips developed a tool that transformed complex data into operational insights to drive better decision making and apply predictive analytics to anticipate future asset needs. Benefits include improved efficiency, reduced costs, improved patient outcomes and experiences, and Increased staff productivity.

PREDICTIVE ANALYTICS TO DETECT PATIENTS AT RISK FOR HEART FAILURE:

A leading clinic wanted to identify patients at risk for developing heart failure in a pilot project that could lead to early intervention and better care for these patients. eInfochips was able to achieve results through predictive modeling of data in the clinic's electronic medical record (EMRs), including "unstructured" data such as clinicians' notes and discharge documents that are not often analyzed. Natural language processing technology was used to analyze and understand these notes in the context of the EMR, the inclusion of unstructured data providing a more complete and accurate understanding of each patient.

Some of the clinical data harnessed included physiological data such as maximum systolic blood pressure, prescription drug use of alpha blockers, beta blockers, beta agonists, and others, previous diagnoses such as Chronic Obstructive Pulmonary Disease and Obesity, lifestyle and environmental factors, such as occupation and marital status.

The pilot applied content analytics and predictive modeling to identify at-risk patients with an 85 percent accuracy rate. In total, 8500 patients were identified as "at risk" for heart failure, 3500 more than what would have been possible through traditional methods.

VISUALIZING HEALTHCARE DATA: A LIVE EXAMPLE FROM THE HEALTHCARE INSURANCE INDUSTRY

Proper data visualization forms the backbone of a well-formulated analytics strategy. To illustrate the business benefits of a well-rounded data visualization strategy, we will take the example of the US healthcare insurance industry. The primary research data was pulled from the 2014 database of healthcare insurance providers hosted by healthcare.gov (Screenshot attached). Comprising more than 78,000 premium value datasets (US$) of all leading insurance providers in the US – Optima Health, Anthem Blue Cross and Blue Shield, Aetna, Blue Cross and Blue Shield of Alabama, HAP, Medica, CoventryOne, Moda Health and more, the data is segregated according to Metal level (Gold, Silver, Bronze), Plan Marketing Schemes, Rating Areas for all major user demographics – Adult up to Age 27, Adult up to Age 50, Family, Single Parent Family, Couple and Child.

	A	B	C	D	E	F	G	H	I	J	K
1	4,631 displayed records			Use filters to select state, county, and metal level							
2	State	County	Metal Level	Issuer Name	Plan Marketing Name	Plan Type	Rating Area	Premium Adult Individual Age 27	Premium Adult Individual Age 50 *	Premium Family	Premium Single Parent Family
68804	VA	ACCOMACK	Gold	Optima Health	Vantage FourSight 1000	HMO	Rating Area 12	$321.09	$547.20	$1,084.60	$736
68805	VA	ACCOMACK	Silver	Optima Health	Vantage FourSight 3500 80%	HMO	Rating Area 12	$262.09	$446.66	$885.32	$601
68806	VA	ACCOMACK	Gold	Optima Health	Vantage FourSight 1000 MO	HMO	Rating Area 12	$1,765.21	$3,008.26	$5,962.64	$4,050
68807	VA	ACCOMACK	Silver	Optima Health	Vantage FourSight 3500 80%_MO	HMO	Rating Area 12	$1,706.21	$2,907.72	$5,763.34	$3,915
68808	VA	ACCOMACK	Bronze	Optima Health	Vantage Equity 3750	HMO	Rating Area 12	$237.51	$404.76	$802.28	$545
68809	VA	ACCOMACK	Bronze	Optima Health	Vantage Equity 4250	HMO	Rating Area 12	$231.37	$394.30	$781.52	$530
68810	VA	ACCOMACK	Bronze	Optima Health	Vantage Equity 4750	HMO	Rating Area 12	$225.19	$383.76	$760.64	$516
68811	VA	ACCOMACK	Bronze	Optima Health	Vantage Equity 3750_MO	HMO	Rating Area 12	$1,681.63	$2,865.82	$5,680.30	$3,859
68812	VA	ACCOMACK	Bronze	Optima Health	Vantage Equity 4250_MO	HMO	Rating Area 12	$1,675.48	$2,855.35	$5,659.54	$3,844
68813	VA	ACCOMACK	Bronze	Optima Health	Vantage Equity 4750_MO	HMO	Rating Area 12	$1,669.29	$2,844.80	$5,638.64	$3,830
68814	VA	ACCOMACK	Bronze	Optima Health	Vantage 3500 60%	HMO	Rating Area 12	$241.33	$411.28	$815.20	$553
68815	VA	ACCOMACK	Catastrophic	Optima Health	Vantage 6350	HMO	Rating Area 12	$196.40	$334.70	$663.40	$450
68816	VA	ACCOMACK	Bronze	Optima Health	Vantage 3500_60%_MO	HMO	Rating Area 12	$1,685.45	$2,872.34	$5,693.22	$3,867
68817	VA	ACCOMACK	Catastrophic	Optima Health	Vantage 6350_MO	HMO	Rating Area 12	$1,717.31	$2,926.64	$5,800.84	$3,940
68818	VA	ACCOMACK	Bronze	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Bronze D	HMO	Rating Area 12	$178.84	$304.78	$604.10	$410
68819	VA	ACCOMACK	Bronze	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Bronze D	HMO	Rating Area 12	$173.36	$295.44	$585.58	$397
68820	VA	ACCOMACK	Bronze	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Bronze D	HMO	Rating Area 12	$182.18	$310.48	$615.40	$418
68821	VA	ACCOMACK	Bronze	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Bronze D	HMO	Rating Area 12	$188.98	$322.05	$638.32	$433
68822	VA	ACCOMACK	Bronze	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Bronze D	HMO	Rating Area 12	$203.99	$347.64	$689.06	$468
68823	VA	ACCOMACK	Silver	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Silver Dir	HMO	Rating Area 12	$226.91	$386.70	$766.48	$520
68824	VA	ACCOMACK	Silver	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Silver Dir	HMO	Rating Area 12	$229.28	$390.74	$774.50	$526
68825	VA	ACCOMACK	Silver	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Silver Dir	HMO	Rating Area 12	$235.02	$400.53	$793.90	$539
68826	VA	ACCOMACK	Silver	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Silver Dir	HMO	Rating Area 12	$241.55	$411.66	$815.94	$554
68827	VA	ACCOMACK	Gold	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Gold Dire	HMO	Rating Area 12	$280.58	$478.17	$947.76	$643
68828	VA	ACCOMACK	Gold	Anthem Blue Cross and Blue Shield	Anthem HealthKeepers Gold Dire	HMO	Rating Area 12	$302.39	$515.33	$1,021.42	$693

Figure 2: Healthcare Insurance data ("Healthcare.gov, 2014")

For data visualization, the Tableau tool was used. Tableau is at the forefront of addressing one of the biggest challenges in data visualization - making databases and spreadsheets understandable to ordinary people. Tableau is a tool matching healthcare expectations with highly intuitive, visual-based data discovery, dashboarding, and data mashup capabilities. The level of granularity and precision rendered in Tableau makes this a handy tool for almost every big data scenario.

The visualization examples and drill-down reports denote a granular, user-friendly picturization which enable the following informed business decisions.

1) MAXIMUM AND MINIMUM PREMIUM RATES FOR A GIVEN ISSUER AND COUNTY IN A GIVEN STATE ¬

Figure 3, 4: Top level report - major issuers, max/min premium rates, user age 50

The first-level report gives an easy to visualize depiction of major issuers present in a given county and the maximum and minimum premium rates they offer for the sample user

demographic – Age 50.

This top view report, a histogram, gives back-of-the-envelope calculations on which issuer offers best value for the selected demographic. A scatter plot shows the spread and compares plan types. The same results can be viewed in a map representation.

2) TOP AND BOTTOM PREMIUM VALUES AND RATING AREA CLASSIFICATION, STATE-WISE

Figure 5, 6: State-wise premium rates and rating areas classification

This granular report depicts the top 5 states which offer maximum number of premium options for user demographic – 50 years. The plans are further classified according to rating areas 1-60.

THE DRILL-DOWN REPORTS PERCOLATE TO STATE AND COUNTY-LEVEL. ALL ISSUERS AND THEIR PLANS CAN BE VIEWED AS BELOW

Figure 7, 8, 9: Drill down reports

eInfochips is a premier Tableau alliance partner for integrating Tableau capabilities to vertical industry solutions across Retail, Manufacturing, Utilities, and also the Healthcare. eInfochips has proven expertise and customization/integration solutions for companies that have adopted, or are looking to adopt Tableau.

ABOUT eInfochips

eInfochips is a global technology firm specializing in product engineering and software R&D services. With over two decades of experience, the company delivers solutions for key verticals like Aerospace, Consumer Devices, Industrial Automation, Media and Broadcasting, Medical Devices and Healthcare, Home Automation, Retail and eCommerce, Security and Surveillance, Semiconductor and ISVs. The company offers expertise in software, hardware, VLSI and mechanical engineering services.

With US headquarters in Sunnyvale, eInfochips has the infrastructure, processes and experience in designing, testing, enhancing and sustaining the next generation of complex, critical and connected product technologies. eInfochips identifies Big Data Analytics, Business Intelligence, Internet-of-Things and Multimedia/Infotainment as key horizontal focus areas.

With 500+ product designs that have more than 10 million deployments worldwide, eInfochips' expertise has been recognized by reputed global

agencies like Gartner, Deloitte and Frost & Sullivan.

At eInfochips, over 1500 engineering professionals deliver projects from 10 design centers across USA and India. The company has sales presence in Austin, Boston, Cedar Rapids, Cincinnati, Chicago, Dallas, Raleigh and Sunnyvale in the US, Toronto (Canada), Bangalore (India), Tokyo (Japan) and London (UK).

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