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E –Hospital Management & Hospital Information Systems – Changing Trends

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Abstract — The rapid growth in Information & Communication Technology (ICT), and the power of Internet has strongly impacted the business and service delivery models of today's global environment. E-Hospital Management Systems provide the benefits of streamlined operations, enhanced administration & control, superior patient care, strict cost control and improved profitability. Globally accepted health care systems need to comply with Healthcare Insurance Portability and Accountability Act (HIPAA) standards of the US and that has become the norm of the Healthcare industry when it comes to medical records management and patient information privacy. The study is focused on understanding the performance indicators of Hospital information systems (HIS), summarizing the latest commonly agreed standards and protocols like Health Level Seven (HL7) standards for mutual message exchange, HIS components, etc… The study is qualitative and descriptive in nature and most of the data is based on secondary sources of survey data. To arrive at a conclusive idea of the larger picture on E- Hospital Management and Hospital information systems, existing survey data and specific successful case studies of HIS are considered in the study. With so many customized versions of E – hospital management solutions (E – HMS) and Hospital Information systems (HIS) available in the market, a generic module wise version of E – Hospital management system is charted out to give a clear understanding for researchers and industry experts. From the specific successful case studies analyzed in the study, the success factors and challenges faced in successful E-HMS implementation are highlighted. Some of the mandatory standards like HIPAA are discussed in detail for clarity on Healthcare system implementation requirements.

Index Terms — Information & Communication Technology (ICT), Health Level Seven (HL7), Healthcare Insurance Portability and Accountability Act (HIPAA), E – hospital management solutions (E – HMS), Hospital Information systems (HIS)

I. INTRODUCTION

Hospital Information systems are in high demand to handle increasing population needs and also aids the practicing doctors and hospital service and support staff with timely service and precision. There are varied metrics available to assess the performance of services like hospital industry, and the successful implementation and usage of Hospital information system forms a crucial role. Hospital information systems are available in the software market which in most cases needs to be customized and in some cases HIS needs to be developed as a customized software based on specific hospital requirements (user requirements). The paper looks at assessing and identifying the key components of E – HMS as its needs and management varies across the globe. Also identification of the key performance indicators of E – HMS / HIS is also attempted from a benchmarking perspective.

1.1 Objective of the study

- To identify the key performance indicators and standards of E - Hospital Management (E – HMS) & Hospital Information Systems (HIS).
- To identify the key components of E - Hospital Management solutions.

1.2 Need for E – Hospital Management & HIS

Hospital Services are needed on an emergency and

daily basis and HIS plays a crucial role. Hospital services are customer and society sensitive and the quality of HIS and service of hospital staff needs to be precise and of highest standards. Today's hi-tech Hospital services are predominantly provided by private players in the market at increased costs despite low cost competition by public sector hospitals. OECD report (2012) finds that attempts to control costs by regulatory means, such as reducing fees paid to healthcare providers and rationing user access, have typically only been temporarily successful.

E-Hospital Management System provides the benefits of streamlined operations, enhanced administration & control, superior patient care, strict cost control and improved profitability. Due to business and legal demands—like the Healthcare Insurance Portability and Accountability Act (HIPAA) of the United States as a Global norm —healthcare organizations are fully realizing the urgency to integrate their businesses. Unfortunately, most of the health information systems are still proprietary and often only serve one specific department within a healthcare business. This represents a significant obstacle to business integration.

II. RESEARCH METHODOLOGY

The study is qualitative and descriptive in nature and most of the data is based on secondary sources of survey data. Such an approach is adopted in the study as the area of research is very broad and sources of data are also spread across multiple locations. To arrive at a conclusive idea of the larger picture on E- Hospital Management and Hospital information systems, analyzing the existing survey data and specific successful case studies of HIS would give a better result in finding the answers to the research question framed.

III. DEFINITION OF HOSPITAL INFORMATION SYSTEM (HIS)

According to Paul R. Vegoda (1987), Hospital Information System (HIS) is defined as, 'an integrated information system which improves patient care by increasing the user's knowledge and reducing uncertainty allowing rational decisions to be made from the information provided. Haux, Schmücker and Winter (1996) view the hospital information system as the entire information processing and information storage subsystem of a hospital, whereby it is not just about computer systems and networks and the computer-based application systems that are installed on them, but it is about the information in a hospital as a whole.

HIS consist of different softwares that are integrated in order to capture data in specific sections of the hospital [Garrido, Raymond, Jamieson, Liang and Wiesenthal [2004:21-22]], handle the workflow of daily medical services and also assist in managing financial, administrative and clinical data. From the various definitions of HIS, it is understood that HIS is a very broad area as it encompasses services catering to varied departments and personnel of an hospital and finally satisfying the patient care in its true sense. Hospital Information Systems (HISs) are supposed to make the right information and knowledge available to the right people, in the right place, at the right time and in the right form.

IV E – HOSPITAL MANAGEMENT / HIS STANDARDS & TECHNOLOGIES

The developments in technology and internet speed made services like Telemedicine a dream come true for today's patient care needs. Telemedicine can be referred to as the provision of medical services from a distance [Wooton, Craig and Patterson, 2006:1]. This includes diagnosis, treatment and prevention of diseases. The types of telemedicine can be categorized as real-time or pre-recorded telemedicine. Also the growing technology and varied solutions in the hospital management domain necessitated for the development of common protocols and standards at global level. Such standards and legal requirements are discussed in further sections.

According to Belgium Federal Public Service – FPS report (2002), high quality of Data storage, data speed, data exchange and networking for Hospital information systems (HIS) is mandatory for efficient performance of Hospital Information Systems (HIS). Especially data storage requirements of departments like radiology are very challenging.

4.1 3LGM^2 – Modeling tool for HIS

3LGM^2 (Three-layer Graph based meta model) is a structured and in some countries already validated

approach for modeling and analyzing HISs.'3LGM^2 combines a functional meta model with technical meta models and is represented using the Unified Modeling Language (UML)' (Winter, Brigl and Wendt., 2003). In a study by Björn Schreiweis (2010), on HIS modeling it adopts the 3LGM^2 model with three layers named domain layer, logical tool layer and physical tool layer. These layers represent different views on a HIS.

According to Hübner-Bloder et al., 2005, the domain layer describes a hospital independently of its implementation by its enterprise functions. The logical tool layer shows the application components. Application components support enterprise or hospital functions and 'are responsible for processing, storage and transportation of data. On the physical tool layer there 'is a set of physical data processing components' that are 'used to realize the computer-based and the paper-based application components'

4.2 HIPAA privacy guidelines for Medical Records and patient information.

One of the key aspects of HIPAA guidelines which need to be complied with by all Hospital management system implementing E – Health management systems of global standards is the privacy rule in HIPAA. The HIPAA Privacy Rule protects all "individually identifiable health information" held or transmitted by a covered entity or its business associate, in any form or media, whether electronic, paper, or oral. The Privacy Rule calls this information "protected health information (PHI).

A detailed guidance manual on de – identification methods to be adopted for PHI content in Hospital records and information systems management is given by U.S. Department of Health & Human Services (Bradley Malin, 2010). The process of de-identification (refer figure 1), by which identifiers are removed from the health information, mitigates privacy risks to individuals and thereby supports the secondary use of data for comparative effectiveness studies, policy assessment, life sciences research, and other endeavors.

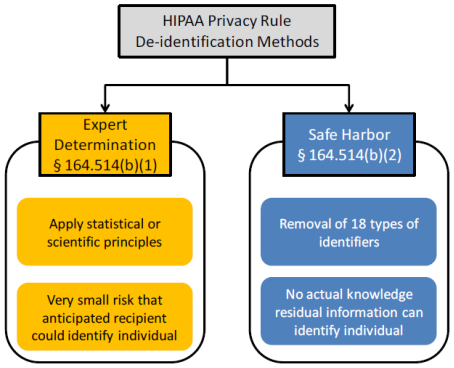

Fig. 1 – HIPAA Privacy rule De – identification Methods

4.3 HL7 / RIM Development Framework

Health Level Seven (HL7) is one of several American National Standards Institute (ANSI) accredited Standards Developing Organizations, operating in the healthcare arena worldwide. ("Level Seven" refers to the highest level of the International Standards Organization's (ISO) communications model for Open Systems Interconnection (OSI) —the application level.) According to Mauro Regio (2005), the HL7 vision is to create an infrastructure for interoperability in the healthcare domain. HL7 uses the reference information model (RIM) to derive domain specific information models and refine them into HL7 message specifications. Traditionally engaged in modeling clinical and administrative data, the most recent version, HL7 version 3.0, is extending its reach to various healthcare business domains such as pharmacy, medical devices, and imaging.

For a given healthcare domain, an HL7 version 3 specification is based on the Reference Information Model (RIM), a common and underlying modeling framework, and includes artifacts like: Use Case Models, Information Models, Interaction Models, Message Models, and Implementable Message Specifications. Leading software industry architects like Microsoft are a longstanding member of the healthcare development domain, involved with HL7 for ten years and a Healthcare Information and Management Systems Society (HIMSS) member since 2002. The Reference Information Model (RIM) (HL7, 2012) is the cornerstone of the HL7 Version 3 development process. RIM is an object model created as part of the Version 3 methodology, the RIM is a large, pictorial representation of the HL7 clinical data (domains) and identifies the life

cycle that a message or groups of related messages will carry. But a summarized view of the basic components of RIM / HL7 is given in figure 2.

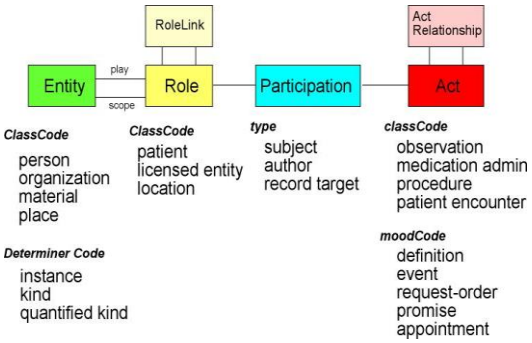

Fig. 2 – RIM / HL7 model

V. E – HOSPITAL MANAGEMENT TASKS & FEATURES

To carve out a comprehensive E Hospital management / Hospital information systems model, some of the various E – Hospital management system tasks are discussed and summarized in the context of the current study.

The most important tasks in hospital information systems can be summarized as follows, (PayamHomayounfar (2012)):

(1) Storage and monitoring of patient's condition:

- Accurate and electronically stored medical records of patients (e.g. drug allergies) are provided
- Visual and auditory warning systems are generated in the event of abnormal test results or other important data
- Time intervals and / or testing periods for tests on patients to be specified
- Data Processing and analysis for statistical purposes and research oriented purposes

(2) Management and Data Flow:

- Support automated patient data transfers between departments and institutions
- Enable graphic or digitized diagnostic images from the hospital database based on the integrated retrieval system
- Digital signatures, in order to create internal orders electronically
- Communication by Laboratory Information System
- Registration of human resources and their properties

(3) Financial Aspects:

- Efficient administration of finances
- Use and monitoring of medicines and effectivity of the ordering process
- Expected and actual treatment costs are listed and reported
- Automated representation of the needs of the nursing staff
- Status analysis of bed occupancy and overall performance in the hospital information system

In the public sector domain, some of the successful e - hospital management solutions include that of the, e-Hospital solution by National Informatics Center, India (NIC, 2013). It is a Hospital Management System that is a workflow based ICT solution for Hospitals specifically meant for the hospitals in Government Sector. This is a generic software which covers major functional areas like patient care, laboratory services, work flow based document/information exchange, human resource and medical records management of a Hospital. It is a patient-centric system rather than a series of add-ons to a financial system.

E Hospital management solution (E-HMS) is designed for multispecialty hospitals, to cover a wide range of hospital administration and management processes. It is an integrated end-to-end Hospital Management System that provides relevant information across the hospital to support effective decision making for patient care, hospital administration and critical financial accounting, in a seamless flow. Some of the salient features of this e-Hospital solution of NIC, India are summarized in table 1.

Table 1. NIC, India - E – Hospital Management Solution Special Features

S.No	Features
1	ISO / IEC 9126 Certified
2	Based on HDF(HL7 Development Framework)
3	Unicode based Indian Multilingual Support
4	Vocabulary- ICD-9, LOINC etc.
5	Comprehensive Reporting on various customizable parameters
6	Comprehensive Role based Access control and Security
7	Data Security and Privacy
8	Audit logging of transactions
10	Powerful Search facility and tracking of patient history
11	Touch Screen Kiosk interface
12	Available on Linux and Windows platform

SOURCE: http://tsu.trp.nic.in/ehospital/

VI. CASE: FUJISOFT – HIS

Fujisoft is a leading software product company based in Japan. With its rich legacy in developing customized software right from the the 1970s, it provides one of the world's best Hospital management solutions. According to Fujisoft (2012), the management environment of hospitals is entering into a phase of major change. For example, new Hospital Accounting Regulations have revised the system of financial statements (including cash flow statements) and hospitals are converting to a Medical Inclusive Payment System based on DPC (Diagnosis Procedure Combination). Furthermore, securing management resources by means of a new fund procurement system (such as the securitization of medical treatment fees and the issuance of hospital bonds) is being adopted.

6.1 Fujisoft HIS modules

The various modules of Fujisoft Hospital solutions can be summarized as below table 2.

Table 2 – Fujisoft HIS Modules

S.No	Module Name	Function
1	FSHosPAck Management	Hospital Management Support System - Daily data handling and management
2	Hospital Comprehensive Physical distribution Management System	Total goods physical distribution management – purchase costs management
3	FS - Incident	Hospital Specific incident reporting system
4	Cash Collection Solution	Complete Sales / Cash collection management

6.2 Challenges in implementation of E – Hospital Solutions / HIS

A "Multi-vendor" management system or system integrator is needed which can select and combine suitable products from those of various manufacturers in accordance with the needs of each E – Hospital Management system (customer). Technology inclusion, exclusion and hybrid combination decision are crucial to success of latest E – Hospital management solutions. Such efficient and precise decision in choice of technology and E – hospital solution management is possible only based on know-how and technological excellence accumulated through longstanding engagements in system design and construction in the medical area.

VII. HIS - SUCCESS FACTORS

According to Garrido et al., (2004), some of the success factors of HIS deployment are discussed in further sections.

The success of the HIS deployment depends on a number of critical factors. First, the commitment of

senior leadership to implement clear targets and expectations is crucial to the success of the business case. Changes to operational processes, job roles, and organizational culture will require resources and the strong and consistent support of leadership. All levels of management should be clearly informed and accountable for the key actions that need to be undertaken to maximize system benefits.

Second, timely implementation of the inpatient information system is imperative because the consequent impact of delays on benefits realization is costly.

Third, because the majority of annual expenses are from labor costs, senior management will need to partner with labor to take advantage of the efficiencies introduced to the workflow by the HIS. Fourth, internal policies must require physicians and frontline staff to comprehensively and accurately codify all hospital discharges and procedures. Finally, workflows must be redesigned to incorporate and exploit the system's functionality.

7.1 Non-Financial Benefits

There are many benefits that are less tangible. Though non-financial, they are no less important to an overall investment decision. These include mission critical benefits such as quality of care, patient safety, and member service enhancement. Improved communication and expedited decision-making not only increase efficiency but also help to reduce errors. Likewise, the ready availability of patient information will prove extremely beneficial to assure continuity of care during the patient's transitions from one care setting to another.

7.2 CASE: Successful E – Hospital Management - Bumrungrad International Hospital, Thailand.

Alice Kok (2009) reports, Thailand's Bumrungrad International Hospital has digitised as many aspects of hospital work as it can—enabling it to more than double the number of patients it can handle each day, increase safety and cut its patients' bills.

Bill payment, human resources, record keeping and inventory management are now all done electronically, allowing the hospital's staff to get more work done. Doctors no longer wait around for patient records, such as X-ray or blood test results, to be delivered by hand. And wasteful duplication has been eliminated because doctors can see what tests have been done already and access results immediately.

Digitization has also been lauded to improved safety. Bumrungrad has an e-prescription system that helps to eliminate errors from illegible handwriting, and allergy alerts that warn doctors against medications unsuitable for patients and can suggest alternatives based on the symptoms observed.

VIII. SUMMARY

According to the Health Evidence report of the WHO (Shaw, 2003) it recommends that, there are in principle five different types of measurement of hospital performance, as below:

- Regulatory inspection
- Surveys of consumers' experiences
- Third-party assessments
- Statistical indicators
- Internal assessments.

Also, based on the above case studies and various deliberations on E – Hospital Management Solutions and HIS, the various components of an E – Hospital management solution are detailed below for easier understanding of future researchers and industry experts.

8.1 E – HMS / HIS - Basic Modules

1. Patient Registration and Appointment Scheduling Module - The Registration module is an integrated patient management system, which captures complete and relevant patient information. The system automates the patient administration functions to have better and efficient patient care process.

2. Outpatient Management Module - The Outpatient module serves as an entry point to schedule an appointment with the Hospital Resident Doctor or Consultant Doctor for Medical Consultations and diagnosis. This module supports doctors to take better and timely consultation decisions by providing instant access to comprehensive patient information.

3. Patient Billing & Insurance Module - The Patient Billing module handles all types of billing for long-term care. This module facilitates cashier and billing operations for different categories of patients like

Outpatient, Inpatient and Referral. It provides automatic posting of charges related to different services like bed charges, lab tests conducted, medicines issued, consultant's fee, food, beverage and telephone charges etc. This module provides for credit partly billing and can be seamlessly integrated with the Financial Accounting Module.

4. Services Module - The service module provides for effectively managing all the services available in the hospital and the charges for each of these services are securely entered and handled.

5. User Manager Module (security workflow) - The User Manager module basically deals with security through controlling the access to the information available in the application. Any user associated with a user group can access only those screens for which the user group has rights. It also deals with the System Related Activity like User Monitor, Creating User Group Master, User Master and view the User Group Lookup of employee database, Maintenance of company documents, User defined error message, Generating Daily Statistical Summary.

8.2 E – HMS / HIS - Optional Modules

1. Pharmacy Module - Pharmacy module deals with the automation of general workflow and administration management process of a pharmacy. The pharmacy module is equipped with bar coding facility, which makes the delivery of medical items to the patient more efficient.

2. Laboratory Information System - The Laboratory module automates the investigation request and the process involved in delivering the results to the concerned department/doctor of the hospital. Laboratory module starts with receiving the online request from doctors and also allows laboratory personnel to generate requests. The Laboratory module supports to perform various tests under the following disciplines: Biochemistry, Cytology, Hematology, Microbiology, Serology, Neurology and Radiology.

3. Radiology Management Module - Radiology module caters to services such as X-ray, Scanning, Ultra sound etc. Scheduling of Radiology resources is possible. The system stores all the result details of various tests and makes a Report based on the Test Results.

4. Electronic Medical Record (EMR) - The EMR Module is a fully integrated knowledge repository that caters to Medical and clinical records of patients in the hospital. The system supports medical professionals of various departments of the hospital with relevant information like medical examinations, diagnoses, treatment histories, test results and so on. The module provides access to critical and complete patient data that leads to high quality cost effective and efficient patient care. The EMR has the following features.

5. Dietary Module - The dietary module in the hospital management system software is designed to assist the hospital kitchen in providing meals to inpatients as per the instructions of the dietician.

6. House Keeping Module - Housekeeping in any hospital is defined as the provision for a clean, comfortable and safe environment in the hospital for patients and general public. Housekeeping in the hospital management system software involves the maintenance of beds in wards, rooms, cubicles. The various housekeeping tasks can be planned, assigned and tracked in the module.

7. Nursing Module - Nursing module is a tool provided in the hospital management system software to the nurses to manage their routine tasks with the objective of improving patient care. It is tightly integrated with the Inpatient module and other clinical modules for smooth flow of information.

8. Emergency Management - Emergency module in the hospital management system software allows fast registration of patients by the capture of key and very specific registration details such as demographic information, keeping in mind the critically of this function. This module also collects information related to Medico Legal Cases (MLC) which is subsequently used for reporting to local authorities.

9. Machine Maintenance - The machine or equipment maintenance module in the hospital management system software facilitates breakdown processing and preventive maintenance scheduling and recording.

10. CSSD - CSSD, or Central Sterile Supply Department is an important and crucial function of most of the mid-size and large hospitals. In certain countries, CSSD

is even mandatory to meet with the government stipulations for hospital licence etc.

11. Blood Bank - This module in the E-Hospital Management System hospital Management Software is quite comprehensive in its nature, maintaining all information regarding the blood donation. The details about the donors and recipients are maintained.

12. Financial Accounting Module - The Financial Accounting Module deals with Cash/Bank, Receipt/Payments, Journal Voucher and General Ledger etc. Books like Cashbook, Bankbook and Ledger book can be generated. This module generates reports like Trail Balance, Balance Sheet and Profit and Loss statement.

13. Fixed Asset module - The Fixed Assets Module deals with all the activities that are related to the Fixed Asset Part of Financial Accounting of any hospital management system software.

14. Payroll Module - The Payroll & Personnel module deals with Pay (and deduction) calculation, printing of salary slip, salary certificates, and PF statements, Gratuity Statement and provides a monthly analysis.

15. MIS Dashboard - The dashboard presented in the hospital management system software is a summary of key parameters values covering all areas of the hospital that are generally monitored by the top management on a regular basis. Some of the parameters could be current bed occupancy, revenue for a period, etc.

IX. CONCLUSION

The various performance indicators and standards of E – hospital management solution and HIS are discussed in the respective section and cases. Success factors of E – HMS / HIS tend to vary depending upon leadership support, training, technology adoption, user friendliness, etc…HIPAA privacy guidelines and HL7 / RIM framework are identified as the primary determinants and metrics of Global compliance in developing and implementing successful E - hospital management solutions. Also the various case study insights on the broader framework of E – Hospital management solution / HIS paves way for future research on Enhancements in E - Hospital Management domain.

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