# A Novel Dashboard Framework To Enhance Patient Outcome In Health Informatics

**Ruchika Saini, Venkatadri Marriboyina, Sanjay Sood**

***Abstract*: The advancements in Information Technology and proliferation of robust data collection devices gathers enormous amount of data in Healthcare Informatics through Electronic Health Records, online patient portals and other mobile medical gadgets. The Healthcare informatics gains the momentum by a well-deserved attention and aimed to gain the insights from the data that is gathered, managed to interpret for the well-being of improvised patient outcome. The process of transformation of data into meaningful insights will help healthcare provider organizations and policy makers to make better decisions.**

***Hence, this paper focuses on the design and development of an intuitive novel dashboard framework for effective decision driven health system to monitor, measure and improve the patient outcome. Section 1 of this paper introduces Health, Health care systems along with technology advancements towards patient care and analytics. Section 2, role of Dashboards in Health Informatics and section 3 provides the novel framework to enhance the patient outcome in Health Informatics and their results analysis.***

***Index Terms*: data analytics, dashboard, healthcare providers, Key Performance Indicators (KPIs).**

## I. INTRODUCTION

Health Informatics is an interdisciplinary field deals with data, knowledge, information pertaining to Health and Health care systems. Health care becomes data intensive field due to the digital data generated from high definition medical images to implantable wearable devices. The rapid growth of digital health data and our thrust to use up to date information to improvise the patient outcome coined as big data challenge in Health care Informatics.

Healthcare organizations are in tremendous pressure to deliver quality care and to achieve improved patient outcomes. The healthcare sector is ready to experience change and data analytics is the change it needs. Healthcare providers and decision makers can make use of analytics to leverage more value and to gain meaningful insights in order to enhance the quality of patient care. The essence of quality care lies in delivering timely and unbiased care that is more efficient, safe, improved and patient-centric.

### Understanding analytics in Healthcare

"Providing right care to every individual at right time" is the ultimate goal of Healthcare. But the road to accomplish this is not straight. The biggest challenge healthcare providers are facing is in coping with the constantly changing and ever-growing Healthcare sector and in meeting up the increased expectations of the population when accessing services.

Healthcare industry is the "data rich" industry; there is no inadequacy of data. But there exists information inadequacy and unwillingness to interpret and contextualize the data being gathered. But with the advancement in technology - making data more accurate, reliable and easily accessible, the opportunity to analyze the data has grown exponentially.

Data and visual analytics applications are playing a pivotal role in providing support to clinical settings, which in today's scenario is the demand as well as an opportunity [20]. According to Mckinsey Global report [10],[12], the US healthcare sector is capable of producing more than $300 billion in value per year, if it uses an effective and visionary approach to exploit the potential of big data.

It's interesting to see how the three Vs of Healthcare (volume, velocity and variety) [11] can be considered as an intuitive characteristic of the data produced by this industry. According to US Institute of Medicine (IOM) report [22], continuous learning system should be the idea of Healthcare which can bring together different processes and enhance patient health and experience by using the data generated by various healthcare processes. The main objective of data analytics is to help organizations make effective decisions for desirable outcomes. The big data shift has introduced different types and stages of data analytics.

Descriptive analytics is one of the simplest forms of analytics. It allows us to analyze historical data to produce meaningful information and to prepare data for future analysis. For example, statistics on the number of users registered distributed by age, state and gender. It enables us to learn from past conducts and how they might impact future results. Predictive analytics focuses on what will likely to happen. It analyzes current and historical data to predict future events and outcomes. Organizations make use of the statistics to forecast what might happen in the future. Prescriptive analytics is a cutting-edge analytics concept based on optimization that help understands how desired outcomes can be achieved. The focus of this study will be on performing descriptive analytics. Fig.1 shows IT adoption of Healthcare Informatics with respect to patient outcomes. And as we move from descriptive to prescriptive analytics, patient experience will keep on refining by optimizing information to achieve better outcomes.

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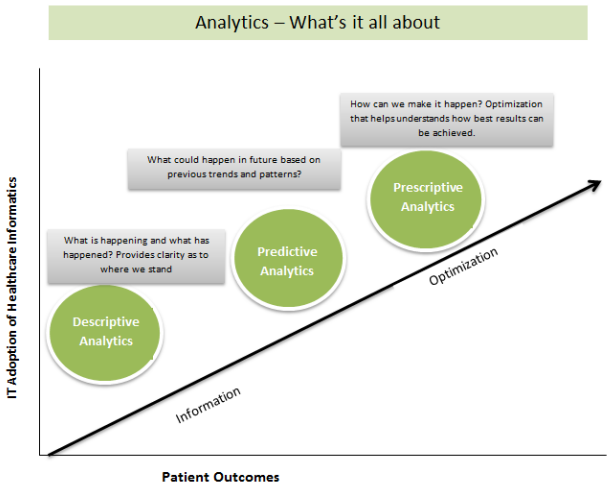


**Fig. 1:** Analytics – What's it all about

## II. DASHBOARD

A dashboard is a way to represent values extracted from essential data visually in the form of reports/views. Dashboard allows organizations and decision makers to monitor multiple performance indicators at once, which will help decision makers to make effective decisions quickly. It also enables us to make it more interactive by adding filters to it, so that users can drill down to gain more insights and can even correlate different reports generated. An effective dashboard needs to be updated on a daily basis in order to deliver real time outcomes. Healthcare provider organizations and policy makers can dig deep into data and embrace analytics to help provide quality care, effective outcomes and better decision making. For getting improved outcomes and making effective decisions about patient care, Healthcare Dashboard can act as an essential tool. As for example, visual representation can help the provider to find out whether a patient's clinical information lies within the range or not on the basis of comparison with a group of patients sharing similarities [21].

### A. Purpose it serves

Delivering real time results by accumulating and extracting value from the data collected is the main purpose of a dashboard. By displaying visual information, data looks more managed and this helps us to perceive whether we are moving on the right path, doing the right things and where we need to improve. Dashboards can help healthcare provider organizations and policy makers make impactful decisions, when utilized properly.

Policy makers are responsible for creating a framework within which healthcare is made available to the country's population. Providers, patients and payors are governed by these policies and functions within them. These policies are made in such a way that irrespective of the country's financial and infrastructure complexities, it focuses on improving the health of country's citizens [4].

Responsible governments prepare their citizens for technological changes; they listen to people to shape policies according to real needs, to adopt digital health safely, efficiently and quickly. The example emphasizes patient centricity, the appropriate regulations of the software technologies, the promotion of the use of digital health and the prevention of ethical challenges. This can be achieved with a powerful collaboration between researchers and policy makers.

1) Role of policy maker with respect to payors: regulates coverage that includes policy makers establishing the eligible beneficiaries, patient costs and maintaining the portfolio of insured services [4].
2) Role of policy maker with respect to providers: policy makers create regulations regarding who can legally provide health services.
3) Role of policy maker with respect to patients: policy makers aimed at maximizing country's citizens' health. They operate within the system's resource constraints. They bring together new resources as they can [4].

Policy makers require scientific evidence, and other parameters governing the health system, expert views and other parameters that may impact the final decision made by policy makers. Intuitive healthcare dashboards with appropriate Key Performance Indicators (KPIs) can speed up the process and quality of decision making for policy makers [2]. These dashboards can help in measuring, monitoring and improving performance efficiently [3].

For creating an effective dashboard, you need to have a clear idea about the objectives to be achieved, target users, technology you will be working upon and many such objectives need to be identified.

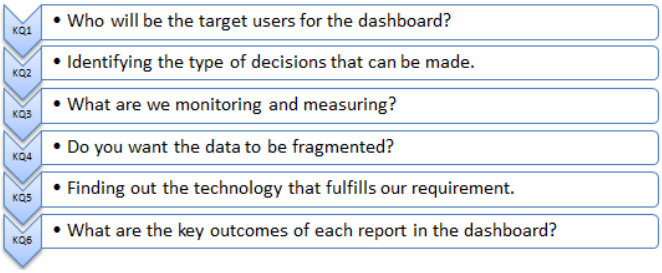


**Fig. 2:** Six key questions that need to be answered before you create your own dashboard

### B. Types of Dashboards

Dashboards are grouped together by parallel features and can be classified as the following:

1) **Decision-Making/ policy-making Dashboard** - These kinds of dashboards are intended to encourage either strategic or operational decision making. Most of these dashboards focused onlookers are at the organizational level, and rendered functionality that allowed the end users to interact with the views in order to focus on the data relevant for them. Examples can be employee performance dashboard for HR, understanding sales from business perspective, traffic sources to the website and many more.
2) **Static Dashboards for cognizance** - These dashboards are inclined towards less interactive essentials commonly found in different dashboards, and are also inclined to be drafted for public knowledge and could be used up immediately. This also displays real-time data from sensors and metrics with less conceptualization knowledge that too without much interaction.

Nevertheless, these dashboards need good domain expertise to look into the semantics of data trends and disseminations [9].

3) **Dashboard for drive to learn** - These tend to represent dashboards in individual occurrences, for instance finance, health, and dieting. These all are drafted for the purposes of communication to and education of the end user. It also intends to show the data candidly to allow the observer to come to a self-sustained closure. This is prevalent in public health dashboards, crime rates dashboards, etc.

### C. Visual Characteristics and Interactivity

Substantial differences can be identified amongst various dashboards on the basis of interactivity going on during the lifecycle of a dashboard and visual appearance.

1) **Creation, arrangement & interaction of a view** Numerous dashboards allow end users to amend the creation and arrangements of views. These dashboards give mouldability for the end users to make changes to the placement of views, modify the ocular representations inside those views, and select the specific scopes and procedures to visualize. User will be able to drill up and down various levels of cascading data. For example, the health dashboard allows the user to select which parameter to visualize [9].
2) **Multiview** - With time dashboards have historically been all in single view documents, few dashboards support tabbed layouts. These dashboards allow end users to move between pages, for the purpose of visualizing different components of decision-making or support to provide required context.
3) **Interpretation** - Many dashboards allow end users to interpret specific views, with making constant modification to the dashboard. These modifications do not apply to the original data; instead, they allow end users to interpret displays for forthcoming investigation.
4) **Change underlying data** - Few dashboards have the capability to write changes to the original database. "What-if" analysis, modeling and data entry can be some of the illustrations of making changes by adding to the data model [9].

## III. METHODOLOGY

Focus of this study was on creating a multipage policy-making healthcare dashboard which will help providers and policy makers a path to build their strategies. To study the Healthcare Performance Dashboard development process, the process was broken down into two phases: In phase one provides answers to the key questions mentioned in the above section and in another focus will be on how it was developed.

To answer KQ1, we determined the target audience for our dashboard. Policy makers are the target users who will be analyzing the reports generated by the dashboard for better decision making.

To answer KQ2, we examined what this dashboard meant to do? For developing the healthcare dashboard, we opted for prescriptive decisions that allowed us to make use of clear Key Performance Indicators (KPIs) and effective visualization which will help policy makers draw conclusions quickly.

To answer KQ3, we identified the data that needs to be monitored and KPIs that could be used as measures. Focus of this work is laid on monitoring the adoption of Health Information Technology phrms (myHealthRecord – A CDAC product) – gender wise, age wise, state wise, clinical record wise and health parameter wise. We can even study the number of users registered state wise over a period of time, visualization of user's vital information (heart rate, blood glucose, blood pressure, respiratory rate, body temperature, SPO2) and state wise comparison of these values over a timeline can be done. To answer KQ4, we decided not to have a customized fragment view but to have a fixed view with common KPIs and filters (state wise and over a timeline). Our objective is to make dashboard easier to understand. Each report represents comparative and historical view of data. To answer KQ5, as we have made this healthcare dashboard for the policy makers, our target was to build it using an Open Source Framework: MEAN STACK. This framework comprises of four technologies: MongoDB Database, Express JS as the server framework, and Angular JS for front end and Node JS for providing server-side JavaScript environment that offers routing and is responsible for handling request and response. Developers prefer MEAN STACK (a light weight framework) for its simplicity and performance (robust and quick) [5]. MongoDB [16],[17] provides an advance mechanism to store huge volume of cascading data produced by healthcare surroundings. To use analytics to its potential, it is required to have a solid storage infrastructure, which can make the process of storing and retrieving more effective, less hindered and less time consuming. MongoDB [10] is a cross-platform document-oriented database that can provide trouble free scalability, high performance and immense availability for fulfilling the need of healthcare sector.

To answer KQ6, we examined the takeaways of each report in the dashboard. This dashboard offers a clear visualization of the adoption of phrms based on multiple indicators, provides a comparative and significant view of user's vital information and policy makers can make effective decisions for shaping their policies accordingly.

**Different Angular and node modules used in building The Healthcare Performance Dashboard:**

1) Adoption
2) Registrations
3) Vital (Heart rate, blood pressure, blood glucose, SPO2, body temperature, Respiratory Rate

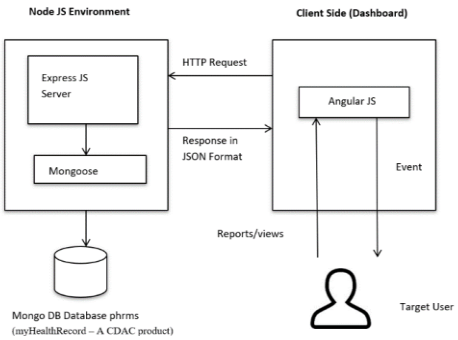


**Fig. 3:** Mean stack workflow for developing The Healthcare Performance Dashboard.

## IV. RESULTS

The healthcare performance dashboard helps policy makers to drill down into data to gain insights for reforming the policies according to people's need.

Fig.4 focuses on the gender wise distribution of users and the below figure indicates that number of male users registered on phrms is way more than the number of female user registrations. Policy makers and providers can strategize to improve the count by spreading awareness in female users so that more and more users can get themselves registered to get access. On the other side, Fig.5 indicates age wise distribution of user registrations with phrms, results show that people in 20-39 age group are more aware than any other age group, more focus should be given on people under age group 65 and above because that's the time when they need quality care.

Fig.6 highlights state wise distribution, indicates which all states need utmost attention when it comes to Health Information Technology awareness among people, so that more and more people can be a part of it. This will help them in getting timely, unbiased and quality care.

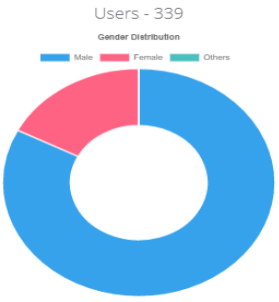


**Fig. 4:** Displays gender wise distribution

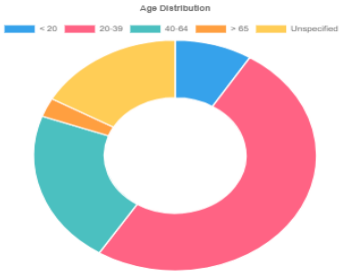


**Fig. 5:** Displays Age wise Distribution

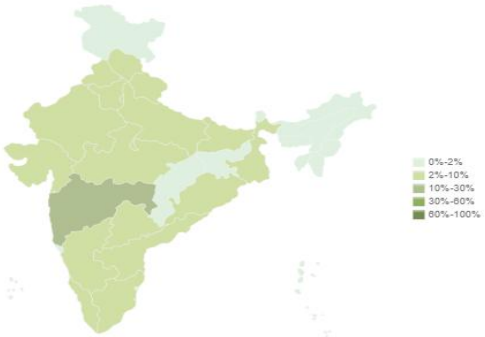


**Fig. 6:** shows adoption in states

The graph given in fig 7, allows the decision makers to compare user registration state wise over a timeline (over a period of 7 days, a month, a year and from the date of existence till date). Each color line indicates different states: Blue line for State 1, Red line for State 2 and Green line for State 3.

The graph given in fig 8, allows the decision makers to compare the average heart rate value of users state wise over a timeline (over a period of 7 days, a month, a year and from the date of existence till date), to gain insights into how geographical conditions and environmental factors effects cardiac health.


**Fig. 7:** represents a comparative and historical view of number of registered users

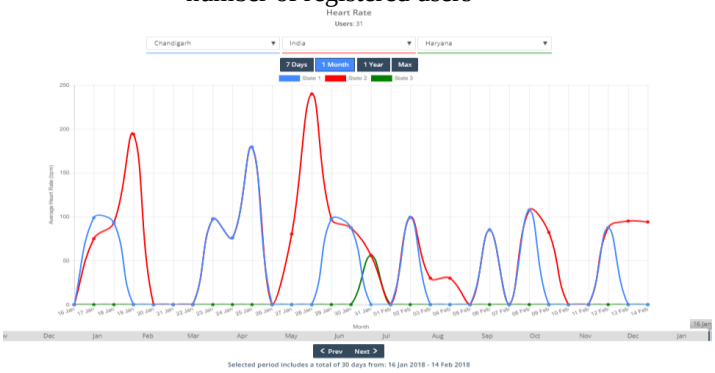


**Fig. 8:** represents a comparative and historical view of average heart rate of users

## V. CONCLUSION AND FUTURE SCOPE

This study enabled us to understand the importance of building an intuitive dashboard and how this dashboard can work wonders for the policy makers. We even emphasized on some of the key questions that needs to be answered in order to build an effective dashboard. For making dashboards more informative, dependencies and relationships among different measures can be identified.

For example, by adding some filters based on age and gender; we can drill down into details and across fragments of data and can gain deep insights.

The healthcare sector is deficient in actionable knowledge in spite of a newfangled wealth of data and information, possibly due to its complexity which it tends to inherit. Predictive analytics on health data is emerging as an important concept that can enable more intense and deterrent treatment options. This can be applied in the healthcare sector to generate relative and precise assessment of key results, with a focus on key features that may be applicable to healthcare-specific applications. The evaluation of predictive analytics technology in medical applications can be assessed, with specific significance on how hospitals have combined predictive analytics into their standard healthcare services to refine quality of care. A feature of healthcare research may include a powerful coupling among different patient parameters (e.g. the way respiratory rate, heart rate and blood pressure interact) to construct attainable markers for assessing clinical data, interpreting and predicting diseases by following comprehensive approach.

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**Ruchika Saini, PhD PURSUING, ruchika-cse@dsu.edu.in** with the teaching experience of 4.5 years having knowledge, skills and understanding of a range of teaching and learning approaches needed to make a positive impact on the progress of students. Subject Matter Expertise: Design and Analysis of Algorithms, Data Structures, Data Communication and Computer Networks, Software Engineering and Healthcare Informatics. Published research papers on volunteer cloud computing. Got an opportunity for doing Winter Faculty Internship Program in "Healthcare Informatics" at CDAC Mohali. Selected to work with THOUGHTWORKS Bangalore for a three weeks bootcamp, extensively implemented the web-based application following the MVC architecture using Test Driven Development (TDD) approach and followed Agile Development Model where Spring Boot, H2 as relational database were used.

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