

Studies on Web Based Patient Support System for Health Monitoring and Quality of Life

Gayathri V Panicker, Bharathi. V., Geethu. P., and Bommanna Raja. K

Abstract—Web-based Patient Support Systems (WPSS) are an emerging multidisciplinary research area in which one studies the support of human activities with the web as the common platform, medium and interface. One of the goals of WPSS research is to extend the human physical limitation of information processing. The availability, accessibility and flexibility of information as well as the tools to access this information lead to a vast amount of opportunities. It also examines how applications and adaptations of existing methodologies on the web platform benefit our decision-making and other various activities. This study proposes a web-based database system of patients' information repository for effective and timely access to information when and where it is needed. The design uses the three-tier web model architecture as its underlying technology and presents an architectural design for a centralized information database system, which will save time in accessing patients' health information and hence prompt healthcare delivery will be achieved for the health industries.

Keywords—Business intelligent life cycle, Health monitoring, Quality of life, Web based patient support system,

I. INTRODUCTION

THE web-based Patient Support Systems (WPSS) are an emerging multidisciplinary research area in which one studies the support of human activities with the Web as the common platform, medium and interface. One of the goals of WPSS research is to extend the human physical limitation of information processing. The availability, accessibility and flexibility of information as well as the tools to access this information lead to a vast amount of opportunities. It also examines how applications and adaptations of existing methodologies on the web platform benefit our decision-making and other various activities. The use of the web technology for Healthcare Information Management System has led to effective healthcare delivery by enabling easy and timely access to patient's information with little or no cost [1]-[7].

Information access is of critical importance in the practice of the public health service. Having timely, accurate and

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readily available information is essential in monitoring the health of communities and populations. Having access to public health data is essential for determining the association of environmental exposures to diseases, as well as measuring the progress and the efficacy of interventions. Effective public health practice relies on the availability of public health data sources and assessment tools to convey information to investigators, practitioners, policy makers, and the general public. Increasing the availability of neighbourhood socioeconomic, health, and environmental characteristics will allow individuals to obtain the knowledge needed to make informed decisions concerning their own health risks and may prompt collective action to equalize the burden of environmental health risks. Many systems have been developed using business intelligence (BI). The business intelligence tools are types of application software designed to report, analyses and present data. The key general categories of business intelligence tools are: spreadsheets, reporting and querying software (tools that extract, sort, summarise, and present selected data), online analytical processing (OLAP) tools, database.

In the economy of today, organisations have a lot of information to gather and process in order to be able to make the best decision as fast as possible. One of the solutions that can improve the decision making process is business intelligence. Business intelligence tools help transforming raw data into smart information and knowledge. Knowledge is typically obtained about customer needs, customer decision-making processes, the competition, conditions in the industry, and general economic, technological, and cultural trends. The term business intelligence was first introduced by Luhn [1] in 1960 as “a set of concepts and methods to improve business decision-making by using fact-based support systems”. Currently, business intelligence refers to methodologies and technologies for the collection, integration, and analysis of all relevant information in a business for the purpose of better business decision-making. Objectives of business intelligence include understanding of a firm's internal and external strengths and weaknesses, understanding of the relationship between different data for better decision-making, detecting opportunities for innovation, and finding cost reduction and optimal deployment of resources.

There are two different classes of BI tools, viz., database management system intelligence tools and Competitive intelligence tools. Database management system intelligence tools are used to manipulate massive operational data and to extract essential business information from them. Examples include decision support systems (DSS), executive information systems (EIS), online-analytical processing

(OLAP), data warehouses, data mining systems, knowledge management (KM), geographic information systems (GIS), digital dashboards etc. They are built on database management systems and are used to reveal trends and patterns that would otherwise be buried in their huge operational databases.

Competitive intelligence tools aim at systematically collecting and analysing information from the competitive environment to assist organisational decision making. The information is mainly gathered from public sources such as those available on the Internet.

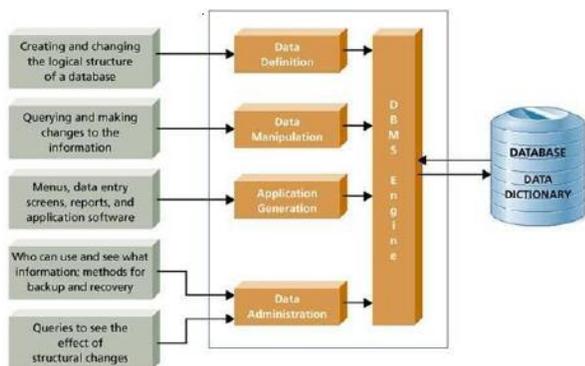


Fig. 1 Schematic representation of BI database

Fig 1 is a schematic representation of business intelligence database, which explains the structural changes in the data during the creation of database. It includes menus, data entry, screens, reports etc. This database includes all the information regarding the hospital.

II. METHODOLOGY

Business intelligence has been known as a popular tool in business management and decision support systems. BI helps to transform raw data into smart information. There are many BI tools such as extract transform and load (ETL), data warehouse, online analytical processing (OLAP), and database. BI tools are usually used in public health fields for financial and administrative purposes. Fig. 2 shows business intelligence life cycle (also see Table I). It comprises four steps, viz., integration, storage, analysis and presentation.

A. Tools used for the Presentation of Data

MySQL and PHP are the typical tools used for the presentation of data. MySQL is an open source relational database management system. It is based on the structure query language, which is used for adding, removing, and modifying information in the database. Standard SQL commands, such as ADD, DROP, INSERT, and UPDATE can be used with MySQL. MySQL can be used for a variety of applications, but is most commonly found on Web servers. A website that uses MySQL may include Web pages that access information from a database. These pages are often referred to as "dynamic," meaning the content of each page is generated from a database as the page loads. Many database-

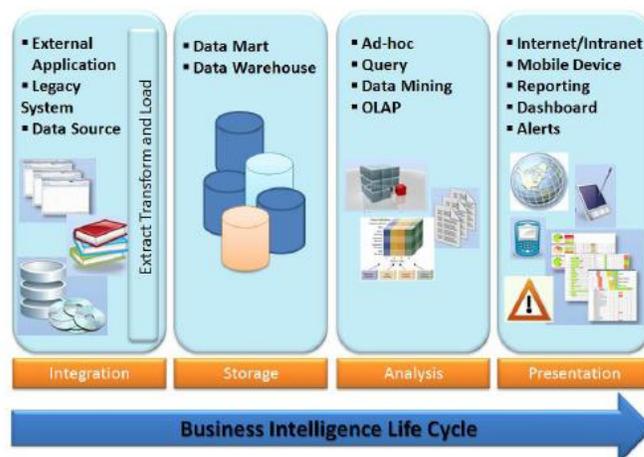


Fig. 2 Business intelligent life cycle

driven websites that use MySQL also use a Web scripting language like PHP to access information from the database. MySQL commands can be incorporated into the PHP code, allowing part or all of a Web page to be generated from database information. Because both MySQL and PHP are both open source (meaning they are free to download and use), the PHP/MySQL combination has become a popular choice for database-driven websites.

The server side language not only designed for web development but also used as a general-purpose programming language. PHP is now installed on more than 244 million websites and million web servers. Originally created by Rasmus Lerdorf in 1995, the reference implementation of PHP is now produced by The PHP Group While PHP originally stood for Personal Home Page, it is now said to stand for PHP Hypertext Pre-processor . PHP commands can be embedded directly into an HTML source document rather than calling an external file to process data. It has also evolved to include a command-line interface capability and can be used in standalone graphical applications. The PHP interpreter only executes PHP code within its delimiters.

B. Fusion Chart

Fusion Charts XT is a perfect addition to our reports, dashboards, surveys, monitors and analytics. Its comprehensive range of chart types with smart reporting capabilities, animations and interactivity are bound to make your apps look stunning and power-packed. Leveraging JavaScript & Flash, Fusion Charts XT functions seamlessly on PCs, Macs, iPods, phones and a majority of other mobile devices. It works with both XML and JSON data, and can integrate with any server side technology and database use. With the extensive documentation and readymade demos it offers, you will need just 15 mins to create our first chart. The stunning looks, refreshing animation and power packed reporting capabilities of Fusion Charts XT have enabled our customers and users to add delight to their applications. Simple column or pie chart, a combination chart, advanced zoom and scroll charts, or specialized sales and marketing charts, Fusion charts XT covers all our charting requirements. All the charts support interactive options like tooltips, drill-

down, exporting as image, PDF, or CSV and JavaScript integration.

The advantages of fusion charts are; stunning looks that will increase our audience, gets started within minutes, renders in both JavaScript & Flash, works with all web technologies and databases, accepts both XML and JSON data, comprehensive range of charts enable the right analysis every single time

The common types of fusion charts are radar (spider charts) and column and bar charts. The Radar chart is a very effective tool for comparing multiple entities based on different characteristics. For instance, they can be used for comparing various cars based on their fuel efficiency, manoeuvrability, and pick-up and engine power.

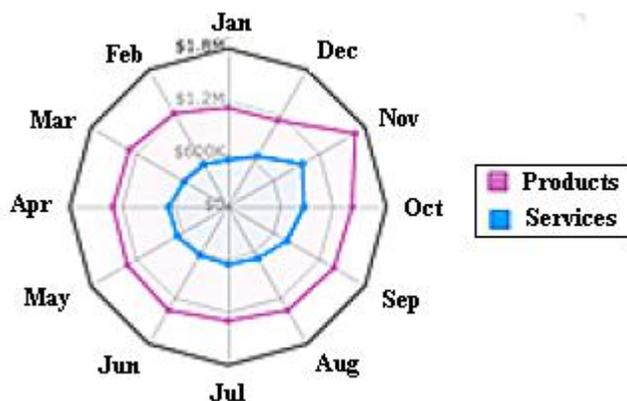


Fig. 3 Radar chart

The column and bar charts are used when we want to compare the values of individual data points with another. They help in bringing out the highs and lows of the data set very easily. Gauges are single value indicators that are used in dashboards, real-time monitors and reports. They are used to display Key Performance Indicators (KPI's), progress indicators and quantity indicators.



Fig. 4 Gauge (KPI)

C. Web Servers

Web servers are computers that deliver Web pages. Every Web server has an IP address and possibly a domain name. Any computer can be turned into a Web server by installing server software and connecting the machine to the Internet. There are many Web server software applications, including public domain software from NCSA and Apache, and commercial packages from Microsoft and Netscape. Server can refer to either the hardware (the computer) or the software (the computer application) that helps to deliver web content that can be accessed through the Internet. A Web server is a program that, using the client/server and the World Wide

Web's Hypertext Transfer Protocol (HTTP), serves the files that form Web pages to Web users.

D. Benchmarking

Benchmarking is the process of comparing one's business processes and performance metrics to industry bests or best practices from other industries. Dimensions typically measured are quality, time and cost. In the process of best practice benchmarking, management identifies the best firms in their industry, or in another industry where similar processes exist, and compares the results and processes of those studied to one's own results and processes. Benchmarking is used to measure performance using a specific indicator resulting in a metric of performance that is then compared to others.

E. Methods

Clinical healthcare providers rely on key performance indicators (KPIs) and key metrics to overcome the challenges of patient care, facility management, and clinical outcomes. Healthcare providers work in environments like hospital emergency rooms and depend on having the latest facts when they need to make a tough call. Healthcare KPIs take the guesswork out of your performance, so we can deliver the best clinical services possible. This will make a quality life by monitoring the health of the patients. Automation systems have also been used in medical applications recently. By the system proposed in this paper, data coming from patients are transferred to a main computer which has a database. By programming the database as desired, data can be accessed and modified any time. Another special feature of this system is its accessibility to the Web server which contains the database over the Internet Patient data is entered to a media, there after it can be accessed in any hospital so that it can be very useful at the time of emergency. At the same time the data is useful to the hospital and government to make a healthy society by intelligence data's from the plotting graph. The following are some of the advantages;

Healthcare moving from paper to data

The transition to electronic health records (EHR) means the healthcare industry has been faced with moving huge amounts of data from paper files to electronic records.

Protecting private data

Ensuring the security of confidential patient health information is paramount as more and more patient data is shared and transferred between healthcare providers and medical institutions.

KPIs improve patient care

Data warehousing (DW) initiatives and business intelligence (BI) software has enabled research, physician, nursing staff, and administrator access to data from all sorts of systems.

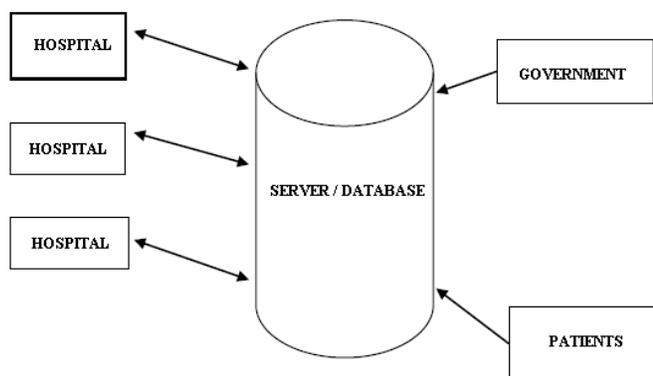


Fig. 5 Public Health

TABLE I
BI TOOLS AND OBJECTIVES IN PUBLIC HEALTH CARE

Public Health Fields	BI Tools	Objectives
Radiology	<ul style="list-style-type: none"> ETL Data Warehouse OLAP Dashboard Data mining 	<ul style="list-style-type: none"> Improve in healthcare quality, safety, efficiency, financial performance
Environmental Health	<ul style="list-style-type: none"> Data Warehouse OLAP Data mining SOLAP Data visualisation 	<ul style="list-style-type: none"> Reduce health risks caused by an environmental source Access to statistics and other information Discover new knowledge
Healthcare	<ul style="list-style-type: none"> ETL Data Warehouse OLAP Dashboard Data mining HTML-based information tool combine: Text information with diagrams and short video sequences Web application Computerised Patient Record (CPR) 	<ul style="list-style-type: none"> Support communication between care givers Perform hospital population surveillance Enable clinical quality initiatives Share decision-making (SDM) Support Health-care planning Remote diagnosis and treatment Monitor patient's body conditions Quality improvement for patient receiving care
Public health management and disease control	<ul style="list-style-type: none"> Decision Support System Operation supporting system GIS Knowledge Discovery in Database Statistical tool 	<ul style="list-style-type: none"> Support the physician or practitioner/patient relationship and plan of care Ensure quality of the care and patient security

III. PATIENT DATABASE

Fig. 6 shows various inputs given to the patient database:

A. Patient Registration

Patient registration is the concept and set of methods needed to correlate the reference position of a dataset gathered by computer medical imaging with the reference position of the patient. This procedure is crucial in computer assisted

surgery, in order to insure the reproducibility of the preoperative registration and the clinical situation.

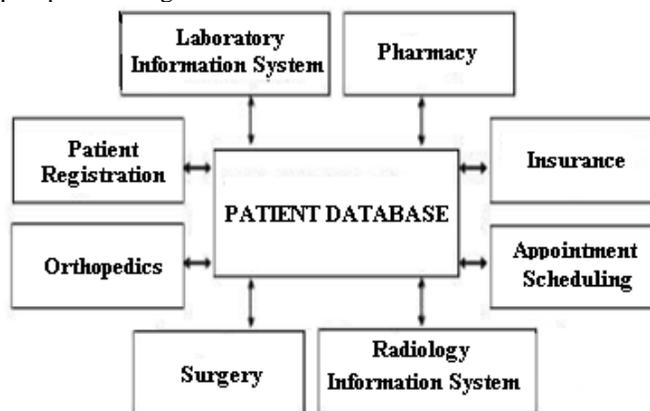


Fig. 6 Various inputs given to patient database

B. Laboratory Information System

Laboratory Information System (LIS) or Laboratory Management System (LMS) is a software-based laboratory and information management system that offers a set of key features that support a modern laboratory's operation

C. Pharmacy

Pharmacy is the health profession that links the health sciences with the chemical sciences and it is charged with ensuring the safe and effective use of pharmaceutical drugs. It includes more modern services related to health care, including clinical services, reviewing medications for safety and efficacy, and providing drug information.

D. Surgery

Surgery is the specialty of medicine that treats diseases and disorders by cutting, removing or changing the body with an operative procedure. Surgery is performed by a surgeon, a physician with specialized training in operative procedures.

E. Radiology Information System

A radiology information system is a computerized database used by radiology departments to store, manipulate, and distribute patient radiological data and imagery. The system generally consists of patient tracking and scheduling, result reporting and image tracking capabilities.

F. Orthopedics

It is the branch of surgery concerned with conditions involving the musculoskeletal system. Orthopedic surgeons use both surgical and nonsurgical means to treat musculoskeletal trauma, sports injuries, degenerative diseases, infections, tumours, and congenital disorders.

IV. APPLICATIONS

A. Accessing of Medical Records through Mobiles

Mobile technology has expanded dramatically around the world. The utilization of smart phones and tablets has

transformed communications, commerce, and entertainment, among other fields. Their emergence has improved service delivery, empowered consumers, businesses, and entrepreneurs, and changed the way in which people access information and make transactions.

This technology is poised to alter how health care is delivered, the quality of the patient experience, and the cost of health care. Mobile technology is helping with chronic disease management, empowering the elderly and expectant mothers, reminding people to take medication at the proper time, extending service to underserved areas, and improving health outcomes and medical system efficiency. Its impact on service delivery and medical treatment, and mobile devices are saving money in the health care system. However, patients are often under informed about even basic aspects of their care. In this work, we hypothesize those mobile devices, which are increasingly available to patients, can be used as real time information conduits to improve patient awareness and consequently improve patient care.

B. Online Accessing of Records through Web

Access is now much more than a way to create desktop databases. It's an easy to use tool for quickly creating browser based database applications .our data is automatically stored in a SQL database, so it's more secure and scalable than ever, and we can easily share our applications with colleagues. The system is composed of main database server, web server for database browsing, and mobile database server for on-spot data access. Patient data and device status data in form of not only discrete mean or peak value data but also real time signal waveform data that are continuously sampled and automatically logged to the remote main hospital database through internet by a portable monitoring server with patient, are stored with a hierarchic structure in the database for efficient access of large amount of data. Observers such as authorized clinicians can access the data either at remote hospital by a web-based client or at on-site bedside by a PDA (Personal Digital Assistant) mobile database client through Internet. Since all data are stored in a structural database, not only current status of patient, but also any searchable past data over any period the observer wants can be provided in a concisely summarized form enabling to capture trends in patient's physiological status changes at a glance. Also the total waveform recording enables user more detail analysis at any specific instance. The system showed good performance and reliability in a simulation test and animal experiments.

C. Advantages

Improved performance: The performance of the database usually improves significantly because only the data is sent across the network. In a database that is not split but is shared by using a network folder, the database objects themselves tables, queries, forms, reports, macros and modules are sent across the network, not just the data.

Greater availability: only the data is sent across the network, database transactions such as record edits are completed more quickly, which leaves the data more available to edit.

Enhanced security: If we store the back-end database on a computer that uses the NTFS file system, we can use NTFS security features to help protect our data.

Improved reliability: If a user encounters a problem and the database closes unexpectedly, any database file corruption is usually limited to the copy of the front end database that the user had open.

Flexible development environment: Because each user works with a local copy of the front end database, each user can independently develop queries, forms, reports, and other database objects without affecting other users.

V. RESULTS AND DISCUSSION

A Hospital database which contains all the information's regarding Patients, Medicines, precaution, treatment, and method have been successfully created.



Fig. 7 Front view of database

Fig. 7 shows the front view of the hospital database which has been created (see also Table II). It includes 3 parts such as core set, menu set, and clinical quality measures. Here the arrow mark represents the benchmark. Benchmark value is given in the database with the information that has been given in the KPI VALUE EDIT FORM. Green colour indicates normal and red colour indicates abnormal condition.

TABLE II

Sl No	DESCRIPTION	num	den	benchmark	condition
1	Core set (COPE use)	170	200	30	normal
2	Core set (maintain problem	156	200	80	abnormal
3	Menu (generate patient list)	200	200	0	normal



Fig. 8 Record vital sign

Fig. 8 shows record and chart changes in the following vital signs:

- (A) Height, (B) Weight, (C) Blood Pressure, (D) Calculate and display body mass index (BMI), (E) Plot and display growth charts for children 2-20 years, including BMI.

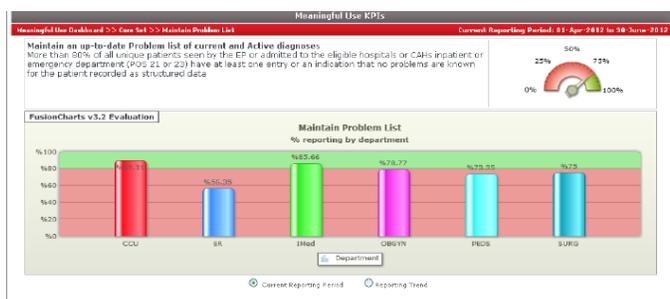


Fig. 9 Core set (maintain problem list)

TABLE III

Sl No	DEPARTMENT	Current % (100)
1	Critical care unit	89.31
2	Emergency medicine	56.35
3	Internal medicine	85.66
4	Obstetrics and gynecology	78.77
5	Pediatrics	73.35
6	Surgery	75.05

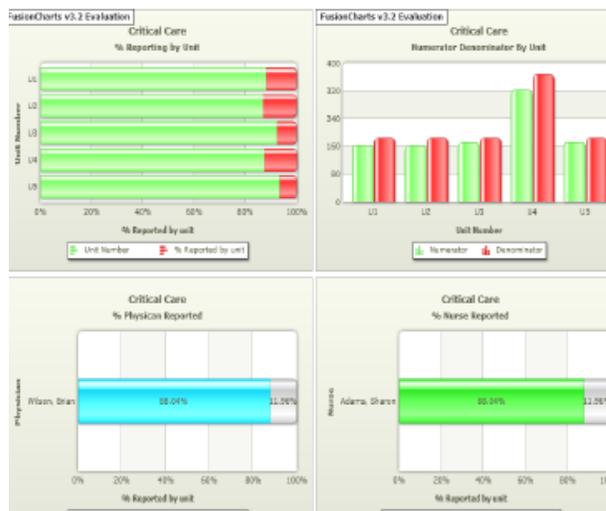


Fig. 11 Evaluation of critical care unit

has been found in each situation. We have generated lists of patients by specific conditions to use for quality improvement, reduction of disparities, research or outreach and the menu.

Description: Generate at least one report listing patients of the EP, eligible hospital or CAH with a specific condition. So here we had given asthma report of the patients in the hospital.

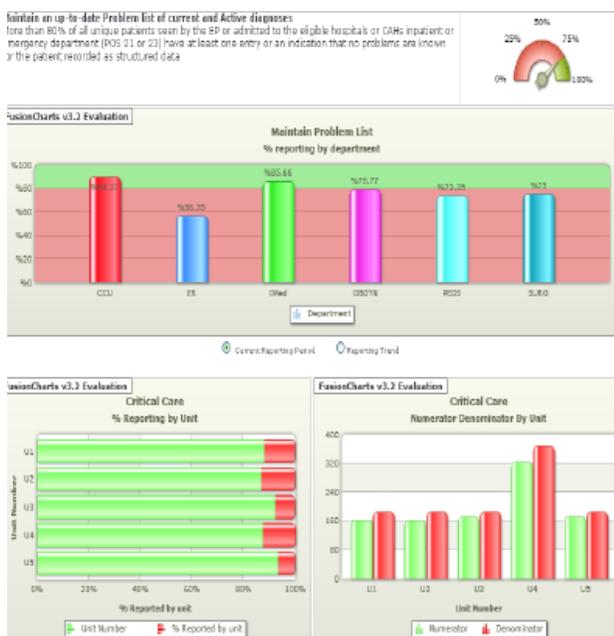


Fig. 10 Evaluation of core set

Fig. 9 shows the core set which Maintain an up-to-date Problem list (also see Table III) of current and Active diagnoses. Fig. 10 shows the fusion chart evaluation of critical care unit. Here green colour represents unit number and red colour represents the percentage reported by unit. Unit number is given in the y axis and percentage reported by unit is given in the x axis. Here we can analyse each unit by comparing it with others.

Fig. 11 shows the evaluation of patients in each unit. First graph shows the physician reported and second graph shows the nurse reported. Here the blue colour represents the physician and green colour represents the nurse. Here a single unit analysis is taking place. About 11.96% of abnormality

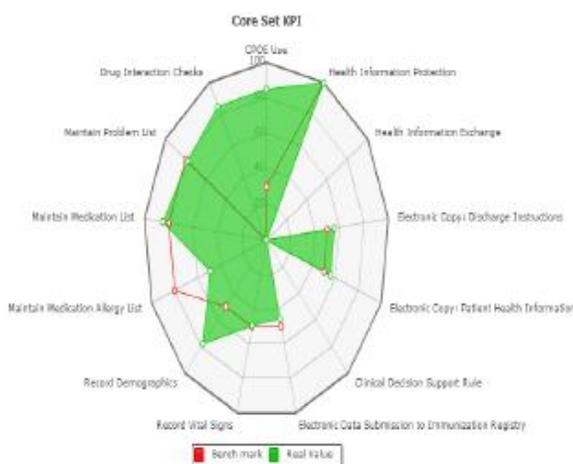


Fig. 12 Radar or spider chart (clinical set KPI)

Fig. 12 shows the radar or spider chart representation of core set. Red colour indicates the bench mark and green colour indicates the real value. Drug interaction checks, maintain problem list, record vital signs, clinical decision support rule, and maintain medication list etc has been updated in the form of spider chart.

We have developed the key performance indicator (KPI) value edition form. In this format we can give the bench mark value, title, set name, description. By clicking the edit, we can make the changes in the database.

VI. FUTURE SCOPE

It is likely that the doctors and nurses will be using the mobile. When they visit a patient they could have a tablet PC with all the current charts and data for that particular patient ready. The architecture for supporting this could be designed in different ways, but the main parts that have to be realized would be:

- An infrastructure for the monitoring devices to push their data into, for example a server with a database.
- An infrastructure for the mobile devices to get the data.
- It could also be realized in such way that the monitoring device stores all the data and applications needing data connected directly to the monitoring device.

Any data associated with a patient is confidential, and must be treated with the highest importance. The standards for wireless networking used today may not be as secure as needed.

Medical applications such offering various alerting and monitoring is very crucial that they have a high availability and run stable. When a person's life depends on it there must be high guarantees that the technology doing the monitoring do not fail. In a wireless setting the system must be designed in such a way that it can deal with less reliability. For example if health workers were to be alerted from a monitoring device through wireless it could be possible that the person was out of reach from the wireless network. This may not be a problem as long as it is not a critical emergency. If it is something that has to be dealt with within the day it can be sufficient to try to resend the message or resend it to somebody else that can deal with it. When it comes down to how it actually is going to be used it is likely to see two cases; real-time alerting which is the primary use of patient monitoring systems, and second use of the data for diagnostic of patients. The real time alerting must be dealt with in a critical way, and wireless for these types of applications is probably not wise. The use of patient monitoring data in consultation is probably likely that can be done wireless. It is not that critical, in the case where wireless network connection fails the doctor can probably go somewhere to get better wireless connection, or transfer the data through other means. The interchange and integration of information should be better. It would be useful to have patient monitoring data integrated in patient journal systems. And vice versa have patient journal data available in the patient monitoring charting applications.

VII. CONCLUDING REMARKS

Studies on web based patient support system show that our hospital database helps us to get the complete information regarding the hospital. We had created this database with the complete support of business intelligence software and html tools such as MySQL, PHP and fusion charts. Business intelligence refers to methodologies and technologies for the collection, integration, and analysis of all relevant information in a business for the purpose of better business decision-making. Four steps involved in BI include integration, storage,

analysis and presentation. Many tools are used in each BI step such as DSS, EIS, ETL, Data warehouse, and dashboard. Database is a tool used in the presentation step involved in business intelligence. Hospital databases are used in a variety of situations to help with hospital management and decision-making.

Note that to develop and evaluate policies, actions and to organize clinical health service delivery, our hospital database is used as a tool to develop a system for efficient and effective decision-making in public health. Many fields in public health, such as blood management, medical procurement disease management and control, and environmental health use databases to deliver information to end users. The web-browser based is the most popular because it acts as an effective tool, easy to access and can be managed anytime and anywhere. Business intelligence has made significant contributions to the cost-effective development of the public health system.

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