

Design and Implementation of Cloud based EHR and CPS – An Echo System approach

Raghavendra Rao TNA¹, Vivek Reddy K², Dr. S. Venkata Raju³

¹Student, School of Computer and Information Sciences, IGNOU
Maidan Garhi, New Delhi, India

²Student, Department of ECE, Munjal University,
Gurgoan, India

³Director, Shubh Soft Solutions Pvt Ltd.,
Bangalore, Karnataka, India.

Abstract— Optimal and effective method has been designed and implemented for maintaining Electronic Health Record (EHR) and Computer based Prescription System (CPS) in a cloud to access from anywhere at any time which further enables medical fraternity in saving the life of the individuals in case of emergency and critical care. This paper focused on cloud based automated system to manage patient information and administration. This eliminates the problem of inappropriate data keeping, inaccurate manual reports, time wastage in storing, processing and retrieving information encountered by the traditional hospital management system in order to improve the overall efficiency of the organization. The tools used to implement the system are Hypertext Markup Language (HTML), Cascading Style Sheet (CSS), Java spring frame work, Hibernate and struts with My Structured Query Language (MySQL) as backend. The design provides excellent patient services and improved information infrastructure. This is a true internet based Software as a Service (SaaS) solution for both independent clinical practice and Nursing homes that addresses the challenges of limited time and informational technology support. Cloud based Electronic Health Record (EHR) and Computer based Prescription System (CPS) System is a platform independent system that virtually any user can access from anywhere through standard internet accessible system.

Keywords— Electronic Health Record, Electronic Health Record (EHR), Computer based Prescription System (CPS), System design, cloud based web application system.

I. INTRODUCTION

Hospital is an organization that mobilizes the skill and efforts of a widely divergent group of professionals, semi-professionals, professional's personnel to provide highly personalized personnel services to the patients [1]. World Health Organization (WHO) has defined hospital as an integral part of social and medical organization that provides the complete curative and preventive health care and treatment to people and treatment to people. Among the all the administrative organization hospital is one of most complex organization. Providing adequate care and treatment to the people is the main purpose of the hospital. Various operational works that are managed in a hospital include: recording information about the Patient, generating bills, recording information related to diagnosis given to the patients, keeping record of the Immunization provided to

the patient, keeping the information about the diet and medicines to which patient is allergic to, keeping the information disease history of the patient and the medical treatment that is given and keeping the information of the treatment that is under going to the patient etc [2]. All these works are done in most of the hospitals on paper. The system should predominantly focus in Patient health record history management electronically. In addition to this it has to provide the features to manage the day to day operation of the hospital and financial transactions. The Cloud based EHR and CPS system comprises a web based application for record keeping, tracking and prescriptions, lab reports and billing with monitoring the history. Administrators, Doctors, Pharmacists, Pathology lab staff receptionists and patients are the different users that have to be supported by the system. The Administrator should have super user privilege to access any portion of the system and the access privileges should be customized to allow the administrator to create roles and the created roles to be assigned to the users. The application should provide the ability to quickly collect and edit data, summarize results, and adjust as well as correct errors promptly [3]. As a cloud based system it should provide a mobile application to retrieve the information on mobile. This paper provides solutions to the existing problems of the hospital. The design improves the accuracy of patient records and provides a way to retrieve the records efficiently. The system provides the ability to retrieve the information in various formats (PDF, CSV, TXT) [4]. The purpose of this paper is to design a Cloud based EHR and CPS system that helps to:

- 1) Eliminate data storage redundancy and provide anywhere access to the data by storing the data in a cloud instead of a local computer or a heap of files.
- 2) Reduces the time wasted in retrieving the historical data of the patient and allows the patients to download their reports from anywhere using the mobile application or the web portal provided for them.
- 3) Increases the efficiency and interactivity in any area of specialization in the hospital.

A. Existing System

The information flow used is a single directional system where the receptionist schedules the doctor appointment to the patient. Doctor examines the patients and refers to appropriate lab for further investigations or prescribes the medicines. If referred to the lab, the billing desk will prepare the bill for the tests and collects the charges. The lab staff collects the samples and make a note of the test to be done and sample collection time. Upon completion of tests a report is generated and submitted to the doctor and then doctor prescribes the medicines or refers to admit the hospital based on the investigations. When patient requests drugs the pharmacy staff prepare the bill for the prescribed medicines and they are dispatched to the patient. If the patient is referred for admission, the details are registered in an inpatient register and a bed is allotted based on their requests and treatment continues. In the existing system, the hospital was maintain a windows based VB application for billing and pharmacy stock inventory and another application for pathology lab. All remaining transactions are maintained manually. The weaknesses identified in the existing system are:

- 1) The receptionist found it tedious to manage the schedules and identify the no show patients.
- 2) The staff found it tiresome and time consuming while retrieving the previous history of the patient and old reports.
- 3) The existing software store data in local computer with less security against tampering of data.
- 4) Paper work reduces the efficiency of work.
- 5) Staff usually wastes a lot of time in retrieving data.

II. SYSTEM DESCRIPTION AND METHODOLOGY

A. Proposed System

The proposed system is Cloud based EHR and CPS system which is a cloud based web application developed using platform independent Java Technologies like Spring, hibernate and Struts with MVC Architecture. The system enables the Receptionists, Doctors, Pharmacists and Pathology Lab staff to easily manage their day to day operations and Administrators can have a at a glance look into the overall process flow and can easily administrate the operations.

The system provides a user-friendly software application. Its main objective is to maintain the history of the patient records. The system provides the features that make the hospital staff to easily manage and collect the required information regarding the hospitality and medical services. The system is very simple in understanding and has a very low learning curve. The system requires very low system resources and it works in almost all configurations. The objectives of the proposed system can be enumerated as follows:

- The privilege based access to the system will secure the data from tapering of records from unauthorized users.
- User-friendly interface to manage the doctor schedules and appointments. Logged in doctors can see the

appointment list and scheduled operations in their at a glance dashboard.

- Patient historical data is displayed including diagnostic reports, previous findings, Allergy / Immunization records, prescriptions, case notes, discharge summary, disease history.
- Interface to manage operation theatre schedules.
- Inpatient management.
- Prescription and Lab report management.
- Anywhere access to the patient records
- Billing and invoicing management
- Drug management that provides a sophisticated stock management system along with proactive expired drug alerts.
- Lab management
- Operation theatre management and operation schedule management.
- End to End patient management.
- Provide connectivity Any Time Any Where through:
 - Tablet PCs
 - Smart phones

The following are the core modules of the system.

1) User Management

Add/Edit Users – All employees including doctors, nursing staff, lab, pharmacy and administration staff are created as users. Each user is identified with a unique id.

Role Management – Users are created with different roles. Each role will have a list of privileges assigned to them. Based on the privileges the users are allowed to access specific resources of the application.

Security Privilege Management – The privilege management allows assigning the privileges to the individual roles.

2) Patient Administration and Medical health records

This module captures complete and relevant patient information and automates the patient administration functions to have better and efficient patient care process

Outpatient Management – This is an entry point that allows the hospital staff to schedule the appointment with the resident doctor or consultant doctor of the hospital for medical consultation and diagnosis. It also allows keeping track of the previous history of the patient.

Inpatient Management – This module provides the features to allocate room/bed to the patient and keep track of the case history.

Patient Billing and Insurance – This facilitates cashier and billing operators for different types of patients including outpatient, inpatient and referral. It provides automatic posting of charges related to different services like bed charges, lab test, medicines, consultation etc., It also allows to credit partly billing and provides integration with Financial accounting.

3) Allergies and Dietary Module

This module in the system is designed to assist the doctor, staff and hospital kitchen in suggesting the dietary plan and/or providing meals to the inpatients as per the instructions, directions of the dietician and allergic history of the patient.

4) Operation Theatre Management

This module allows the administrator to keep track of the schedules and charges of the operation theatre, surgeries and doctor schedules.

5) Pharmacy Management

This is module automates the general workflow and administration of a pharmacy. This module equipped with bar coding facility that provides a more efficient way of delivering the medicines to the patients.

6) Pathology Laboratory Management

This module automates the investigation request and the process involved in delivering the results to concerned department or doctor of the hospital. It supports various test related to Biochemistry, Haematology, Cytology, Microbiology, Neurology, Radiology and Serology etc., The automation starts with receiving an online request from the concerned doctor or lab staff and allows to track billing, report generation and storing the image files also.

7) Financial accounting

This module deals with Cash/Bank receipts and payments, vouchers and ledgers. It also provides the facility to generate day balance sheets and Trial balance.

8) Mobile Application

Separate mobile applications are provided to the doctors and administrators along with patients. Based on their role and privileges, access to the data is provided like the patients will have access to their historical data, doctors can access their schedules and case history of their patients and admin will have access to the financial operations and schedules.

B. Methodology

Various hospitals were visited to collect appropriate information. The purpose of the study is to find out the current state of their management system and how to make it more efficient. Various stake holders were interviewed in order to know their duties and challenges they are facing during their duties. Vouchers, bills of payments, lab reports, prescriptions and inpatient log books are reviewed to understand how the "System of Number" for referencing and storing the data for future reference.

C. System design and implementation.

The following tables show the software and hardware requirements for production.

TABLE I
SOFTWARE REQUIREMENTS

Operating System	Windows 8 or Above / Linux 64 bit
JRE	JRE 1.8
Backend Database	MySQL 5.5
Web Server	Apache Tomcat 7.x or above
Browser	Firefox 3.6 or above Internet explorer 11 Google Chrome 62.x

TABLE 2
HARDWARE REQUIREMENTS

Processor	Intel Core I5 or above
RAM	2 GB
Hard disk	10 GB
Monitor	TFT Flat monitor 16"
Keyboard	Windows keyboard
Mouse	Windows mouse

TABLE 3
CLOUD SERVER REQUIREMENTS

Processor cores	At least 1 vCPU
RAM	3.5 GB
Hard disk	100 GB
Operating System	Windows Server 2012 or RedHat Linux Server 6 or above 64 bit
Web server support	Apache Tomcat 7.x or above

III. SYSTEM TESTING

Testing was done on individual modules of the system to make sure they meet necessary functional requirements such user authentication, role based access, list the patient history for individual patients, financial flow, report generation and allowing the administrator to modify or delete records if necessary. Modules are integrated and compatibility was tested in order to ensure that modules are forming a complete working system.

IV. RESULTS

The developed system has been tested and deployed in major multispecialty hospitals. The system automatically generated patient ids and identifies the outpatients and inpatients separately. It is also providing the facility to add the stock details of the drugs and manage the inventory very easily. We observed the growth in the revenue and also the number of patients serviced after deploying the application because of ease of use and anywhere accessibility of patient health records for the patients. The results are plotted in following graphs.

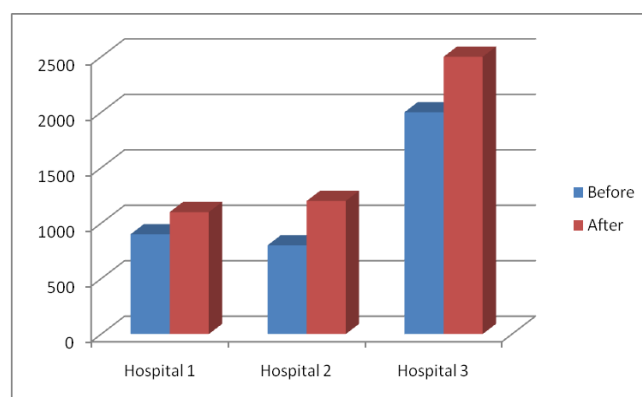


Fig. 1 No. of Patients Serviced Before and After Installation

V. CONCLUSION

The developed cloud based EHR and CPS demonstrated significant improvement in solving the issues with the existing system in relation to the security, ease of use and performance concerns.

The developed system can further be extended with elastic cloud, bigdata and analytics for effective monitoring of the system. The success factors of the system tend to vary depending on leadership, support, training, technology adoption and user friendliness.

REFERENCES

- [1] A.K. Malhotra, Hospital Management system: An Evaluation, Global Indian Publications, 2009.
- [2] Mansi Chitkara, Namita Khandelwal, and Avinash Chaporkar, Project Report on Hospital Management System, 2010.
- [3] Waban Charles, Project report on Computerized Health Records Management System, 2007.
- [4] E –Hospital Management & Hospital Information Systems – Changing Trends, Premkumar Balaraman, Kalpana Kosalram, I.J. Information Engineering and Electronic Business, 2013.
- [5] HOSPITAL MANAGEMENT SYSTEM - Digvijay H. Gadhari, Yadnyesh P. Kadam, Prof. Parineeta Suman, International Journal for Research in Engineering Application & Management, 2016.