Inward Patient Care System

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Abstract— Healthcare systems have improved tremendously since the advent of Electronic Medical Records (EMR). Though there are many healthcare systems they do not fully facilitate most requirements in Sri Lankan context. Unavailability of effective mechanism to manage Inward patients and patient Bed Head Ticket is a visible problem. Therefore as a solution the Inward Patient Management System (IPMS) and electronic Bed Head Ticket systems (eBHT) are developed to solve above problem, and enhanced with new features under the title Inward Patient Care System (IPCS). IPCS is a low cost, easy to deploy analytical system designed for hospital doctors and nurses. The IPCS implemented using technologies and coding languages such as Java, Hibernate, CodeIgniter a powerful Personal Home Page (PHP) framework and native android. The proposed system has the ability to expand further according to the timely needs arising in the health sector.

Keywords— eBHT- electronic Bed Head Ticket, HHIMS – Hospital Health Information Management System, HIS-Health Information System, IPCS- Inward Patient Care System, IPMS-Inward Patient Management System

I. INTRODUCTION

A good Health Management Information System (HMIS) is necessary to manage a health organization effectively and efficiently [1]. In the health sector an extensive demand for Electronic Medical Record (EMR) system is available currently worldwide as well as among local health care providers. World Health Organization (WHO) introduced a health information system to SriLanka two decades ago but that is not up and running by now because it is not feasible and customizable to Sri Lanka. By analysing existing systems; open Medical Record System (openMRS) which is a patient-centric record system focuses on developing countries where malaria, tuberculosis, *and* acquired immune deficiency syndrome(AIDS) affect human lives [2], and Health Information Management System (HHIMS) an open-source medical record software developed to use in Sri Lankan hospitals [3]. Sri Lanka Institute of Information Technology (SLIIT) Research team introduced Health Information System (HIS) system framework [4]. HIS framework consists of independent modules such as Out Patient Department (OPD) Module, Pharmacy Module, Surgical Module, Admin Module, Inward Patient Management System (IPMS) [5] and electronic Bed Head Ticket (eBHT) module. Each module of Health Information System (HIS) framework has its own functionality to provide services to web bound frontend which is the interface between user and data access layer. HIS Framework can be extended easily to support new requirements.

IPMS already included eBHT module with ward and bed viewing, prescribe medicine and diagnosis treatment functions and web application mapping same functions and allocate ward admissions, add allergies, internal transfer admissions, and requests for laboratory test functions. IPMS is being from HIS framework and has been identified as a set of research problems. Among identified problems include; unavailability of proper nurse drug alert methodology to give patient's medicine on time, unavailability of transferring patient details between two hospitals, ensure eBHT module fully functional in online mode and specific features are functioning offline, provide and analyse statistical reports for the hospitals, effective discharge mechanism to save time of waiting to discharge and patient history archiving.

The Inward Patient Care System (IPCS) Web application includes the tasks as discharging patient, medical charts handling, archiving patient details, transferring patient details between hospitals in a secure manner via Central Portal Server (CPS) and eBHT contains features as digital signature mechanism for patient discharging, offline data synchronization and storing, Quick Responsive (QR) code scanning, prescribing medicine, diagnosis diagram and updating medical charts real-time. Thus the main objective of the IPCS of attempting to develop a fully functional IPCS with newly added features covering main research problems is achieved. The IPCS supports doctors and nurses tasks to be fulfilled efficiently and effectively thus allowing to provide patient care as quality service.

II. METHODOLOGY

In the proposed system a combination of waterfall and agile methodologies was followed throughout the development of the system. The research started with a feasibility study to prove that it is technically and operationally feasible. It is open source technology based product with less technological constraints and the final outcome is low cost easy to deploy analytical system and designed for non-technical users as hospital staff doctors and nurses. Requirements were gathered based on users' requirements by hospital visits and interviews.

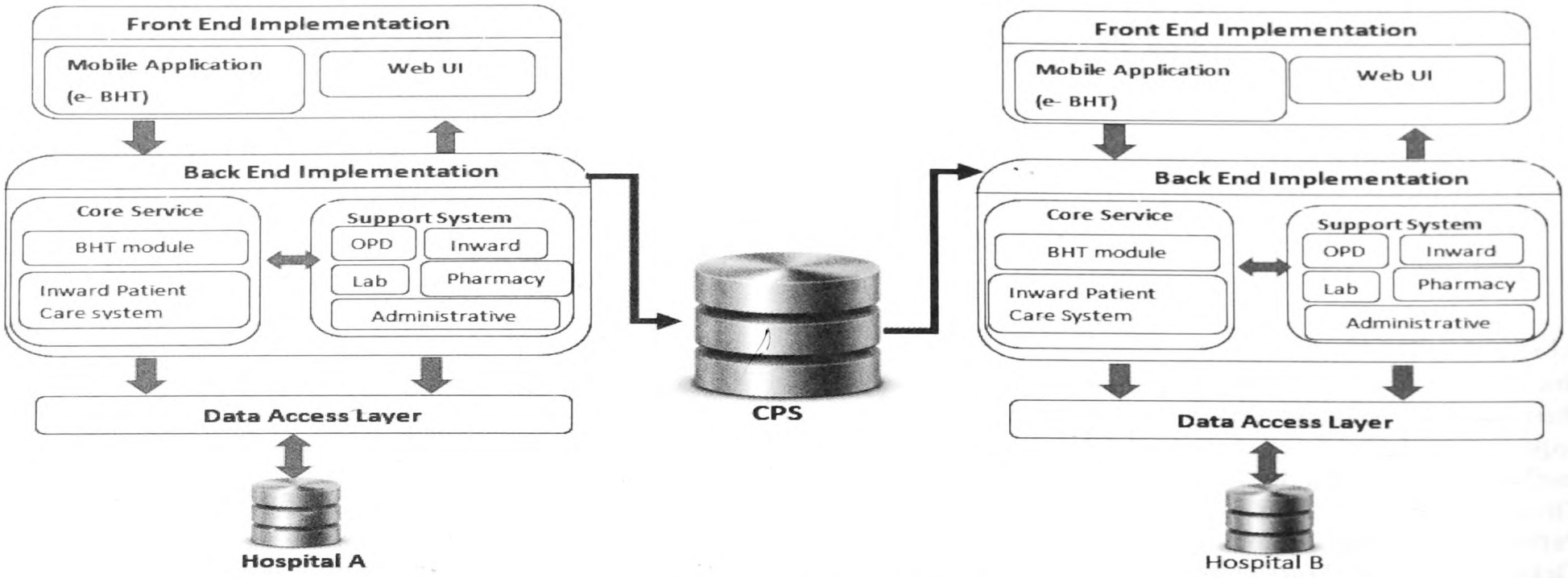

Fig. 1. High Level Architecture Diagram

Designing phase is conducted as per the essential features identified at the requirement stage. Design concepts as abstraction, refinement and modularity which is software architecture is divided in to modules used in this stage [4].

Designing optimal methods to retrieve patient's information and user friendliness is mainly considered here. Implementation phase can be defined as a set of different phases since the technological advancements are constantly adding and improving. The verification phase is conducted by testing the product throughout the software development life cycle process in related to the proposed system. Testing and evaluation conducted based on manual testing along with test first design concept. Since the system is developed for hospitals which need system availability which is constantly maintained, and thus maintenance procedure is continuously conducted. IPCS and eBHT solution are developed on the HIS framework [6].

Software solution is mainly implemented as frontend and backend. Frontend application is where the Inward Patient Care module is implemented and interacts with the user. Frontend is designed on Model View Controller (MVC) architecture and use CodeIgniter framework a powerful Personal Home Page (PHP) framework to create full-featured web applications [7]. MVC is used since it isolate the application logic from the user interface layer and supports separation of concerns [8]. Frontend uses a Java Script Object Notation (JSON) string in order to communicate with the backend which has data access layer and referred as server side which uses Java web services. EBHT uses native android for frontend design. But uses same backend services to retrieve data and same SQL database.

Backend implementation is done using Hibernate. Hibernate is used for mapping database with the backend implementation. Enterprise Service Bus is planned to use as a middle wear as future work. This software architecture model helps to design and to implement the interaction and communication between mutually interacting software applications in Service-Oriented Architecture (SOA). The high level architecture diagram in figure 1 indicates how theIPCS and eBHT modules interact with the other HIS modules and CPS which are connecting two hospitals that has same HIS frame work in order to transfer patient details.

A. IPCS Web module

The main purpose of this module is to manage the patients ward admissions in the inward effectively. Patient details is much important for the doctors in certain criteria. Once a patient comes to the hospital the doctor can search the patient's History from the patient Health Information Number (HIN) [9].

This research component consists of a way to search patient from HIN and download a Portable Document Format (PDF) [10]. When the time of patients discharge an archive file with the patient's summarized details will be saved to the system with the relevant details. The Nurses are responsible for distributing the drugs according to the give the drug chart to the patients'. They have maintain each and every patient's drug chart. For the convenience of the nurse, a method has been implemented to generate a drug alert which reminds the patient's bed head number, drug dosage and frequency and display a drug chart with related information. The patients' diet is an important process in the hospital. This system has provided a function to analyze the patients diet charts. When the patient is discharged a discharge report is generated. As an enhanced feature of the system, it provides function of generating a discharge diagnosis card that can send with patients.

B. eBHT Module

An eBHT is a necessary requirement in the Sri Lankan government hospitals. Therefore eBHT becomes the main unique feature of IPCS. EBHT module is implemented on android Platform. It requires Wi-Fi or Mobile data to be synchronized with the web application. In the real world scenario this will be a problem since there will be many instances that Wi-Fi is not available when required. A hospital information system, being a critical system requires availability as well as sustainability. Offline synchronization has a number of benefits; Improving application responsiveness by caching server data locally on the device, allowing end-users to create and modify data even when there is no network access [11]. The figure 2 indicates a comparison between IPMS existing system and IPCS newly added features in both web module and eBHT.

The local database in the tablet is used to cache and store data temporary until the synchronization is completed. When the doctor is conducting ward round the doctor can scan QR code which is attached in the patient's bed and can view information about the patient, write prescriptions, and draw medical diagrams which are required to decide and elaborate patient's health status. The diagnosis diagram will be included in the final discharge ticket.

Patients face various difficulties when being discharged from hospital. This matter arises when the doctor is either being absent or performing another task in another ward. Therefore patients have to wait till the arrival of the doctor to get the signature in order to be discharged from the hospital. The Doctor can view discharge requests and the patient's profile then doctor can approve or disapprove the request using a digital signature. Since the nurses are the people who directly interact with patients, thus it is essential to allow them the privileges to update relevant data and create required charts in eBHT and to maintain a nurse note. Both these functions are developed in IPCS.

C. Transferring Patient Details via CPS

In the current system external transfer of patient's part is not implemented. This System has been implemented with CPS which acts as an orchestrator between local hospitals. CPS contains general details which belong to registered patients and redirection fields which are relevant to the aforementioned patients rather than storing all the information of the patients inside a main server. There isn't a connection implemented from IPCS external transfer to facilitated transfer of patient's details.

When a patient is transferred from one hospital to another hospital, the proposed system should ensure below requirements:

- Communicate effectively with hospitals to facilitate continuity of care
- Plan and manage discharging of patient in order to minimize time waste
- Transfer patients externally, safely and appropriately by protecting patient details confidentiality
- Prepare Documentation required to accompany the patient on discharge and transfer.

When considering a software application system security should be highly considered. In order to fulfil this major requirement a powerful security mechanism has to be established and maintained properly. Because information of

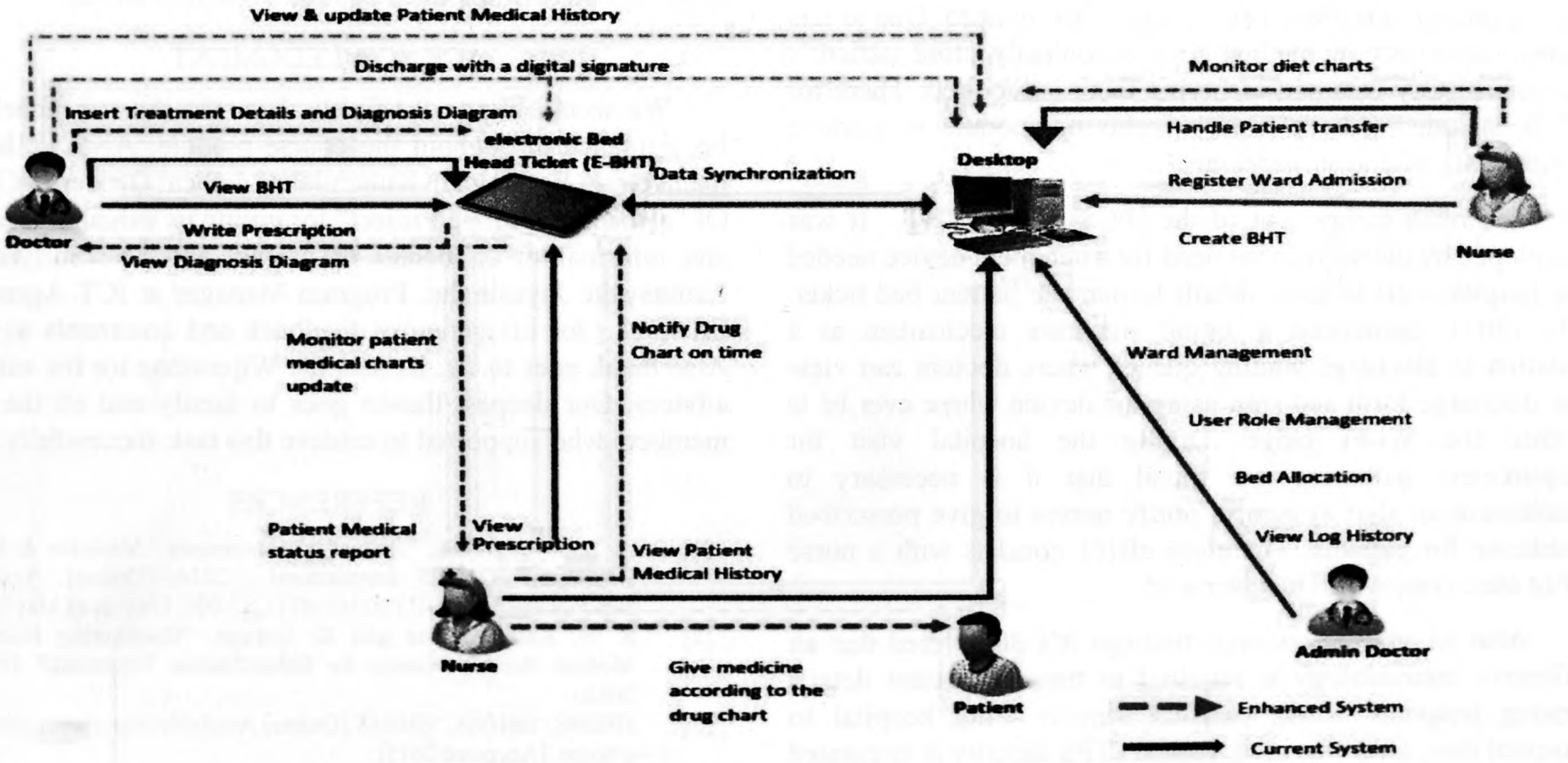

Fig. 2. Main Functions of IPCS Web Module and e-BHT

a patient should be kept confidentially since it directly focuses the privacy of the patient.

System functionalities should be approached with user authentications. Transferring patient records between two hospitals which is a high level function of this system has been properly automated. Privacy should be protected since there is a high possibility of accessing data by hackers. The access levels are considered since this system stores patient's confidential data. The secure version of HTTP is known as Hyper Text Transfer Protocol Secure (HTTPS) which is widely used in online transactions which consists confidential data. HTTPS is a protocol to transfer encrypted data over the web [12].

III. RESEARCH FINDINGS

Even through a literature survey, it was identified that there are many systems to manage patients however they were not in accordance with the requirement of our target market which is local government hospitals. The HIS framework consists of IPMS and eBHT modules. But it was evident it is yet to be developed and need more enhancement features' which haven't been addressed properly. The research team found that hospital policies differ from hospital to hospital and there aren't common policies available yet. Therefore systems currently available differs. The research findings were not only considered from user's perspective but also from patient perspective as well.

The findings included the necessity of web module consists of patient history archiving, effective mechanism to manage patient bed head ticket electronically, transferring patient details between hospitals in external transferring instances. The IPCS functions were developed to achieve these tasks effectively. Patient's medication history is stored as a manual documentation in local hospitals. But these documents are hardly reused to retrieve patient data when in need. Due to this reason an effective method to electronically store patient's ailment history data and archiving them is required. There for IPCS included patient history archiving module to retrieve patient data whenever necessary.

The main component of the IPCS is the eBHT. It was developed by identifying the need for a handheld device needed for hospital staff to enter details to manage patient bed ticket. The eBHT introduced a digital signature mechanism as a solution to discharge waiting queues where doctors can view the discharge form and sign using the device where ever he is within the Wi-Fi range .During the hospital visit for requirement gathering we found that it is necessary to implement an alert system to notify nurses to give prescribed medicine for patients. Therefore eBHT consists with a nurse drug alert system will be enhanced.

Also among the research findings it's discovered that an effective methodology is required to transfer patient details among hospitals where patients transfer from hospital to hospital thus, CPS was used. And HTTPS security is integrated to the system, along with Statistical reports to analyze patient details of each hospital which contains HIS framework.

IV. CONCLUSIONS AND FUTURE WORKS

The rapid growth of Information & Communication Technology (ICT) and the power of internet has strongly impacted the business and service delivery models of today's global environment. HIS provide the benefits of streamlined operations, enhanced administration & control and superior patient care [13]. The rapid advancement in database, web and wireless technologies have given rise to new applications that were impossible just few years ago. One of these applications is Health Management System (HMS), because when considering about transferring or sharing medical data is a critical part. Health information storage has high vulnerability because a patient medical data is private issue to the patient.

With the development in the information technology field many industry adopts to the possibilities given by technology. This includes the health sector which is far more complex and vast field to comprehend. Since health sector is quite broad the adaptations happen slowly even though the interest among professionals is quiet high. It is possible as a future research component to view X-rays, and lab reports via eBHT and attempt to use patient wrist device to receive patient medical details without the nurse visiting patient always. The eBHT is allowed to expand further and developed in cross platform as well. The entire backend is possible to more technological advancement by converting it to spring framework in future. The IPCS system needs to work without failing because these information stored are crucial when it comes to health sector. The database failing are identified using the newly created system and the server clustering is obtained. The identification of a failover and redirecting the request to the replicated database can be implement as future research works.

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