A study on the process of integration of Hospital Information System with Patient Information Management System of VistA and its challenges

A dissertation submitted in partial fulfillment of the requirements
For the award of

Post-Graduate Diploma in Health and Hospital Management

By

Perlika Sharma

International Institute of Health Management Research

New Delhi -110075

November, 2010

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under the guidance of

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Certificate of Internship Completion

Date:……..

TO WHOM IT MAY CONCERN

This is to certify that Ms. Perlika Sharma has successfully completed her 3 months internship in our organization from 9th August, 2010 to 9th November, 2010. During this internship she has worked on……(task performed) under the guidance of me and my team at Dell Services, Noida. (Any positive comment)…….

We wish her good luck for her future assignments.

(Signature)

_____(Name)

_____Designation

Certificate of Approval

The following dissertation titled "**A study on the process of integration of Hospital Information system with Patient information management system of VistA and its challenges** " is hereby approved as a certified study in management carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite for the award of **Post- Graduate Diploma in Health and Hospital Management** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

Dissertation Examination Committee for evaluation of dissertation

Name	Signature
_____	_____
_____	_____
_____	_____

Certificate from Dissertation Advisory Committee

This is to certify that **Ms. Perlika Sharma**, a participant of the **Post- Graduate Diploma in Health and Hospital Management**, has worked under our guidance and supervision. She is submitting this dissertation titled "**A study on the process of integration of Hospital Information system with Patient information management system of VistA and its challenges ”** in partial fulfillment of the requirements for the award of the **Post-Graduate Diploma in Health and Hospital Management**.

This dissertation has the requisite standard and to the best of our knowledge no part of it has been reproduced from any other dissertation, monograph, report or book.

Faculty Advisor	Organizational Advisor
Designation	Designation
IIHMR	Organization
New Delhi	Address
Date	Date

Abstract

A study on the process of integration of Hospital Information System with Patient Information Management System of VistA and its challenges

By

Perlika Sharma

This project is based on the study of the process of integration of hospital information system of a chain of 8 hospitals located in the NCR region with the patient information management system module of VistA EHR. The Hospital is a leading and well respected corporate healthcare provider in India. It provides high quality healthcare services at primary, secondary and tertiary levels. HIS or Hospital Information System is an application developed by the Hospital to automate the various processes being followed in their hospitals.

The Veterans Health Information Systems and Technology Architecture (VistA) is an enterprise-wide information system built around an electronic health record, used throughout the United States Department of Veterans Affairs (VA) medical system, known as the Veterans Health Administration (VHA).It is an integrated system of software applications that directly supports patient care. By providing electronic health records capability, VistA is thereby one of the most widely used EHRs in the world. An Electronic Health Record is an evolving concept defined as a systematic collection of electronic health information about individual patients. It is a record in digital format that is capable of being shared across different healthcare settings by being embedded in network-connected enterprise wide information systems.

Patient Information Management System (PIMS) is a suite of software which is one of the modules in VistA. It allows professionals in the medical field to organize, schedule, and analyze patient information.

But in this project basically the ADT function of PIMS is being focused on. The existing Hospital Information System (HIS) in the Hospital currently contains all the modules of Admission, Billing, Lab, Radiology, Pharmacy, Materials Management etc. The Hospital

would like to implement VistA that can be integrated with the existing Hospital HIS to provide advanced clinical functionality which is limited in the current HIS.

So, Vista is being implemented in the hospital which needs to be integrated to the HIS for smooth functioning of the Hospital. There is a need to integrate these two different systems, HIS and VistA, by means of an Integration Engine. The Open source Integration Engine Mirth is used to send the messages between these two applications - HIS and VistA. Also, an HIS wrapper needs to be created to convert data from HIS into an HL7 message and vice versa. With the integration of the Hospital HIS and VistA, there is a need to maintain patient administration related data in both the systems. This data will be transferred at near real-time between the two systems in the form of HL7 messages. The integration engine is software which moves data between information systems. This process involves the transformation of data between messaging standards and requires support for multiple transmission protocols.

“Mirth’s ability to support multi-channel messaging modes, multi-protocol connectors, multiple languages for transformer scripting, and a full complement of end-point technologies make it an attractive interface engine for VistA-based solutions,”

Firstly, the trigger events in which the information has to be exchanged between the two systems are identified.Process like Patient registration, admit/Visit notification, transfer, discharge, cancel admission and cancel discharge will be performed at the Hospital HIS and this information will flow to VistA PIMS through integration using HL7 messages. After the events are identified and requirements are taken, data mapping is done in the systems. It is the comparison of the fields maintained for capturing the same data in the two diverse systems like HIS and VistA.

After the implementation of VistA and its integration with HIS the system will be working as the patient information will be easily passing from one system to the other through the integration engine – Mirth. As HIS and VistA are two diverse software, there are many problems identified in their integration process. The challenges faced during the integration process were identified through interviewing the people who were actually involved in the process. They were as – HL7 incompatibility of HIS, different data storage formats in both the systems, modifying VistA according to the Indian context and many more.

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Acronyms/Abbreviations/Key-Words

✓ ADOPTS	ACCESS, DEFINE, OPTIMIZE, PREPARE, TRANSFORM, SUSTAIN
✓ CPRS	COMPUTERIZED PATIENT RECORD SYSTEM
✓ PIMS	PATIENT INFORMATION MANAGEMENT SYSTEM
✓ EHR	ELECTRONIC HEALTH RECORDS
✓ EMR	ELECTRONIC MEDICAL RECORDS
✓ HL-7	HEALTH LEVEL-7
✓ HIS	HOSPITAL INFORMATION SYSTEM
✓ PACS	PICTURE ARCHIVAL AND COMMUNICATION SYSTEM
✓ CPOE	COMPUTERISED PATIENT ORDER ENTRY
✓ MAR	MEDICATION ADMINISTRATION RECORDS
✓ BCMA	BAR CODE MEDICATION ADMINISTRATION
✓ MUMPS	MASSACHUSETTS GENERAL HOSPITAL UTILITY MULTI-PROGRAMMING SYSTEM
✓ DBMS	DATA BASE MANAGEMENT SYSTEM
✓ VistA	VETERANS HEALTH INFORMATION SYSTEMS AND TECHNOLOGY ARCHITECTURE
✓ IE	INTEGRATION ENGINE
✓ API	APPLICATION PROGRAMMING INTERFACE
✓ SCORM	SHARABLE CONTENT OBJECT REFERANCE MODEL
✓ CSG	CLUSTER SERVICE GROUP
✓ TAT	TURN AROUND TIME

1 PART - 1

1.1 INTERNSHIP REPORT

1.1.1 ORGANIZATIONAL PROFILE

Dell Perot Systems is an information technology services provider based in Plano, Texas, USA. Peter Altabef has served as president and chief executive officer since 2004. For more than 26 years, Dell has empowered countries, communities, customers and people everywhere to use technology to realize their dreams. Customers trust it to deliver technology solutions that help them do and achieve more, whether they're at home, work, school or anywhere in their world.

On September 21, 2009, Perot Systems agreed to be acquired by Dell for $3.9 billion. The acquisition resulted in a compelling combination of two iconic information-technology brands. H. Ross Perot and eight associates founded Perot Systems in June 1988 after having sold Electronic Data System (EDS) to General Motors. Before its acquisition by Dell Inc., Perot Systems was a Fortune 1000 corporation with more than 23,000 associates and 2008 revenues of $2.8 billion. Perot Systems maintains offices in more than 25 countries around the world, including the United States, Europe, India, China and Mexico

As a top-five finisher for the third consecutive year, Perot Systems was named to the Fortune magazine "Most Admired Companies in America" list for IT Services in 2008.

The expanded Dell is better positioned for immediate and long-term growth and efficiency driven by:--

- Providing a broader range of IT services and solutions and optimizing how they're delivered
- Extending the reach of Perot Systems' capabilities, including in the most dynamic customer segments, around the world
- Supplying leading Dell computer systems to even more Perot Systems customers.

It provides a portfolio of services to help hospitals identify and take advantage of EHR through the implementation of EHR.

Healthcare delivery and administration continues to become more complex. Uncompensated care is on the rise, demographics are changing, and patients are demanding more for their healthcare dollars. All the while, there continues to be a shortage of healthcare professionals to address the ever-demanding needs of consumers and patients.

To meet these challenges, Dell Perot Systems provides the right combination of clinical and business process improvements, coupled with technology to help hospitals and health systems achieve an environment that is interconnected, streamlined, efficient, and patient-focused. Its vision for the healthcare industry is simple: It wants healthy people to successfully interact with a safe, efficient, and consumer-friendly healthcare system.

Their team of physicians, nurses, and clinicians, as well as healthcare consultants and technologists are experienced in end-to-end hospital operations and understand how to develop, design and implement processes and technologies that bring about real provider transformation. They apply their extensive experience and expertise for:

- Clinical Transformation - Healthcare providers today are facing the challenges of increasing the quality of care delivery and enhancing services while reducing costs. By implementing advanced clinical systems combined with care transformation programs, organizations are finding ways to fund new change initiatives while improving quality. Dell Perot Systems joins with the staff to improve care delivery processes and achieve measurable results.
- Information Technology Solutions — Operational performance can be improved only when information technology is planned, designed and implemented to support an efficient way of doing things. Dell Perot Systems can help improve the productivity and quality of your services, as well as enhance the usefulness of clinical, HR, patient accounting, and administrative applications.Their global technology capabilities and Solution Centers deliver concentrated expertise for Cerner, McKesson, Meditech, Lawson, and Siemens solutions to name a few. Implementing, integrating, and supporting the right infrastructure automates clinical and administrative processes and in turn enhances the quality of care delivery

- Revenue Cycle Solutions — Whether the organization is financially distressed, has limited access to capital, high volumes of low-yielding accounts, or simply wants to improve the overall performance of their revenue cycle, Dell Perot Systems has the expertise and solutions that improve all revenue cycle metrics, with the realization that increasing cash is key because it provides the financial resources that allow for improving patient care.

It delivers the best healthcare possible. Whether it is a hospital, health system, or physician practice providing care, a health plan paying for care, or an integral part of the healthcare supply chain, delivering the best healthcare possible requires to be responsive, efficient, accurate, and innovative in a constantly changing industry.

Every day around the globe, its mission is to provide the full spectrum of infrastructure, application, and business process solutions that are the best service possible. By leveraging its extensive expertise,they are able to provide the organizations with creative, integrated, and innovative solutions that best meet their tactical and strategic objectives. For 20 years, other organizations have put their trust in Dell Perot Systems to deliver solutions that improve the business of health so they can transform care.

1.1.2 Managerial Tasks

Management in all business and organizational activities is the act of getting people together to accomplish desired goals and objectives efficiently and effectively. Management comprises planning, organizing, staffing, leading or directing, and controlling an organization (a group of one or more people or entities) or effort for the purpose of accomplishing a goal. Because organizations can be viewed as systems, management can also be defined as human action, including design, to facilitate the production of useful outcomes from a system. This view opens the opportunity to 'manage' oneself, a pre-requisite to attempting to manage others.

In the organization I performed different managerial tasks as organizing the future state workshops, designing the templates for capturing patient data by the physicians, arranged the different user screens according to their comfort, updated all the configurations and managed time to complete the given task in the given time.

1.1.3 Organizational Learnings

As a trainee in Dell Services, I have learnt many valuable things which will be useful for me further in my career. According to me Dell is an ideal start for me which anybody at my stage can think of. I have attained great learning through the esteemed organization and contributed to it in my own little way to meet organization goals.

I was posted with the VistA CPRS configuration team where i have learnt the various configurations, template designing, creating reminders and attaching them to reminder dialogs and many more things which are as follows:

- CPRS VistA – Created many templates on CPRS
- Created Reminder Dialogues on roll and scroll (Cache)
- Created patient objects and health summaries
- Configured procedures on CPRS
- Configured Consults
- Created Users on CPRS
- Registered patients on roll and scroll
- Created appointments on roll and scroll
- Created Clinics on roll and scroll
- Created an institution on roll and scroll
- Created a hospital location
- Created a ward and division location
- Configured notifications
- Organized and attended future state workshops
- Configured Lab. tests
- Changed Patient's information
- Activated users
- Assigned keys to the users
- Changed provider's information like signature, access codes and verifying codes
- Changed the format of Coversheet (GUI) of CPRS
- Involved in testing of CPRS
- Created Health Factors

- Studied the process of integration of VistA PIMS with His, challenges involved in the same and recommendations.

Apart from these learning, i also got to know the work and organizational culture which is also a significant and integral part of an organization.

2 PART - 2

2.1 DESSERTATION OVERVIEW

The dissertation is based on the project of implementation of EHR in the 8 hospitals in Delhi/NCR region. This report focuses on the process of integration of the PIMS module of VistA EHR with the already existing HIS in the hospital. The overview of the dissertation report is as follows.

2.1.1 Problem Statement

The problem is to seamlessly integrate two distinctly separate systems. Both the systems vary in their data defining and data messaging formats and so it's difficult to transfer the data into other system in the real time which is important for integrating the two systems.

2.1.2 Objective

The general and specific objectives of the project are as follows:

2.1.2.1 General Objective

To study the process of Integration of HIS with PIMS module of VistA with the challenges involved in this and resolving those challenges.

2.1.2.2 Specific Objectives

The specific objectives are as following :

- Exchange of patient information between HIS and PIMS.
- Identifying the main trigger events
- Interfaces between the HIS and PIMS module of VistA.
- Purpose and the functioning of the integration engine called Mirth between the two applications, HIS and PIMS module of VistA.
- Parser and its functioning
- Challenges faced during this integration process.
- Resolving those challenges.

2.1.3 Scope of the Project

This project includes the process of integration of Hospital HIS with the PIMS module of vista for transferring patient related information and also the challenges involved in the process. This study analyzes the process with respect to integration of VistA PIMS and HIS. Overall this study helps in understanding the basic requirements of integration of VistA PIMS module with HIS and hence can help the hospital to use EHR along with HIS as one entity.

2.1.4 Need of the Project

As the HIS and VistA are two distinctly separate systems, there is a need to integrate them for the following reasons:

- To send the patient's information captured in HIS to VistA in the real time and vice-versa.
- To process and maintain the data in both the systems.

2.1.5 Benefits

Benefits of integration of the HIS and PIMS module of VistA are as follows:

- Patient's admission, discharge and transfer information will be transferred in real time from one system to the other system.
- Same information can be processed and maintained in both the systems.

2.1.6 Assumptions

Assumptions for the project are as follows:

- It is assumed that the people who participated in the interviews are well versed with the existing HIS and VistA modules and are personally involved in the integration process.
- Requirements from the client side are fixed and finalized.
- The departments have well established workflow which is adhered properly.

2.1.7 Data Sources

The data sources for the project are as follows:

- Integration Requirements and Message profile documents of the organization.
- VistA Manual

- HIS Workflow (Client Hospital)
- HL7 training document from the organization
- VistA CPRS Manual
- Requirement Document of VistA-EHR CPRS Module v1.0 (organization)

2.1.8 Work Plan

The work plan of the project includes the activity tables and the Gant charts.

The activity table for the overall project is as follows:

ACTIVITY	**TIME TAKEN**
Defining the Problem	9th AUG – 29th AUG 2010
Literature Survey	30th AUG- 12th SEP 2010
Methodology Adopted	13th SEP-19th SEP 2010
Data Collection	20th SEP-10th OCT 2010
Compilation and Analysis	11TH OCT-25TH OCT 2010
Documentation	26TH OCT-9TH NOV 2010

Table 3. Activity Table for the Project Plan

The Gant chart for the above activity table is as follows:

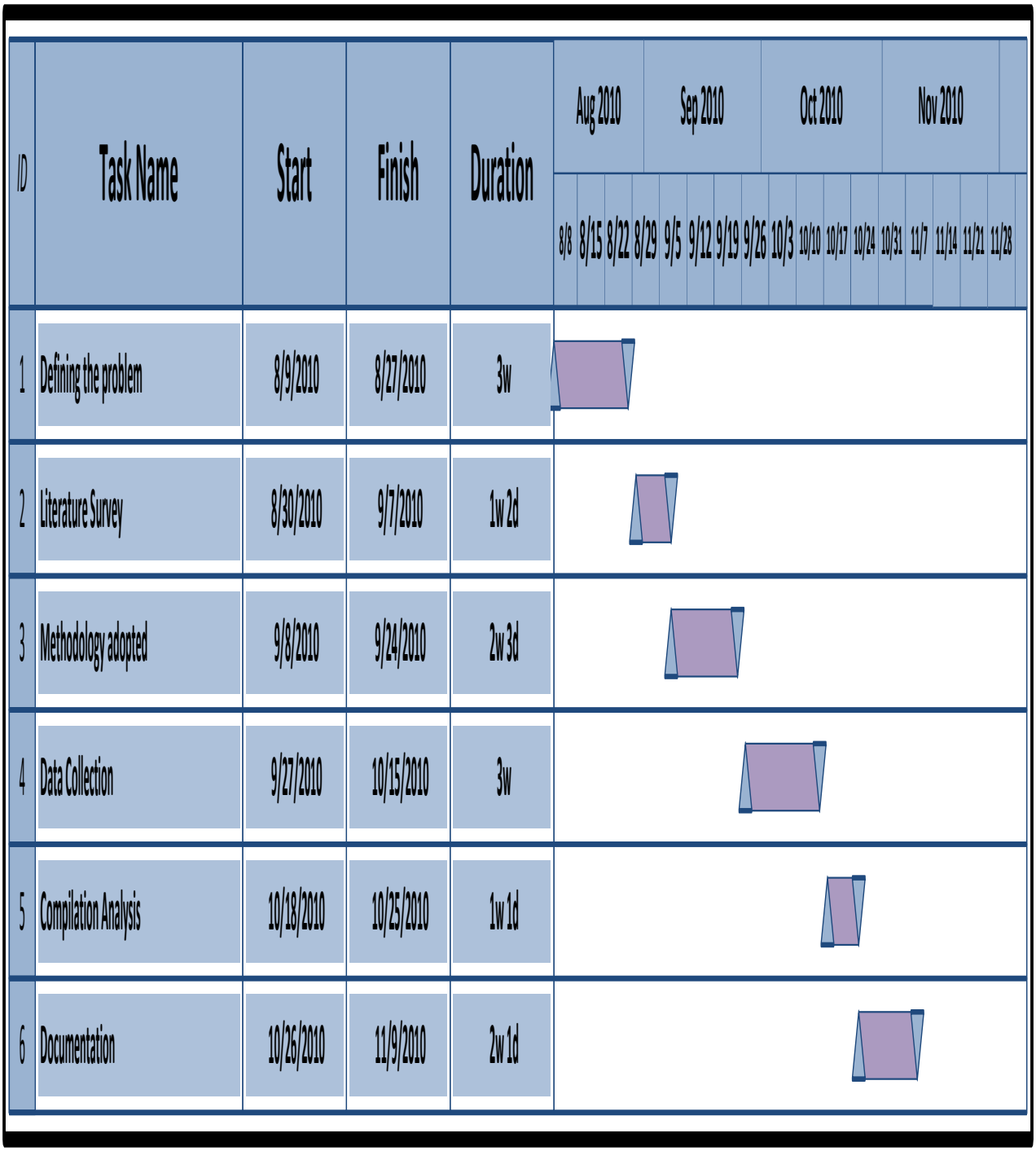


Figure 1. Gant Chart for the Project Plan

The activity table for the detail work break down plan are as follows:

ACTIVITY	TIME TAKEN
Defining the Problem • Identifying the nature of problem • Defining the objective and scope of the project • Defining the need, benefits, assumptions and limitations.	**9th AUG – 29th AUG 2010** • 9th AUG – 13th AUG 2010 • 16th AUG – 20th AUG 2010 • 23rd AUG – 27th AUG 2010
Literature Survey • Referring to internet search, white papers and journals. • Referring to books	**30th AUG- 12th SEP 2010** • 30th AUG – 3rd SEPT 2010 • 6th SEPT – 10th SEPT 2010
Methodology Adopted • Observations and Interviews	**13th SEP-19th SEP 2010** • 13th SEPT – 17th SEPT 2010
Data Collection • Primary data collection • Secondary data collection	**20th SEP-10th OCT 2010** • 20th SEPT – 1st OCT 2010 • 4th OCT – 8th OCT 2010
Compilation and Analysis	**11TH OCT-25TH OCT 2010**
Documentation	**26TH OCT-9TH NOV 2010**

Table 4. Activity Table for the Work Break Down Plan

The Gant chart for the above detailed work break down plan is as follows:

ID	Task Name	Start	Finish	Duration
1	**Defining the problem**	**8/9/2010**	**8/27/2010**	**3w**
2	Identifying the nature of Problem	8/9/2010	8/13/2010	1w
3	Defining Objective and Scope of Project	8/16/2010	8/20/2010	1w
4	Defining the need,benefits and assumptions,Limitations	8/23/2010	8/27/2010	1w
5	**Literature Survey**	**8/30/2010**	**9/10/2010**	**2w**
6	Referring to internet search,whitepapres,journals	8/30/2010	9/3/2010	1w
7	Referring to books	9/6/2010	9/10/2010	1w
8	**Methodology adopted**	**9/13/2010**	**9/17/2010**	**1w**
9	Observations,Interviews	9/13/2010	9/17/2010	1w
10	**Data Collection**	**9/20/2010**	**10/8/2010**	**3w**
11	Primary Data Collection	9/20/2010	10/1/2010	2w
12	Secondary Data Collection	10/4/2010	10/8/2010	1w
13	**Compilation Analysis**	**10/11/2010**	**10/25/2010**	**2w 1d**
14	**Documentation**	**10/26/2010**	**11/9/2010**	**2w 1d**

Figure 2. Gant Chart for the Work Break down Plan

2.1.9 Limitations

Due to confidentiality issues only part of the methodology could be adopted as questionnaires were not allowed to be used for empirical study purposes.

2.2 PROJECT OVERVIEW

In today's world, information has been considered as a strategic source of power – empowerment to make timely informed decisions. This fact cannot be overemphasized in healthcare, where an informed decision can make the difference between life and death (or disability) for a patient. Incidentally, most often we find ourselves rich in data yet poor in tools required to convert it to information. The Indian healthcare system has recently realized the potential of information and communication technologies in completely transforming care delivery at hospitals.[1]

This project is based on the study of the process of integration of Hospital information system of a chain of 8 hospitals located in the NCR region with the patient information management system module of VistA EHR. The Hospital is a leading and well respected corporate healthcare provider in India. It provides high quality healthcare services at primary, secondary and tertiary levels. HIS or Hospital Information System is an application developed by the Hospital to automate the various processes being followed in their hospitals. HIS has transformed the way hospital functions. It is a truly automated system which has transformed their business processes into a near paperless system, controlling costs, saving time and thereby aiding in quick decision making and increasing the efficiency of the total system of the organization. This is possible as all the information is available online at any point of time. The information pertaining to the patient's previous visits, surgeries, diseases, allergies, lab reports, medication, etc. are available at his fingertips for analyzing and providing proper medication. In facilitating interoperability through standards, the hospital helps its members enhance, promote professional collaboration, and raise the level of patient care. HIS is used by this hospital for data records and activities that process the data and information.[2]

2.2.1 Introduction

An Electronic Health Record is an evolving concept defined as a systematic collection of electronic health information about individual patients. It is a record in digital format that is capable of being shared across different healthcare settings by being embedded in network-connected enterprise wide information systems.

EHR may include a whole range of data in comprehensive or summary form, including demographics, medical history, medication and allergies, immunization status, laboratory test results, radiology images, and billing information.

Advantages of an Electronic Health Record

- Easy access to information
- Comprehensive and standardized documentation
- Improved quality of patient care
- Increased nursing efficiency
- Improved process communication
- Reduced medication errors
- Reduced hospital costs
- Meet various accreditation requirements
- Promote evidence based medicine
- Improved patient's experience in the hospital
- Reduced TPA denials
- Better control of Management
- Reduced pilferages
- MIS reports

Rationale: To enhance care delivery excellence by measurably improving quality of service and reducing costs through the effective alignment of people, process and technology.

The EHR currently being implemented in the Healthcare organization is VistA.

Veterans Health Information Systems and Technology Architecture (VistA)

The Veterans Health Information Systems and Technology Architecture (VistA) is an enterprise-wide information system built around an electronic health record, used throughout the United States Department of Veterans Affairs (VA) medical system, known as the Veterans Health Administration (VHA).[2]

This system is public domain software, available through the Freedom of Information Act directly from the VA website, or through a growing network of distributors. The VistA software alliance is a non-profit trade organization that both promote the widespread adoption of versions of VistA for a variety of provider environments.[3]

By 2008, the VHA was the largest single medical system in the United States, providing care to 5 million veterans, employing 180,000 medical personnel and operating 163 hospitals, over 800 clinics and 135 nursing homes. By providing electronic health records capability, VistA is thereby one of the most widely used EHRs in the world. VistA supports both ambulatory and inpatient care.[2]

It was developed using the M or MUMPS language/database. The VA currently runs a majority of VistA systems on the proprietary Intersystems Cache version of MUMPS, but an open source MUMPS (Massachusetts General Hospital Utility Multi-Programming System) database engine, called GTM for Linux and Unix computers has also been developed. GTM is an implementation of the Standard M programming system (M = MUMPS = Massachusetts General Hospital Utility Multi-Programming System).[4] VistA is written in Standard M. GTM is an implementation of M from Fidelity Information Services. In addition, the free and open source nature of GTM allows redundant and cost-effective failsafe database implementations, increasing reliability for complex installations of VistA.[5]

Features of VistA

VistA is a collection of about 100 integrated software modules.[6] Some of the modules included in VistA which enables the user with a number of advantages are:

Computerized Patient Record System (CPRS) Module

The most significant is a graphical user interface for clinicians known as the Computerized Patient Record System (CPRS), which was released in 1997. In addition,

VistA includes computerized order entry, bar code medication administration, electronic prescribing and clinical guidelines. CPRS provides a client–server interface that allows health care providers to review and update a patient's electronic medical record.[7] This includes the ability to place orders, including those for medications, special procedures, X-rays, nursing interventions, diets, and laboratory tests.[8] CPRS provides flexibility in a wide variety of settings so that a consistent, event-driven, Windows-style interface is presented to a broad spectrum of health care workers. CPRS provides electronic data entry, editing, and electronic signatures for provider-patient encounters as well as provider orders. Its computer-based provider order entry (CPOE) capability is an important enabler in the migration from paper-based charting to electronic medical records (EMRs).[9]

Laboratory Module

Laboratory module enables the user with Ordering of tests and procedures on both patient and non-patient specimens, Collection and Accessioning of specimens into the Laboratory database, Processing and analysis in appropriate department or work areas, review and verification of results, Reporting of results and/or diagnoses for clinical health care treatment, Analysis and reporting of quality control data used in generating results and Providing management statistical data as well as requirements for accreditation by regulating bodies and agencies.[3]

Radiology Module

Radiology / Nuclear Medicine package is a comprehensive software package, designed to assist with the functions related to processing patients for imaging examinations. The Radiology / Nuclear Medicine package automates the entire range of diagnostic functions performed in imaging departments, including request entries by clinical staff, registration of patients for exams, processing of exams, recording of reports/results, verification of reports on-line, displaying/printing results for clinical staff, automatic tracking of requests/exams/reports, and generation of management statistics/reports, both recurring and ad hoc. The Radiology / Nuclear Medicine package automates many tedious tasks previously performed manually, providing faster, more efficient and accurate data entry and more timely results reporting.[3]

One of the important features provided by VistA is

VistA Imaging

The Veterans Administration has also developed VistA Imaging, a coordinated system for communicating with PACS (radiology imaging) systems and for integrating others types of image-based information, such as, pathology slides, and scanned documents, into the VistA electronic medical records system. This type of integration of information into a medical record is critical to efficient utilization.[5]

Surgery Module

The Surgery package is designed to be used by Surgeons, Surgical Residents, Anesthetists, Operating Room Nurses and other surgical staff. The Surgery package is part of the patient information system that stores data on the Department of Veterans Affairs (VA) patients who have, or are about to undergo, surgical procedures. This package integrates booking, clinical, and patient data to provide a variety of administrative and clinical reports.[3]

Pharmacy Module

The Pharmacy package provides a method of management, dispensing, and administration of inpatient drugs within the hospital. Hospital Medications combines clinical and patient information that allows each medical center to enter orders for patients, dispense medications by means of Pick Lists, print labels, create Medication Administration Records (MARs), and create Management Reports. Hospital Medications also interacts with the Computerized Patient Record System (CPRS) and the Bar Code Medication Administration (BCMA) packages to provide more comprehensive patient care.

VistA EHR also includes functionality tailored to meet the specific needs of clinics and physician offices, such as:

- Ability to interface to existing practice management / billing systems, lab services and other applications
- Scanning and inclusion of scanned documents into the medical record
- Prescription finishing and faxing

- Clinical quality measure reporting capabilities
- Support for disease management, using clinical reminders
- Templates for obstetrics/gynecology (OB/GYN) and pediatrics care

Now Vista which is being implemented in the healthcare organization needs to be integrated to the following three for smooth functioning

- Home Hospital Information system (HIS)
- Picture Archival and Communication System (PACS)
- Lab analyzers

Division of work in implementation is as follows:

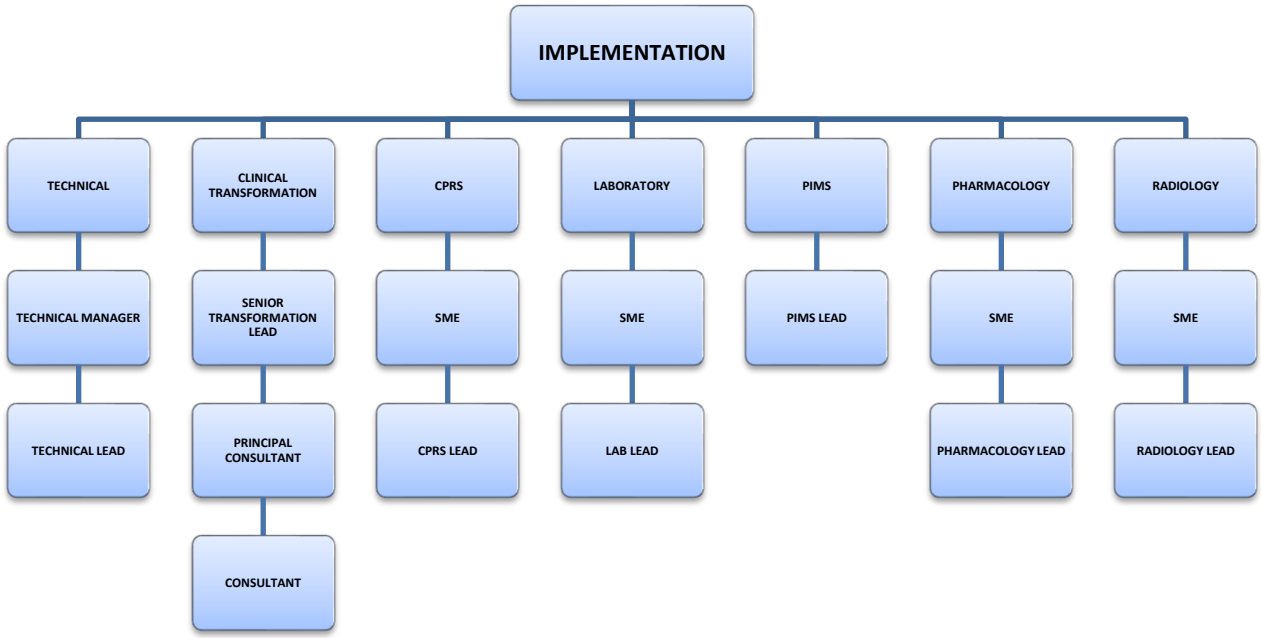


Figure 3. Division of work in implementation

Points to keep in mind before starting off with the EHR implementation:

- The hospital's EHR implementation has a better chance for success if the hospital organizes it into three categories: team, tactics and technology.
- Studies have found that a practice's employees are the key to an EHR implementation's outcome, with project managers playing a critical role.
- Everyone involved with the new EHR will need to be open-minded about changing the way the practice operates.
- If the hospital's EHR implementation team is given unrealistic goals, the project is likely to end as a perceived failure.
- When it comes to the hospital's implementation tactics, spend as much time as possible planning, which should cut down on surprises as the project proceeds.
- It's critical that the hospital maintain a consistent policy on who will handle data entry and which data they will enter.
- It's critical that the hospital maintain a consistent policy on who will handle data entry and which data they will enter.
- When the hospital is ready to "go live" with the EHR, try to avoid starting on a Monday, which is already the hospital's busiest day.
- Many practices designate in-house EHR "power users" to whom other employees can turn first for advice and support.
- Technological problems, such as poorly written software or inadequate server memory, can cripple an EHR implementation.
- Line up expert IT support and maintenance.
- The hospital's data should be backed up daily.
- With careful planning and good advice, the hospital's EHR project will succeed

The objective of the implementation of VistA EHR in the Healthcare organization is to ensure smooth and uninterrupted running of the same as this will enable the hospital to have a whole range of data in comprehensive form including patient demographics, medical history, medication and allergies, immunization status, laboratory test results, radiology images and billing information.[3] This objective is set to be attained by the means of clinical transformation "a comprehensive ongoing approach to care delivery

excellence that measurably improves quality, enhances service, and reduces costs through the effective alignment of people, process and technology. The clinical transformation triad is depicted as:

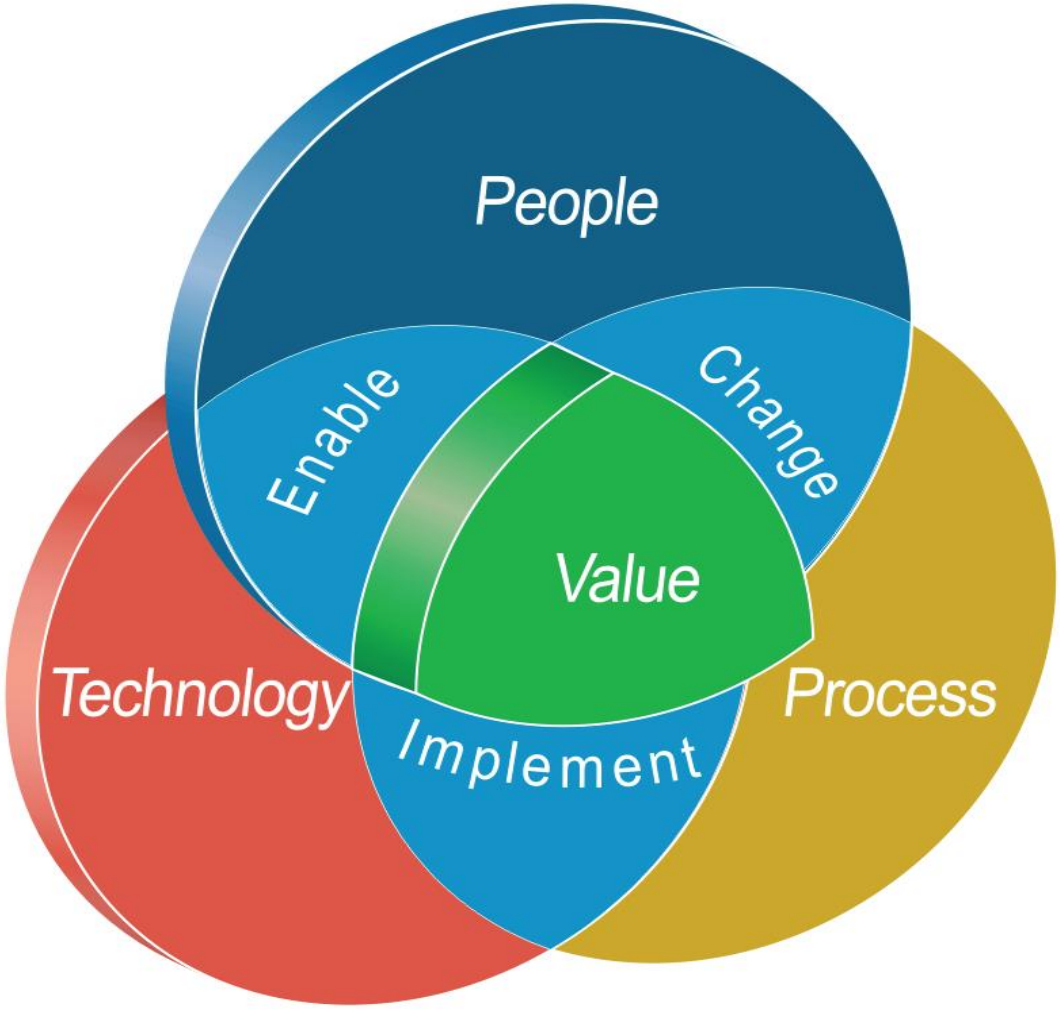


Figure 4. Clinical Transformation Triad

The measurable benefits of this transformation for the client, the clinicians, and the patients include:

- Increased safety through reduction of adverse medical events
- Increased quality through implementation of clinical best practices
- Decreased costs through identification of opportunities for improved operational efficiency
- Improved clinical adoption by effectively engaging clinicians

- Well defined metrics for success
- Improved clinical decision making, leading to accelerated process improvements throughout the organization

The goal is to attain the above sated benefits by means of clinical transformation.

Dell is not only working with customers to successfully implement technology in their care environments, but is also striving to incorporate clinician adoption and benefits realization into these initiatives to ensure measurable success. For example, the early benefits of adding this performance improvement and tracking capability is the ability for nurses to perform 100 percent chart audits on admission and shift assessments. This capability and focus allows for improved care planning, reduced potential for omission of critical assessment information about the patient, and dramatically improved compliance.

Clinician adoption rates:

The rate has been very high for hospitals in which Dell Services has been involved in the implementation process. As an example, we were involved in two of our largest health system customers' clinical adoption processes, and the results ranged from 75 to 85 percent, among the highest in the country. This is in comparison to the single digit adoption rates we have seen at sites where we have not been involved.[16]

Our perspective has developed as a result of that experience, which has seen a shift in the historical focus on the technical aspects of deployment to the current emphasis on adoption and value. In our view, healthcare transformation requires a fundamental and interconnected change in the structure and function of healthcare systems that will transform the characteristics of healthcare, resulting in optimized health and quality of life for all patient populations and added value for all stakeholders.[16]

A Continuous Measurable Process:

We look at healthcare transformation as a continuous process that provides real measurable value, but poses significant challenges. First, transformation requires a substantial investment of time, talent, and financial resources to be successful. Clinical systems and the needed hardware and infrastructure are expensive and require expertise

for successful deployment and for the ongoing maintenance and updates that are necessary for continued benefits.[16]

Second, a successful transformation effort needs to have precisely aligned critical success factors. The strategic drivers for the business and the stakeholders need to be well understood and the drivers for sustainability of the continuous process of improvement required for transformation need to be articulated. Success requires an unwavering focus on the structures and functions to be transformed with a clearly defined methodology, roadmap, and accountability for making the change happen. It is imperative that success is described in terms of value measures that are defined and validated.[16]

Third, the continuous process of transformation is challenging to execute: the healthcare environment is dynamic, with changing regulatory requirements, practice variations, and reimbursement standards at the same time that there are entrenched practices and practitioners within organizations that are reluctant to change.[16]

Patient Information Management System (PIMS) is a suite of software which is one of the modules in VistA. It allows professionals in the medical field to organize, schedule, and analyze patient information.[6]

Patient Information Management System (PIMS) is a suite consisting of four main components:

- The Admission/Discharge/Transfer (ADT) application includes:
    - Basic bed control functions (admissions, transfers, discharges)
    - Day Surgeries
    - Inpatient listings and reports
    - Census calculation and reporting
    - Incomplete chart tracking, and
    - Scheduled visits (admissions, day surgeries, outpatient visits from outside the area).
- The Clinic Scheduling application provides:
    - Outpatient appointment management;

- Tracking patients on waiting lists
- File Room activities - pulling paper charts for appointments, walk-ins and chart requests;
- Various reports on clinic capacity and workload.

- The Sensitive Patient Tracking (SPT) module allows a facility to track access to patient records, either those designated as sensitive or all records. Accessing sensitive records warn users that they are accessing a restricted record. Non-sensitive records can be tracked with no warning to computer users. The software tracks which menu option the user was executing when he/she selected a patient along with date and time.
- The Patient Record Flag module , is used to alert medical staff and employees of patients whose behavior and characteristics may pose a threat either to their safety, the safety of other patients, or compromise the delivery of quality health care. These flag assignments are displayed during the patient look-up process.

But in this project basically the ADT function of PIMS is being focused on.

There is a need to integrate these two different systems, HIS and VistA, by means of an Integration Engine. The Open source Integration Engine Mirth is used to send the messages between these two applications - HIS and VistA. Also, an HIS wrapper needs to be created to convert data from HIS into an HL7 message and vice versa.

With the integration of the Hospital HIS and VistA, there is a need to maintain patient administration related data in both the systems. This data will be transferred at near real-time between the two systems in the form of HL7 messages.

The middleware platform which is being used for the integration of VistA with the existing HIS is Mirth. An integration engine is software which moves data between information systems. This process involves the transformation of data between messaging standards and requires support for multiple transmission protocols.

Mirth is an open source Java-based integration engine sponsored and primarily developed by WebReach, Inc. Mirth was designed based on the client-server style and the enterprise service bus architecture.

Mirth delivers the industry's first free, open source Health Level 7 (HL7) messaging middleware. The standards-based Mirth software is designed to dramatically reduce the time and cost required to achieve health information system interoperability and data exchange, and to speed secure information sharing across communities of healthcare professionals.

"Mirth's ability to support multi-channel messaging modes, multi-protocol connectors, multiple languages for transformer scripting, and a full complement of end-point technologies make it an attractive interface engine for VistA-based solutions,"

2.2.2 Background

The Hospital has continuously invested in Information Systems, from the Hospital Information System (HIS) to Accounting and Financial System, Picture Archiving and Communication System (PACS), Quality Information System, Telemedicine and Business Intelligence. A crucial piece of information that is still missing within the broad picture of healthcare automation relates to the Electronic Patient Health Record, which would contribute, in a large measure to the attainment of medical excellence. The Hospital's experience has revealed quite a few insights to the reasons for adopting health informatics, expected end results and the hurdles on the way to achieving them.[12]

The Hospital group utilizes a Hospital Information System for the enterprise wide transaction handling and resource planning. A centralized database with an application running on server-client architecture promotes the aggregation of data from multiple hospitals and gives a unified view.[13] Patient encounters are recorded on the information system with a trail of the services utilized, their consequent material consumption and billing. Flat reports are generated for a multitude of users both for operational tracking as well as for analysis, optimization and strategizing further growth plans for the hospitals. Business intelligence is beginning to play a larger role in the visibility of information and in its ability to drive objective and informed decisions, the ultimate aim of which is to deliver performance.[11] DICOM compatible diagnostic images acquired from CT, MRI, X-Ray, Ultrasound, Gamma Camera, Echo-cardiology, C-Arm etc. are archived and accessed from the PACS. Images can be viewed on Desktops using PACS Interface Software.

Accounting and Financial System handles the ledger entries for the transactions recorded in the HIS as well as other expenditure incurred by the organisation in setting up and running new facilities and services. Management Information System is an endeavor to measure and monitor the quality initiatives undertaken by the organization. A diverse set of parameters are recorded and measured under its ambit, to provide objectivity and transparency to the process of quality improvement.[10]

The existing Hospital Information System (HIS) in the Hospital currently contains all the modules of Admission, Billing, Lab, Radiology, Pharmacy, Materials Management etc. The Hospital would like to implement VistA that can be integrated with the existing

Hospital HIS to provide advanced clinical functionality which is limited in the current HIS.[12]

So, Vista is being implemented in the hospital which needs to be integrated to the HIS for smooth functioning of the Hospital.

2.2.3 Literature Survey

2.2.3.1 Costs and benefits of health information technology

(By Shekelle PG, Morton SC, Keeler EB.)

Objectives : An evidence report was prepared to assess the evidence base regarding benefits and costs of health information technology (HIT) systems, that is, the value of discrete HIT functions and systems in various healthcare settings, particularly those providing pediatric care.

Data Sources : PubMed, the Cochrane Controlled Clinical Trials Register, and the Cochrane Database of Reviews of Effectiveness (DARE) were electronically searched for articles published since 1995. Several reports prepared by private industry were also reviewed.

Review Methods : Of 855 studies screened, 256 were included in the final analyses. These included systematic reviews, meta-analyses, studies that tested a hypothesis, and predictive analyses. Each article was reviewed independently by two reviewers; disagreement was resolved by consensus.

Results : Of the 256 studies, 156 concerned decision support, 84 assessed the electronic medical record, and 30 were about computerized physician order entry (categories are not mutually exclusive). One hundred twenty four of the studies assessed the effect of the HIT system in the outpatient or ambulatory setting; 82 assessed its use in the hospital or inpatient setting. Ninety-seven studies used a randomized design. There were 11 other controlled clinical trials, 33 studies using a pre-post design, and 20 studies using a time series. Another 17 were case studies with a concurrent control. Of the 211 hypothesis-testing studies, 82 contained at least some cost data. We identified no study or collection of studies, outside of those from a handful of HIT leaders, that would allow a reader to make a determination about the generalizable knowledge of the study's reported benefit. Beside these studies from HIT leaders, no other research assessed HIT systems that had comprehensive functionality and included data on costs, relevant information on organizational context and process change, and data on implementation. A small body of literature supports a role for HIT in improving the quality of pediatric care. Insufficient data were available on the costs or cost-effectiveness of implementing such systems. The ability of Electronic Health Records (EHRs) to improve the quality of care in ambulatory

care settings was demonstrated in a small series of studies conducted at four sites (three U.S. medical centers and one in the Netherlands). The studies demonstrated improvements in provider performance when clinical information management and decision support tools were made available within an EHR system, particularly when the EHRs had the capacity to store data with high fidelity, to make those data readily accessible, and to help translate them into context-specific information that can empower providers in their work. Despite the heterogeneity in the analytic methods used, all cost-benefit analyses predicted substantial savings from EHR (and health care information exchange and interoperability) implementation: The quantifiable benefits are projected to outweigh the investment costs. However, the predicted time needed to break even varied from three to as many as 13 years.

Conclusions : HIT has the potential to enable a dramatic transformation in the delivery of health care, making it safer, more effective, and more efficient. Some organizations have already realized major gains through the implementation of multifunctional, interoperable HIT systems built around an EHR. However, widespread implementation of HIT has been limited by a lack of generalizable knowledge about what types of HIT and implementation methods will improve care and manage costs for specific health organizations. The reporting of HIT development and implementation requires fuller descriptions of both the intervention and the organizational/economic environment in which it is implemented.

2.2.3.2 Open source challenges for hospital information system (HIS) in developing countries: a pilot project in Mali

(Cheick-Oumar Bagayoko, Jean-Charles Dufour, Saad Chaacho, Omar Bouhaddou, and Marius Fieschi,DER Santé Publique, Faculté de Médecine, Pharmacie et d'Odonto-Stomatologie, Bamako, Mali,Laboratoire d'Enseignement et de Recherche sur le Traitement de l'Information Médicale, Faculté de Médecine, Université de la Méditerranée 27, boulevard Jean Moulin 13385 Marseille Cedex 5)

Background : We are currently witnessing a significant increase in use of Open Source tools in the field of health. Our study aims to research the potential of these software packages for developing countries. Our experiment was conducted at the Centre Hospitalier Mere Enfant in Mali.

Methods : After reviewing several Open Source tools in the field of hospital information systems, Mediboard software was chosen for our study. To ensure the completeness of Mediboard in relation to the functionality required for a hospital information system, its features were compared to those of a well-defined comprehensive record management tool set up at the University Hospital "La Timone" of Marseilles in France. It was then installed on two Linux servers: a first server for testing and validation of different modules, and a second one for the deployed full implementation. After several months of use, we have evaluated the usability aspects of the system including feedback from end-users through a questionnaire.

Results : Initial results showed the potential of Open Source in the field of health IT for developing countries like Mali.

Five main modules have been fully implemented: patient administrative and medical records management of hospital activities, tracking of practitioners' activities, infrastructure management and the billing system. This last component of the system has been fully developed by the local Mali team.

The evaluation showed that the system is broadly accepted by all the users who participated in the study. 77% of the participants found the system useful; 85% found it easy; 100% of them believe the system increases the reliability of data. The same proportion encourages the continuation of the experiment and its expansion throughout the hospital.

Conclusions : In light of the results, we can conclude that the objective of our study was reached. However, it is important to take into account the recommendations and the challenges discussed here to avoid several potential pitfalls specific to the context of Africa.

Our future work will target the full integration of the billing module in Mediboard and an expanded implementation throughout the hospital.

2.2.3.3 Implementing an integrated computerized patient record system: Towards an evidence-based information system implementation practice in healthcare.

(Bahlol Rahimi, MSc,Anna Moberg, PhD, Toomas Timpka, MD, PhD,and Vivian Vimarlund, PhD,Department of Computer and Information Sciences, Linköping University, Linköping, Sweden;Östergötland County Council, Linköping, Sweden)

A large number of health information system (HIS) implementations fail due to insufficient organizational harmonization. The aim of this study is to examine whether these problems remain when implementing technically integrated and more advanced generations of HIS. In a case study, data from observations, interviews, and organizational documents were analyzed using qualitative methods. We found that critical issues in the case study implementation process were the techniques employed to teach the staff to use the integrated system, involvement of the users in the implementation process, and the efficiency of the human computer interface. Comparisons with a literature review showed both recurrence of previously reported implementation problems and new issues specific to the integrated system context. The results indicate that the development of evidence-based implementation processes should be considered.

2.2.3.4 A Computerized Hospital Patient Information Management System

By Eldon D. Wig

The information processing needs of a hospital are many, with varying degrees of complexity. The prime concern in providing an integrated hospital information management system lies in the ability to process the data relating to the single entity for which every hospital functions - the patient. This paper examines the computer system developed to accommodate hospital needs with respect to a central patient registry, inpatients (i.e., Admission/Transfer/Discharge), and out-patients. Finally, the potential for expansion to permit the incorporation of more hospital functions is examined. During the last decade, the computer industry has moved from the one-time development of massive software systems consisting of numerous subparts to the development of numerous subparts followed by a successive integration over time to ultimately create a massive software system. Thus, with respect to hospital software systems, the question to be addressed is which subpart(s) should be implemented first? In other words, what is the starting point?

Within a hospital are a myriad of departments each of which performs highly specialized functions. Regardless of department, the common denominator is the patient. It follows, therefore, that the starting point when considering the development of a hospital information software system must have something to do with the patient. Every department within a hospital requires some or all of the patient's demographic information (e.g., name, sex, date of birth) . The existence of such a facility is commonly termed a central registry. The work performed by any department in a hospital is created by the people being treated as either inpatients or outpatients. Thus, the existence of inpatient and outpatient functions is vital also. Thus, three major components are needed to form an initial software system for a hospital: central registry, inpatients, and outpatients. It is important that the system be designed in such a way as to permit the integration with software for other departments.

2.2.3.5 What Is the Patient Information Management System...?

By Kyra Bartolomei, eHow Contributor updated: April 28, 2010

According to a 2010 update by the Healthcare Information and Management Systems Society, the health care field is extremely welcoming of the technological advances that are taking place to increase the efficiency of maintaining patients' medical charts. These changes have caused many providers to rely on patient information management systems to store important health data.

Definition : According to the November 2006 publication by Image Computing Systems Laboratory, patient information management systems are electronic databases that store patient files in a centralized location. There is no limit to the amount of pages, or files, that can be uploaded into patient information management systems.

Features : The November 2006 publication by Image Computing Systems Laboratory states that patient information management systems can contain any type of information about a patient, from his general demographics to the kinds of medication he is on.

Format : Patient information management systems are formatted to read like a regular medical chart. Users can click on files that they want to open, and the document will appear on the screen. Files can be emailed, faxed or printed upon request.

Users : Not everybody can access a patient information management system, because medical files are highly confidential documents that are protected by the HIPAA regulation. According to the U.S. Department of Health and Human Services, patient information management systems are highly restricted areas, so users are assigned (usually doctors, nurses or medical assistants) and given special permission to access information when appropriate.

Significance : Patient information management systems have helped doctors' offices become more efficient. Instead of writing everything down by hand, medical staff can input information directly into a system that will do all the storing and filing for them. Also, patient information management systems make patient data easily accessible

Technological advances have moved the paper files and checklists of yesterday's doctor's office to computers. Medical providers are relying increasingly on the computer-based patient information management system to organize the health care of the people they treat. A patient information management system is an electronic database. Authorized users can add, delete or change any of the information in a patient's computer file when medically appropriate, or simply refer to it as needed. Some systems allow patients to access the database in order to add important information or review their treatment history.

General Patient Information : The most basic feature of such systems is the general patient information database, which contains details such as the patient's address, insurance information, family health history, and lists of medications and lab tests that have been prescribed. Data can be reviewed by attending physicians and sent electronically to other doctors brought in on the case.

Patient Scheduling : Such systems can track a patient's appointments with his doctor, as well as with specialists to whom the patient is referred. Appointment reminders can be automatically mailed out to the patient, and the schedule can be uploaded to the doctor's calendar.

Billing Systems : Billing and insurance verification can be built into patient information systems. Some software companies offer packages that also include collection management and programs for electronic claims submissions, remittances and online tracking of claim status.

Significance : Besides being convenient, patient information systems are important to a health care provider's ability to provide quality services to her patients. A central database of easily accessible information allows a physician to quickly get up to speed on a patient's history, and also reduces errors traceable to handwriting, such as incorrectly filled prescriptions.

2.2.4 Data Collection

2.2.4.1 Methodology Adopted

The study involves the analysis of the primary as well as secondary data. Study also involves examining the current HIS registration module and the PIMS module of VistA. For this study all the features of the VistA and HIS registration, admission, transfer and discharge are studied carefully, mapped with the requirements of the client and process of the integration of both the systems is identified. Apart from that the challenges in the process of integration are also identified.

2.2.4.2 Type of Data

The data was collected by the following methods:

- Primary data collection - In primary data collection, the data is collected using methods such as interviews, observation, etc. The primary data, which is generated by the above methods is qualitative in nature.

  Interviewing is a technique that is primarily used to gain an understanding of the underlying reasons and challenges for people. Interviews are undertaken on a personal one-to-one basis and in a group. The advantages of interviewing are :

  - Serious approach by respondent resulting in accurate information.
  - Good response rate.
  - Completed and immediate information.
  - Possible in-depth questions.

  Types of interview conducted were structured, semi-structured and unstructured.

- Secondary data collection- Secondary data is data that has already been collected by someone else for a different purpose. The various documents are used for various information which are taken from the organization.

2.2.4.3 Data collection tools

The different data collection tools are as follows:

- Review of the requirement document for integration of HIS and VistA given by the organization.

- Observation of the data mapping process.
- Review of VistA CPRS Manual.
- Observation of the features VistA CPRS module.
- Interviews with the Integration team of the organization.

2.2.4.4 Primary data collection

Primary data was collected through:

- Interview with the integration team of the organization.
- Observation and review of the features of HIS (Hospital information System) registration and PIMS module of VistA.
- Direct Observation of the processes of data mapping and configuration

2.2.4.5 Secondary data collection

Secondary data was collected through:

- Review of HIS Manual.
- Review of current workflows of OPD and IPD departments.
- VistA CPRS user Manual
- Integration Requirements and Message profile documents of the organization.
- HL7 training document from the organization
- Requirement Document of VistA-EHR CPRS Module v1.0 (organization)
- Other books, papers, websites and articles.

2.2.4.6 Study design

The study design is as follows:

- Identifying the main trigger events and their requirements
- Purpose and the functioning of the integration engine – Mirth
- Data mapping in HIS and VistA
- HL7 messaging formats
- Process of parsing

2.2.5 Observations and Discussion

The Open source Integration Engine Mirth is used to send the messages between these two applications - HIS and VistA. Also, an HIS wrapper needs to be created to convert data from HIS into an HL7 message and vice versa.

With the integration of the Hospital HIS and VistA, there is a need to maintain patient administration related data in both the systems. This data will be transferred at near real-time between the two systems in the form of HL7 messages.

The functional overview of HIS and VistA integration is as follows :

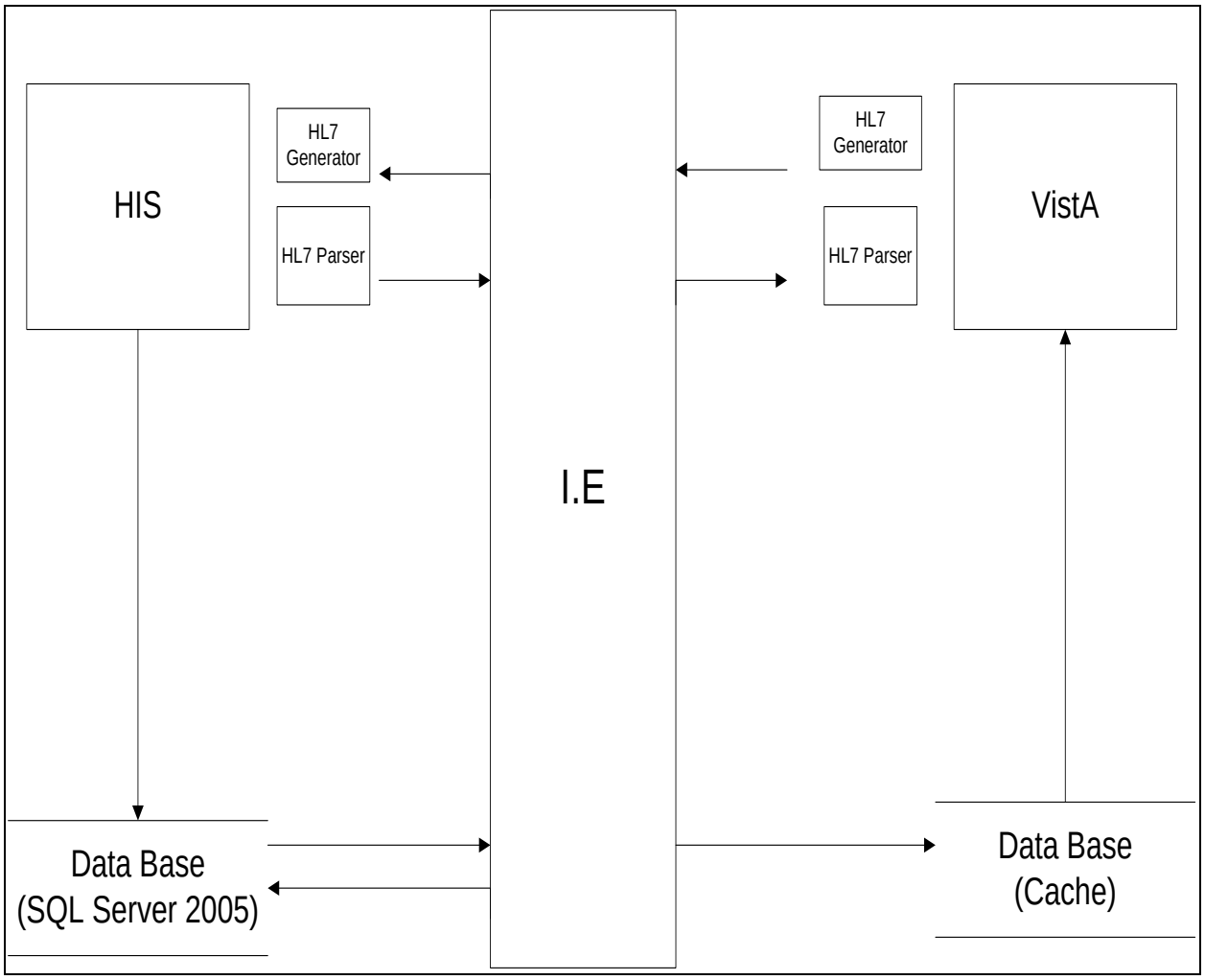


Figure 5. Functional Overview of HIS and VistA integration

The major aspects involved in the process of integration of PIMS module of VistA and HIS are as following :

2.2.5.1 Identifying the main trigger events and their requirements

Firstly, the trigger events in which the information has to be exchanged between the two systems are identified.Process like Patient registration, admit/Visit notification, transfer, discharge, cancel admission and cancel discharge will be performed at the Hospital HIS and this information will flow to VistA PIMS through integration using HL7 messages. Admit/Visit notification, discharge and transfer may be initiated by the physician as a CPRS order. However, the execution of the order will be performed in HIS and integrated with VistA.

For identifying the main trigger events and their requirements, the process work flows of the following departments were studied :

- OPD Process flow
- Discharge Process flow in the IPD
- Inter-Ward Transfer Process flow

All the above mentioned process flows are attached in the Annexure.

The following diagram shows the areas where there is a need for integration which basically includes Registration, ADT i.e Admission, Discharge and transfer.

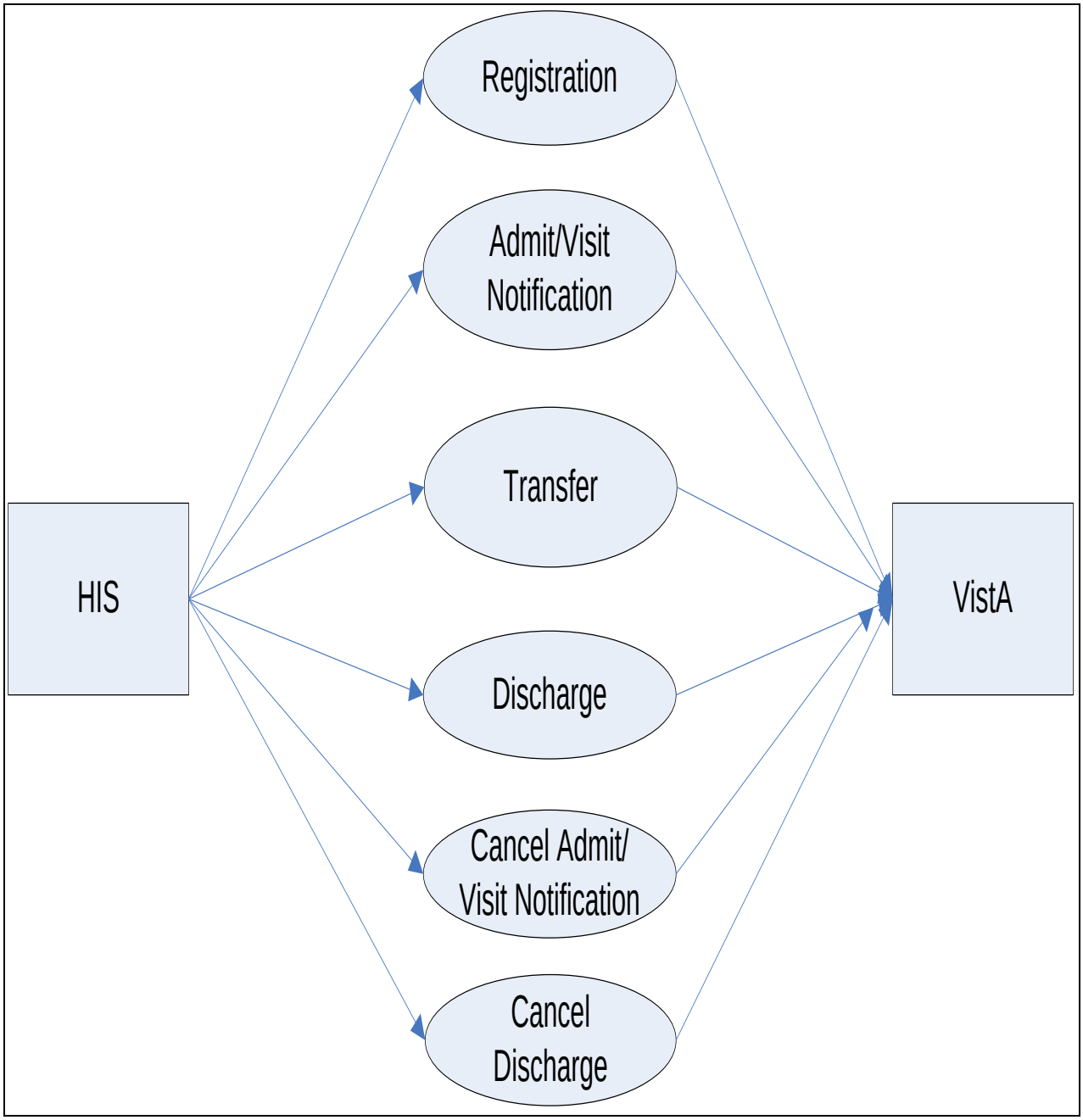


Figure 6. Areas for integration between HIS and VistA (PIMS)

Registration

Patient registration transaction signals that the patient has arrived or checked-in as a one-time, or recurring patient and is not assigned a bed. It conveys patient demographics and visit information that was captured at the time of encounter. This transaction is used for

both inpatients and outpatients. Patient registration should be captured and reflected in both HIS and VistA.

Exchange of information during Registration

HIS will capture patient registration information and will send it to Integration Engine (IE) i.e Mirth. Then the integration engine will receive patient registration message and send acknowledgement message to HIS. It will also send patient registration message to VistA and receive acknowledgement message from VistA.

Following are the scenarios where patient registration takes place in HIS:

- Patient registered from "OPD Registration Desk" screen of HIS Front Office module. Message generated when clicked on "Save".
- Patient registered from "Triage Nursing Station" (Emergency screen) of HIS Emergency module. Message generated when clicked on "Save".
- Patient registered from "IPD Registration Desk" screen of HIS ADT module. Message generated when clicked on "Save".
- Patient registered from "IPD Registration Desk-Pre ADT" screen from HIS Pre-ADT module. Message generated when clicked on "Save and Admit".
- Patient registered as dependent from "IPD Registration Desk" screen of HIS ADT module. Message generated when clicked on "Save".
- Alternate trigger points applicable when the patient has been registered in HIS but not in VistA.

Patient Admission / Visit Notification

A patient admission or visit notification is sent as a result of a patient undergoing the admission process which assigns the patient to a bed. It signals the beginning of a patient's stay in a healthcare facility. Patient admission should be captured in HIS and must reflect in both HIS and VistA. It can be of the following types :

- Emergency admission of a patient should be captured and reflected in both HIS and VistA
- Pre-admission of a patient should be reflected in both HIS and VistA

- New admission of a patient should be captured and reflected in both HIS and VistA

Exchange of information during Admission/ Visit Notification

The HIS will capture patient admission information and will send it to IE. Then IE will receive patient admission message and send acknowledgement message to HIS. It will send patient admission message to VistA and will receive acknowledgment message from VistA. VistA will receive patient admission message from IE and send an acknowledgement message to IE. It will updates the patient information in VistA PIMS.

Following are the scenarios where patient admission takes place in HIS:

- Patient admitted from "Admit" screen of HIS ADT module. Message generated when clicked on "Save".
- Patient admitted from "Admit" screen of HIS Pre-ADT module. Message generated when clicked on "Save".
- Patient admitted from "Admit" screen of HIS Emergency module. Message generated when clicked on "Save".
- Alternate trigger points applicable when the patient is available in HIS but not in VistA which are :
    - In case a patient is not in VistA, and is being admitted from "ADT Module", "Emergency Module" or "Pre ADT Module" of HIS, an admission message has to be sent to VistA.
    - In case a patient is not in VistA, and some patient information is updated in HIS from "ADT Module" of HIS, an admission message has to be sent to VistA and then rest of the messages will follow.
    - In case a patient is not in VistA, and admission of the patient is cancelled from "ADT Module" or "Emergency Module" of HIS, an admission message has to be sent first and then the rest of the messages will follow.
    - In case a patient is not in VistA, and is being discharged from "IP Module", "Emergency Module" or "Pre ADT Module" of HIS, an admission message has to be sent first and then the discharge message will follow.

- In case a patient is not in VistA, and discharge of the patient is cancelled from "IP Module", "Emergency Module" or "Pre ADT Module", an admission message has to be sent first and then the rest of the messages will follow.
- In case a patient is not in VistA, and a patient transfer/inter org transfer is done from "ADT Module of HIS, an admission message has to be sent first and then the rest of the messages will follow.
- In case a patient is not in VistA, and is being admitted from "Emergency Module" or some patient information is updated from "Emergency Module" of HIS, an admission message has to be sent to VistA.

Cancel Admit / Visit Notification

For admitted patients, the cancel event is sent when an admit/visit notification event is cancelled, either because of an erroneous entry of the admission event, or because of a decision not to admit the patient after all. Cancellation of admission in IP and Emergency should be reflected in both HIS and VistA.

Exchange of information during cancellation of admission or visit notification

The HIS will capture patient admission cancellation information and send it to IE. The IE will receive patient admission cancellation message and send acknowledgement message to HIS. It will then send the admission cancellation message to VistA and receive acknowledgment message from VistA. VistA will receive patient admission cancellation message from IE and send an acknowledgement message to IE and will update the patient information in VistA PIMS.

Following are the scenarios where patient admission cancellation takes place in HIS:

- Alternate trigger points applicable when the patient has been admitted in HIS but not in VistA.

Transfer

A patient transfer event is issued as a result of the patient changing his or her assigned physical location. Transfer can be within the same ward, can be in different ward of the same organization or can be inter-organizational. Patient transfer information must be captured in HIS and must reflect in both HIS and VistA. Transfer completion message should be sent to VistA.

Exchange of information during Transfer

The HIS will capture patient transfer information and send it to IE. The IE will receive patient transfer message and send acknowledgement message to HIS. It will also send the patient transfer message to VistA and receive acknowledgment message from VistA. VistA will receive patient transfer message from IE and update the new location for the patient in VistA PIMS.

Following are the scenarios where patient transfer takes place in HIS:

- Patient transferred from “Transfer” screen of HIS ADT module. Message generated when clicked on “Save”.
- Patient transferred from “Inter Hospital Transfer” screen of HIS ADT module. Message generated when clicked on “Save”.

Discharge

A discharge event signals the end of a patient's stay in a healthcare facility. It signals that the patient's status has changed to "discharged" and that a discharge date has been recorded. Patient discharge information must be captured in HIS and must reflect in both HIS and VistA. IP/Emergency Discharge from billing for a patient should be reflected in both HIS and VistA

Exchange of information during Discharge

HIS will capture patient discharge information and send it to IE. The IE will receive patient discharge message and send acknowledgement message to HIS. It will then send the patient discharge message to VistA and receive acknowledgment message from VistA. VistA will receive patient discharge message from IE and send acknowledgement message to IE and update the patient information in VistA PIMS.

Following are the scenarios where patient discharge takes place in HIS:

- Patient discharged from “Make Bill” screen of HIS IP Billing module. Message generated when clicked on “Discharge”.
- Patient discharged from “Make Bill” screen of HIS Pre-ADT module. Message generated when clicked on “Discharge”.
- Patient discharged from “Make Bill” screen of HIS Emergency module. Message generated when clicked on “Discharge”.

Cancel Discharge

The cancel discharge event is sent when an discharge/end visit event is cancelled, either because of erroneous entry of the discharge event or because of a decision not to discharge or end the visit of the patient after all. IP/ER discharge cancellation from billing should be reflected in both HIS and VistA.

Exchange of information during cancellation of discharge

The HIS will capture discharge cancellation information and send it to IE. The IE will receive discharge cancellation message and send acknowledgement message to HIS. It will also send the discharge cancellation message to VistA and receive acknowledgment message from VistA. VistA will receive discharge cancellation message from IE and send an acknowledgement message to IE and will update the patient information in VistA PIMS.

Following are the scenarios where discharge cancellation takes place in HIS:

- Alternate trigger points applicable when the patient has been admitted in HIS but not in VistA.

Acknowldegement from VistA

Every time an application (HIS/IE/VistA) accepts a message and consumes the data, it is expected to send an acknowledgment message back to the sending application.

VistA will perform the following checks in the HL7 message before sending the accept acknowledgement :

- MSH (message header in HL7 message) should be present.

- Following fields should be present in MSH segment:
    - MSH.1
    - MSH.2
    - MSH.9

Error Handling

Errors will be handled within all components of the architecture. These include the HIS, IE and VistA. In the event of any failure, the system will handle with pre-configured and/or identified actions. An email notification along with the details of the message will be sent to configured support group. For example, in the event of an error occurring in HIS, while generating the message, it will be entered in the error log and email will be sent to the user to look into the matter manually.

Error Handling will happen in case of any errors at the following:

- HIS
- IE
- VistA

Notification will be sent for each error. Enhanced mode of acknowledgement will not be used.

2.2.5.2 Purpose and the functioning of the integration engine – Mirth

An integration engine is software which moves data between information systems. This process involves the transformation of data between messaging standards and requires support for multiple transmission protocols.

Mirth Exchange is an initiative aimed at transforming healthcare delivery, quality, and safety by making high-value, standards-based interoperability solutions available to all stakeholders across the healthcare community on an open source basis.

Mirth Exchange is the industry's first repository of health information exchange interfaces and associated assets — documentation, sample messages, specifications, test

harnesses, forums, issue tracking, and utilities — made available on a free and open source basis for community-driven development, testing, sharing, and refinement.

Mirth Exchange will fast-track healthcare interoperability by making common interfaces available for sharing and re-use, reducing time and cost barriers to interoperability. For example, an HIE can make available interfaces that they've invested in available to other HIEs and vice-versa. This will speed interoperability for all HIEs and, of course, other healthcare organizations. Hospitals, health systems, clinics and laboratories can do likewise.

Coupled with Mirth Connect, the leading open source interface engine, Mirth Exchange provides a platform for implementing and disseminating standards-based open source interoperability solutions. These solutions will help simplify the integration of legacy HIT systems, Meaningful Use platforms, and Health IT systems joining the NHIN.

"Mirth's ability to support multi-channel messaging modes, multi-protocol connectors, multiple languages for transformer scripting, and a full complement of end-point technologies make it an attractive interface engine for VistA-based solutions,"

This is an engine, which integrates the end applications by receiving and labelling the messages from the communication end-points. Communication end-points are the components, which handle communication between both source and destination end-point applications and Integration Hub. They are responsible for initiating/receiving the communication request with the end-point applications. It also translates and routes these messages to the required destination end-point application with assured delivery. Routing is the process of moving message(s) from source to destination EPA, which qualifies the pre-defined rules.

2.2.5.3 Data mapping in HIS and VistA

After the events are identified and requirements are taken, data mapping is done in the systems. It is the comparison of the fields maintained for capturing the same data in the two diverse systems like HIS and VistA. **Data mapping** is the process of creating data

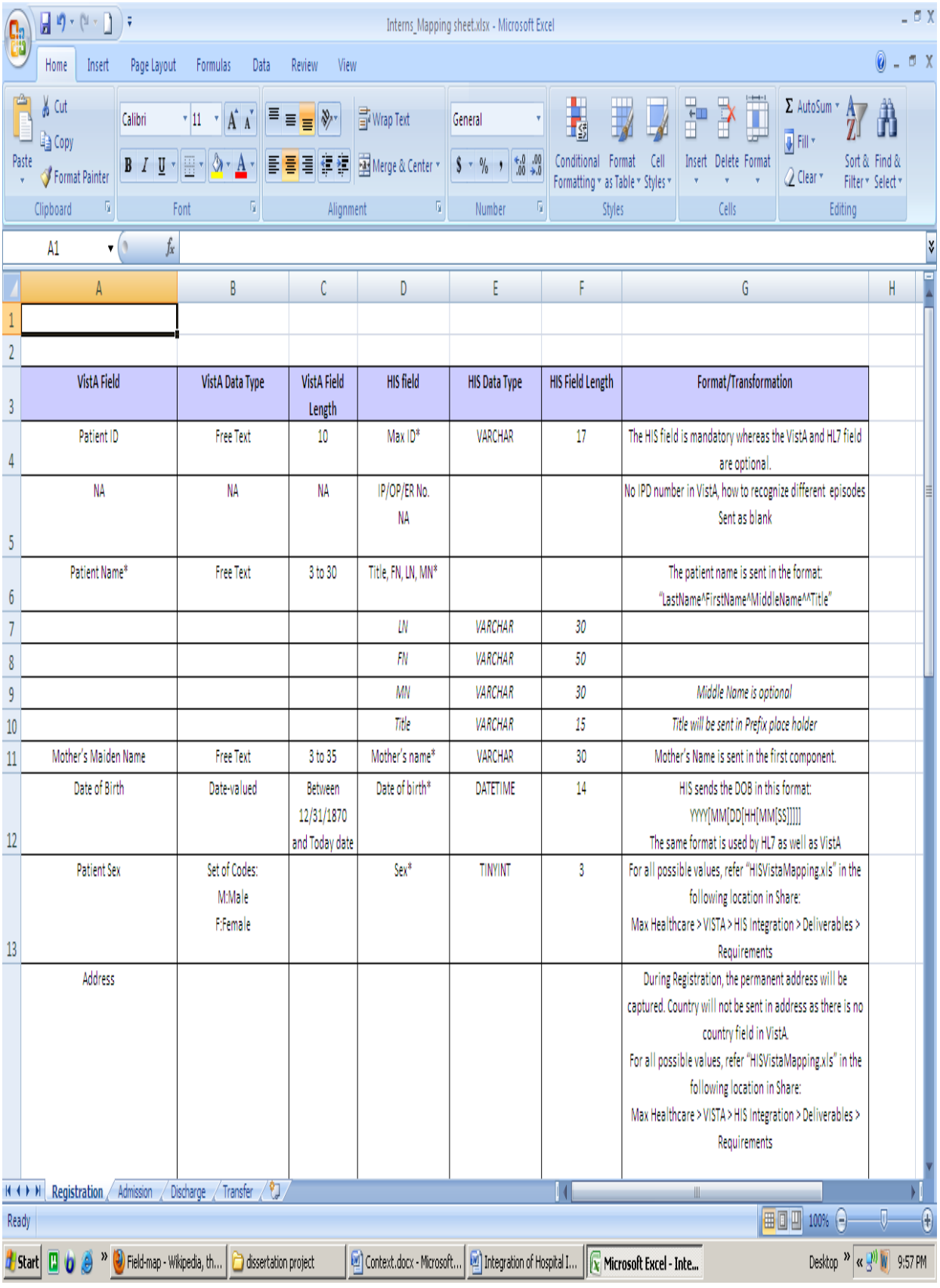
element mappings between two distinct data models. Data mapping is used as a step for a wide variety of data integration tasks including:

- Data transformation or data mediation between a data source and a destination. Data transformation converts data from a source data format into destination data.
- Identification of data relationships as part of data lineage analysis
- Discovery of hidden sensitive data such as the last four digits social security number hidden in another user id as part of a data masking or de-identification project
- Consolidation of multiple databases into a single data base and identifying redundant columns of data for consolidation or elimination

HIS and VistA data mapping is significant as the fields of both the systems for the same information to be captured are different in many ways. So it is necessary to compare both the fields and its format for capturing patient information. For integrating the systems, it is essential that the patient information is captured in a similar manner which is compatible for both the systems of HIS and VistA so that information can flow easily in any direction. It is mainly done for the processes like registration, admission, discharge and transfers.

For example, following screen shots are taken to show the way of data mapping for these four basic events.

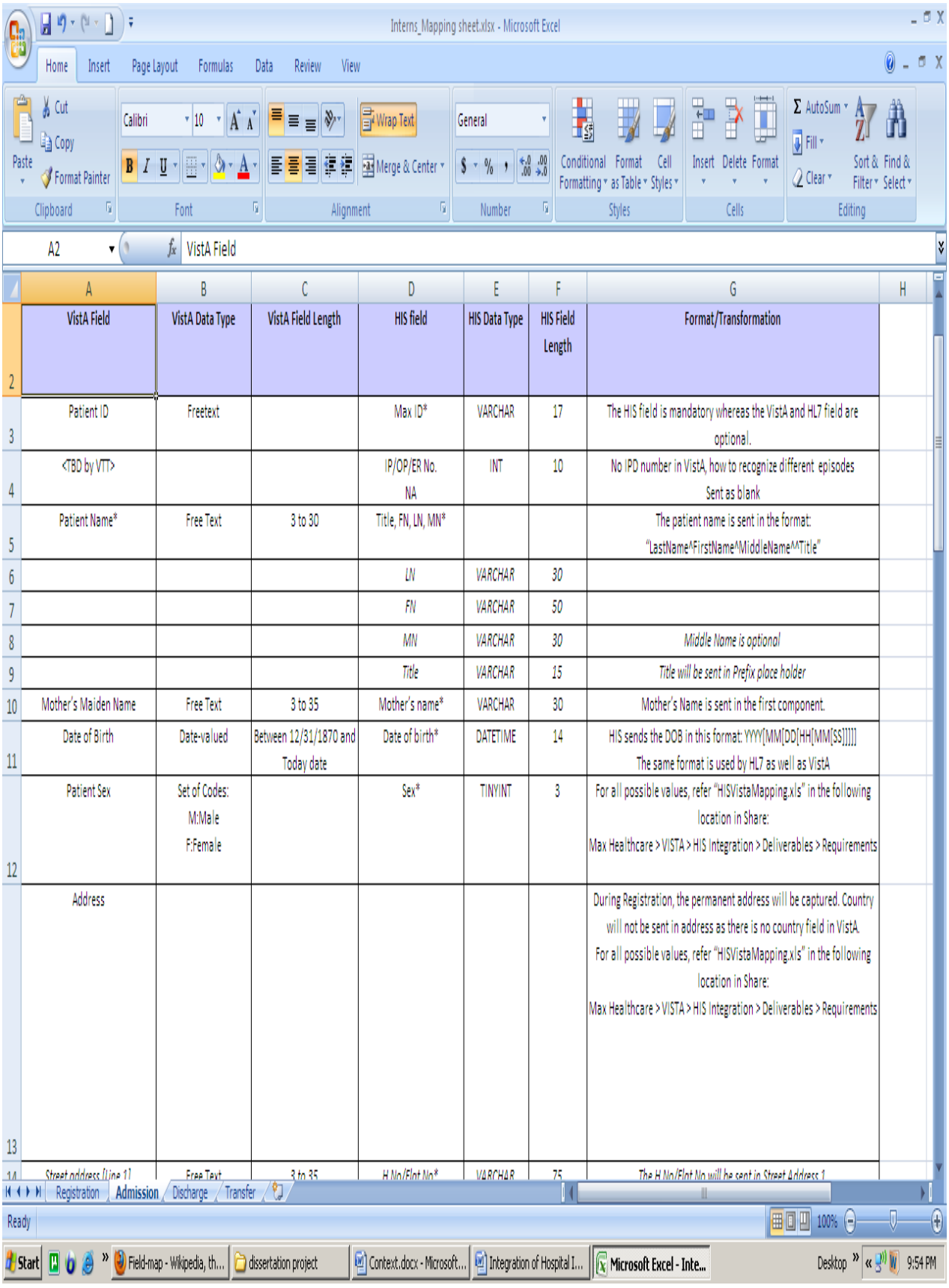
For the registration process :



VistA Field	VistA Data Type	VistA Field Length	HIS field	HIS Data Type	HIS Field Length	Format/Transformation
Patient ID	Free Text	10	Max ID*	VARCHAR	17	The HIS field is mandatory whereas the VistA and HL7 field are optional.
NA	NA	NA	IP/OP/ER No. NA			No IPD number in VistA, how to recognize different episodes Sent as blank
Patient Name*	Free Text	3 to 30	Title, FN, LN, MN*			The patient name is sent in the format: "LastName^FirstName^MiddleName^^Title"
			LN	*VARCHAR*	*30*	
			FN	*VARCHAR*	*50*	
			MN	*VARCHAR*	*30*	*Middle Name is optional*
			Title	*VARCHAR*	*15*	*Title will be sent in Prefix place holder*
Mother's Maiden Name	Free Text	3 to 35	Mother's name*	VARCHAR	30	Mother's Name is sent in the first component.
Date of Birth	Date-valued	Between 12/31/1870 and Today date	Date of birth*	DATETIME	14	HIS sends the DOB in this format: YYYY[MM[DD[HH[MM[SS]]]]] The same format is used by HL7 as well as VistA
Patient Sex	Set of Codes: M:Male F:Female		Sex*	TINYINT	3	For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements
Address						During Registration, the permanent address will be captured. Country will not be sent in address as there is no country field in VistA. For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements

Figure 7. Data Mapping for the Registration Process

For the admission process :



Interns_Mapping sheet.xlsx - Microsoft Excel

A2: VistA Field

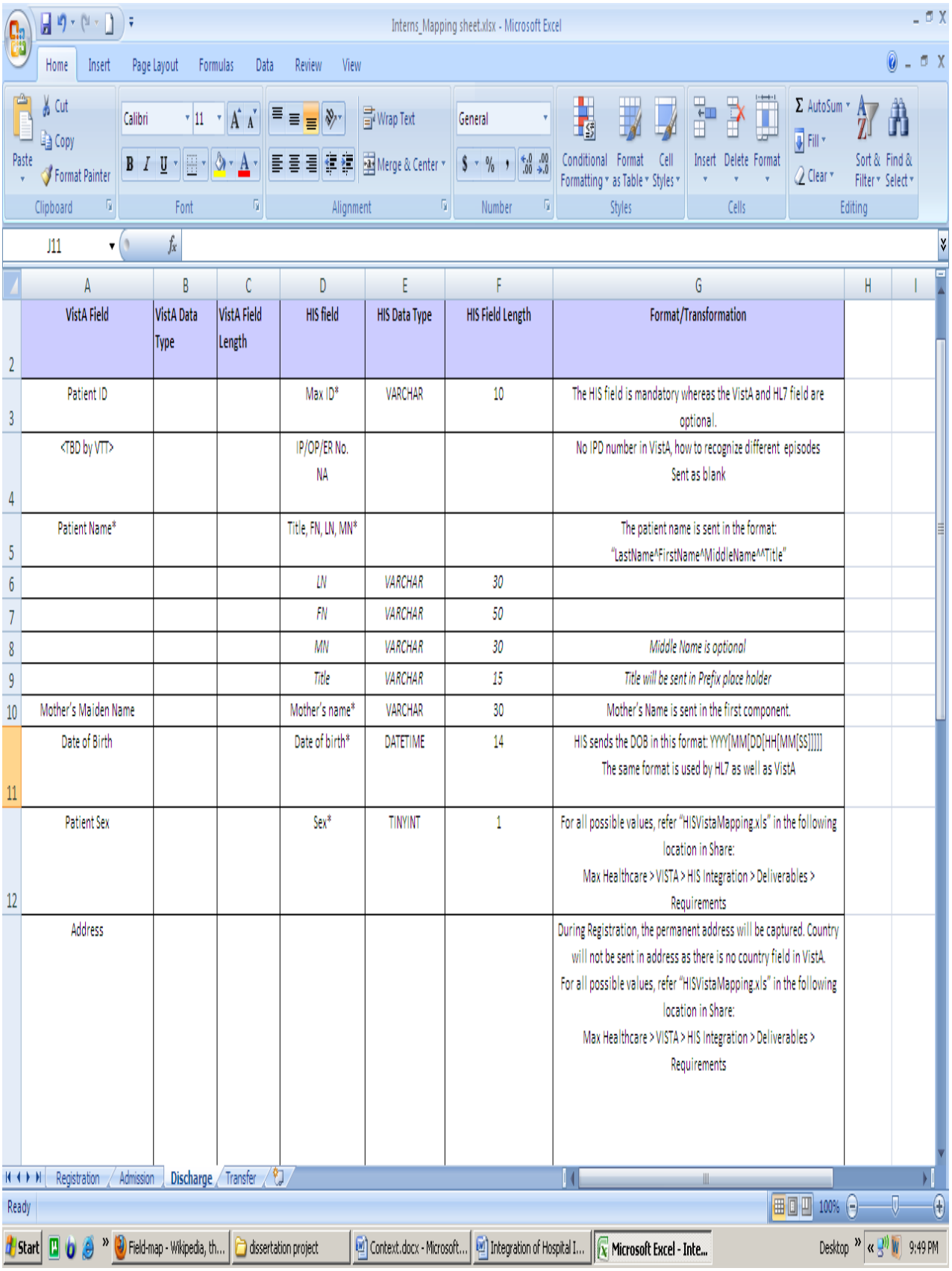
	A	B	C	D	E	F	G	H
2	VistA Field	VistA Data Type	VistA Field Length	HIS field	HIS Data Type	HIS Field Length	Format/Transformation	
3	Patient ID	Freetext		Max ID*	VARCHAR	17	The HIS field is mandatory whereas the VistA and HL7 field are optional.	
4	<TBD by VTT>			IP/OP/ER No. NA	INT	10	No IPD number in VistA, how to recognize different episodes Sent as blank	
5	Patient Name*	Free Text	3 to 30	Title, FN, LN, MN*			The patient name is sent in the format: "LastName^FirstName^MiddleName^^Title"	
6				*LN*	*VARCHAR*	*30*		
7				*FN*	*VARCHAR*	*50*		
8				*MN*	*VARCHAR*	*30*	*Middle Name is optional*	
9				*Title*	*VARCHAR*	*15*	*Title will be sent in Prefix place holder*	
10	Mother's Maiden Name	Free Text	3 to 35	Mother's name*	VARCHAR	30	Mother's Name is sent in the first component.	
11	Date of Birth	Date-valued	Between 12/31/1870 and Today date	Date of birth*	DATETIME	14	HIS sends the DOB in this format: YYYY[MM[DD[HH[MM[SS]]]]] The same format is used by HL7 as well as VistA	
12	Patient Sex	Set of Codes: M:Male F:Female		Sex*	TINYINT	3	For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements	
13	Address						During Registration, the permanent address will be captured. Country will not be sent in address as there is no country field in VistA. For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements	
14	*Street address [Line 1]*	Free Text	3 to 35	*H No/Flat No**	*VARCHAR*	75	*The H No/Flat No will be sent in Street Address 1*	

Registration | Admission | Discharge | Transfer

Ready

Figure 8. Data Mapping for the Admission Process

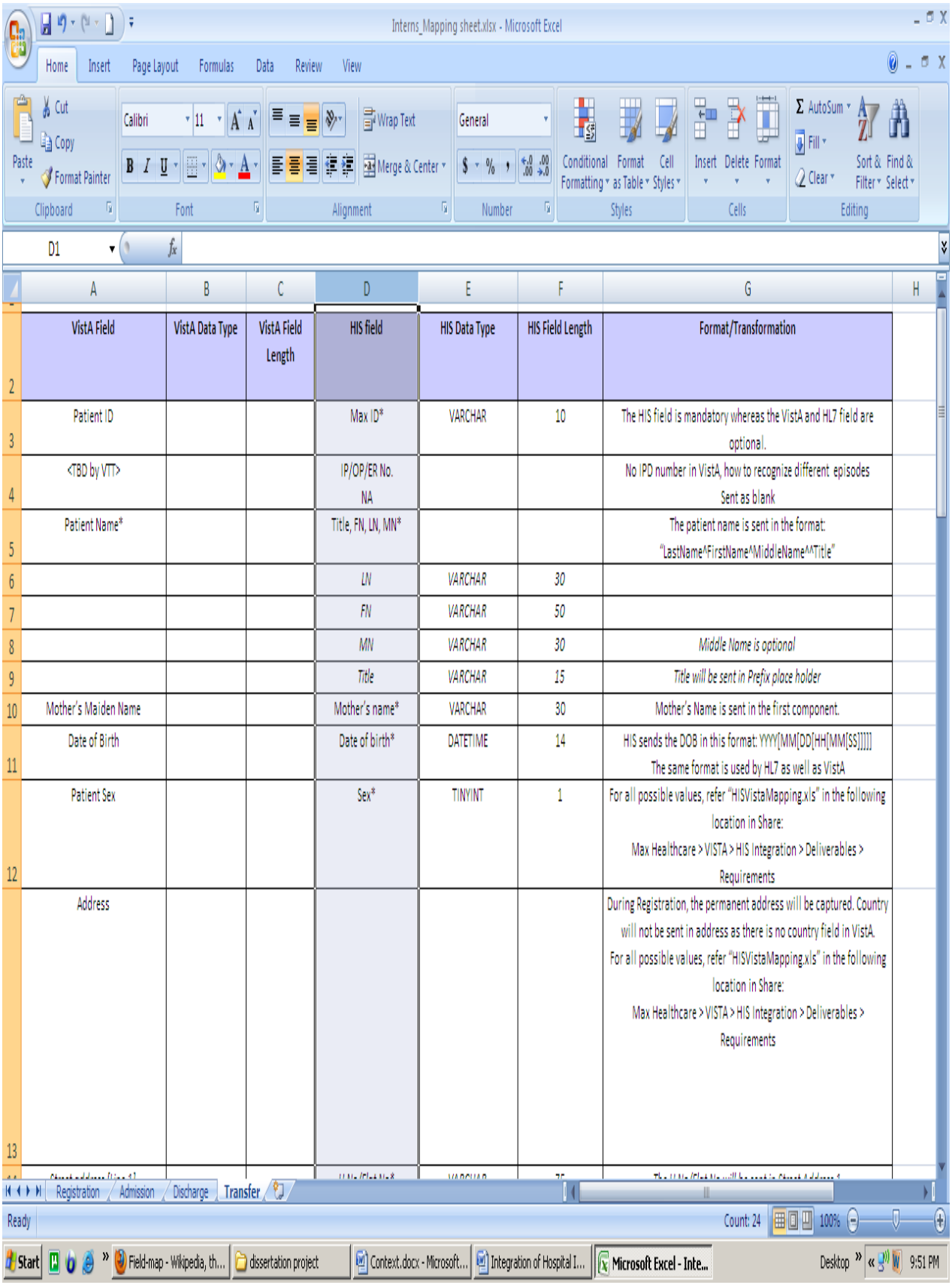
For discharge process :



	A	B	C	D	E	F	G	H	I
2	VistA Field	VistA Data Type	VistA Field Length	HIS field	HIS Data Type	HIS Field Length	Format/Transformation		
3	Patient ID			Max ID*	VARCHAR	10	The HIS field is mandatory whereas the VistA and HL7 field are optional.		
4	<TBD by VTT>			IP/OP/ER No. NA			No IPD number in VistA, how to recognize different episodes Sent as blank		
5	Patient Name*			Title, FN, LN, MN*			The patient name is sent in the format: "LastName^FirstName^MiddleName^^Title"		
6				*LN*	*VARCHAR*	*30*			
7				*FN*	*VARCHAR*	*50*			
8				*MN*	*VARCHAR*	*30*	*Middle Name is optional*		
9				*Title*	*VARCHAR*	*15*	*Title will be sent in Prefix place holder*		
10	Mother's Maiden Name			Mother's name*	VARCHAR	30	Mother's Name is sent in the first component.		
11	Date of Birth			Date of birth*	DATETIME	14	HIS sends the DOB in this format: YYYY[MM[DD[HH[MM[SS]]]]] The same format is used by HL7 as well as VistA		
12	Patient Sex			Sex*	TINYINT	1	For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements		
	Address						During Registration, the permanent address will be captured. Country will not be sent in address as there is no country field in VistA. For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements		

Figure 9. Data Mapping for the Discharge Process

For the process of transfer :



	A	B	C	D	E	F	G	H
2	VistA Field	VistA Data Type	VistA Field Length	HIS field	HIS Data Type	HIS Field Length	Format/Transformation	
3	Patient ID			Max ID*	VARCHAR	10	The HIS field is mandatory whereas the VistA and HL7 field are optional.	
4	<TBD by VTT>			IP/OP/ER No. NA			No IPD number in VistA, how to recognize different episodes Sent as blank	
5	Patient Name*			Title, FN, LN, MN*			The patient name is sent in the format: "LastName^FirstName^MiddleName^^Title"	
6				*LN*	*VARCHAR*	*30*		
7				*FN*	*VARCHAR*	*50*		
8				*MN*	*VARCHAR*	*30*	*Middle Name is optional*	
9				*Title*	*VARCHAR*	*15*	*Title will be sent in Prefix place holder*	
10	Mother's Maiden Name			Mother's name*	VARCHAR	30	Mother's Name is sent in the first component.	
11	Date of Birth			Date of birth*	DATETIME	14	HIS sends the DOB in this format: YYYY[MM[DD[HH[MM[SS]]]]] The same format is used by HL7 as well as VistA	
12	Patient Sex			Sex*	TINYINT	1	For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements	
13	Address						During Registration, the permanent address will be captured. Country will not be sent in address as there is no country field in VistA. For all possible values, refer "HISVistaMapping.xls" in the following location in Share: Max Healthcare > VISTA > HIS Integration > Deliverables > Requirements	

Figure 10. Data Mapping for the Process of Transfer

2.2.5.4 HL7

Health Level Seven (HL7) is a standard for electronic data exchange in all healthcare environments, with special emphasis on inpatient acute care facilities (i.e., hospitals). The term “Level 7” refers to the highest implementation protocol level for a definition of a networking framework as presented in the Open System Interconnection (OSI) model of the International Organization for Standardization (ISO). This is not to say that HL7 conforms to ISO defined elements of the OSI’s seventh level. HL7 does, however, correspond to the conceptual definition of an application-to-application interface placed in the seventh layer of the OSI model. In the OSI conceptual model, the functions of both communications software and hardware are separated into seven layers, or levels. The HL7 Standard is primarily focused on the issues that occur within the seventh, or application, level. These are the definitions of the data to be exchanged, the timing of the exchanges, and the communication of certain application-specific errors between the applications. However, of necessity, protocols that refer to the lower layers of the OSI model are sometimes mentioned to help implementers understand the context of the Standard. They are also sometimes specified to assist implementers in establishing working HL7-based systems.

The HL7 Version 2.4 Standard currently addresses the interfaces among various healthcare IT systems that send or receive patient admissions/registration, discharge or transfer (ADT) data, queries, resource and patient scheduling, orders, results, clinical observations, billing, master file update information, medical records, scheduling, patient referral, patient care, clinical laboratory automation, application management and personnel management messages. HL7 Version 2.4 is designed (and used) to support a central patient care system as well as a more distributed environment where data resides in departmental systems.

Goals of HL7

HL7’s purpose is to facilitate communication in healthcare settings. The **primary goal** is to provide standards for the exchange of data among healthcare computer applications that eliminate or substantially reduce the custom interface programming and program maintenance that may otherwise be required. This primary goal can be delineated as a set of goals:

a) The Standard should support exchanges among systems implemented in the widest variety of technical environments. Its implementation should be practical in a wide variety of programming languages and operating systems. It should also support communications in a wide variety of communications environments, ranging from a full, OSI-compliant, 7-level network “stack” to less complete environments including primitive point-to-point RS-232C interconnections and transfer of data by batch media such as tape, CD and USB Flash Drive.

b) Immediate transfer of single transactions should be supported along with file transfers of multiple transactions.

c) The greatest possible degree of standardization should be achieved, consistent with site variations in the usage and format of certain data elements. The Standard should accommodate necessary site-specific variations. This will include, at least, site-specific tables, code definitions and possibly site-specific message segments (i.e., HL7 Z-segments).

d) The Standard must support evolutionary growth as new requirements are recognized. This includes support of the process of introducing extensions and new releases into existing operational environments.

e) The Standard should be built upon the experience of existing production protocols and accepted industry-wide standard protocols. It should not, however, favor the proprietary interests of specific companies to the detriment of other users of the Standard. At the same time, HL7 seeks to preserve the unique attributes that an individual vendor can bring to the marketplace.

f) While it is both useful and pertinent to focus on information systems within hospitals, the long-term goal should be to define formats and protocols for computer applications in all healthcare environments.

g) The very nature of the diverse business processes that exist within the healthcare delivery system prevents the development of either a universal process or data model

to support a definition of HL7's target environments. In addition, HL7 Version 2.4 does not make a priori assumptions about the architecture of healthcare information systems nor does it attempt to resolve architectural differences between healthcare information systems. For at least these reasons, HL7 Version 2.4 cannot be a true "plug and play" interface standard. These differences at HL7 Version 2.4 sites will most likely require site negotiated agreements.

h) A primary interest of the HL7 Working Group has been to employ the Standard as soon as possible. Having achieved this, HL7 has also developed an infrastructure that supports a consensus balloting process and has been recognized by the American National Standards Institute (ANSI) as an Accredited Standards Organization (ASO).

i) Cooperation with other related healthcare standards efforts (e.g., ACR/NEMA DICOM, ASC X12, ASTM, IEEE/MEDIX, NCPDP, etc.) has become a priority activity of HL7. HL7 participates in the ANSI HITSP.

Message Framework

The Standard is written from the assumption that an event in the real world of healthcare creates the need for data to flow among systems. The real-world event that initiates an exchange of messages is called a **trigger event**.

For example, the trigger event **a patient is admitted** may cause the need for data about that patient to be sent to a number of other systems. The trigger event, **an observation (e.g., a CBC result) for a patient is available,** may cause the need for that observation to be sent to a number of other systems. When the transfer of information is initiated by the application system that deals with the triggering event, the transaction is termed an **unsolicited update**.

HL7 allows the use of trigger events at several different levels of data granularity and inter-relationships. For example, most Patient Administration (ADT) trigger events concern single objects (such as an admit event, which creates a message that contains data about a single person and/or account). Other ADT trigger events are concerned with relationships between more than one object (e.g., the merge events, which specify patient or account merges).

A **message** is the atomic unit of data transferred between systems. It is a unit of information, used for communicating between two or more EPA's.
Elements of an HL7 Message are as :

- Segments
- Fields
- Components
- Subcomponents

HL7 messages are ASCII messages and are defined sequence of segments and/or segment groups. Each segment, group, or message set within a message can be optional and/or repeating.
A **segment** is a logical grouping of data fields. Segments of a message may be required or optional. They may occur only once in a message or they may be allowed to repeat. Each segment is given a name. For example, the ADT message may contain the following segments: Message Header (MSH), Event Type (EVN), Patient ID (PID), and Patient Visit (PV1).
Each segment is identified by a unique three-character code known as the Segment ID. Each segment has its own semantic purpose. An HL7 message definition also states whether each segment is mandatory or not.
A field is a string of characters. Fields for use within HL7 segments are defined by HL7 . Each field has its own unique purpose and is defined by the HL7 standard for each segment. A field may be either a primitive data type (string, number, etc.), or in turn be made up of **components and subcomponents**, which can be a primitive data type.
Each message has a **message type** that defines its purpose. For example the ADT Message type is used to transmit portions of a patient's Patient Administration (ADT) data from one system to another. A three-character code contained within each message identifies its type
Messages are a collection of segments. These segments need to occur in a specific sequence in the message. **Sequencing** can be defined as the process of sending the messages from source to destination in the same order as received from the source with possible omissions (skipping) in between. The sequence, optionality and repeatability of these segments is defined in the HL7 specification for the given message type.

An HL7 message profile is an unambiguous specification of one or more standard HL7 messages that have been analyzed for a particular use case. It prescribes a set of precise constraints upon one or more standard HL7 messages.

HL7 does not care how systems actually store data within an application. When fields are transmitted, they are sent as character strings

An example of an HL7 message is –

MSH|^~\&|ADT1|MCM|LABADT|MCM|198808181126|SECURITY|ADT^A01|MSG00001|P|2.4|<cr>

EVN|A01|198808181123||<cr>

PID|1||PATID1234^5^M11^ADT1^MR^MCM~123456789^^^USSSA^SS||JONES^WILLIAM^A^III||196

10615|M||C|1200 N ELM STREET^^GREENSBORO^NC^27401-1020|GL|(91-9)379-1212|(919)271-3434||S||PATID12345001^2^M10^ADT1^AN^A|123456789|987654^NC|<cr>

NK1|1|JONES^BARBARA^K|WI^WIFE||||NK^NEXT OF KIN<cr>

PV1|1|I|2000^2012^01||||004777^LEBAUER^SIDNEY^J.|||SUR||||ADM|A0|<cr>

2.2.5.5 Process of parsing

Parsing is the process of analyzing an input sequence in order to determine its grammatical structure with respect to a given formal grammar. It is formally named **syntax analysis**. Parsing splits a sequence of characters or values into smaller parts. It can be used for recognizing characters or values that occur in a specific order. In addition to providing a powerful, readable, and maintainable approach to regular expression pattern matching, parsing enables you to create your own custom languages for specific purposes. A **parser** is a computer program that carries out this task.

In computing, a **parser** is one of the components in an interpreter or compiler, which checks for correct syntax and builds a data structure. This parses the source code of a

computer programming language to create some form of internal representation. Parsers are written by hand or generated by parser generators.

In this case also parser helps in sending and receiving messages in the format which is readable and maintainable with the system.

2.2.6 Project Management Plans

2.2.6.1 Change Management Plan

The change requests on the project deliverables and project artifacts are managed in the following process :

- Change Control Board is formed to review change requests. It is used to approve or reject change requests. After the project scope has been baselined, each requested change must go through a change control review process.
- Project Manager needs to be proactive in looking for deviations from project plan and then take timely corrective action. After that the Project Manager needs to evaluate the effectiveness of corrective action, and measure performance of corrective action, and then determine the need for further corrective action.
- When a change request is received, the following steps must be taken (in this order) –
    - Evaluate (assess) the impact of change to the project
    - Create alternatives including cutting other tasks, crashing, fast-tracking etc.
    - Meet with management, sponsors etc.
    - Meet with the customer if necessary

2.2.6.2 Risk Management Plan

Programme risk management is a series of processes and activities targeted to identifying, evaluating, responding to, and controlling any threats and opportunities that surround a programme. Managing programme risks is a great way to make a programme feasible and pave the way for good strategic, operational, project and programme management. Responding to programme threats and opportunities is an integral part of the programme risk management process.

Following are the possible options for programme risk responding :

- **Reduction & Mitigation :** This response to programme risks allows reducing the probability of the programme-level risks occurrence and mitigating the impact the

risks have upon the programmed. It aims at minimizing the chance that the programme will suffer from a negative impact.

- **Removing :** This response to programme risks aims at removing the risks completely. Following the concept of this response, to remove a programme-level risk you can try to change the programme's scope, make changes in procurement management (e.g. changing a supplier), or re-organize the sequence of programme tasks.
- **Transferring :** This response is about moving programme threats to a third party that takes ownership of the threats. Here's how it words: once ownership of a risk is taken by a third party, they become responsible for risk mitigation. At the same time, this response of effective programme risk management doesn't allow transferring risks to an internet division of your company, only external resources are allowed. Often programme managers set up an insurance policy to transfer programme risks to an insurance agency.
- **Retaining :** This response of programme risk management assumes that the team agrees on keeping identified risks and continues working on the programme. This means takes into account the probability of risk occurrence yet it proceeds with performing tasks. However, Retaining requires uses effective monitoring tools of project and programme risk management to keep track of the risks and take immediate action in case of emergency. This response to programme threats is cost-effective until risks have the lowest possible probability of occurrence.

The successful practice of risk management in the project assumes three core steps:

- Analyzing Risks
- Planning Risk Responses
- Controlling and Reporting Risk

2.2.7 Challenges in the integration process

The challenges faced during the integration process were identified through interviewing the people who were actually involved in the process.

They are as following :

- The HL7 incompatibility of HIS makes it difficult to integrate it with VistA. As Health Level Seven (HL7) is a standard for electronic data exchange in all healthcare environments. It addresses the interfaces among various healthcare IT systems that send or receive patient admissions/registration, discharge or transfer (ADT) data, queries, resource and patient scheduling, orders, results, clinical observations, billing, master file update information, medical records, scheduling, patient referral, patient care, clinical laboratory automation, application management and personnel management messages. VistA is a product which is completely compatible with HIS. But as HIS is not compatible with HL7 it is a challenge to integrate both of them.

  HL7 message format requires some mandatory fields to be included which may be mandatory or optional in the case of HIS. So, to match the fields and convey the HIS message, the fields have to be matched properly and similarly in both the systems.
- VistA is the system, basically developed by the Veterans in United States, so it was developed keeping the Veterans into consideration which is different from an Indian scenario. Whereas HIS is based on the Indian Hospital which is typically for the Indian patient's perspective. Hence many aspects which are important and required for Veterans are not at all required for Indians.

  For example, SSN which is a Social Security Number in United States and is being given to every individual is recorded in the system in Patient details. But in India there is no such number allotted to individuals. In this case, it is a challenge to map the field for SSN in HIS. Then, the data type in the field of SSN is fixed as a nine digit number which is also different from the Hospital's outpatient and inpatient number. So, matching the VistA's SSN field is to be matched to the HIS's outpatient number field.
- The frequently changing requirements from the client side also creates problem for the process.

- The way data is stored in both the systems is very different. For example the Patient's name in HIS is stored in parts like first, middle and last name whereas in VistA it is as one name.
- In HIS there are different types of patients like Outpatients, Inpatient, emergency and pre-ADT where as in VistA there are only two types of patients that is Outpatient and Inpatient.

So, the legacy HIS is an in-house product modified as per the day to day processes of the Hospital whereas VistA is a standard product which is not easily modifiable as per the Indian processes making it difficult to integrate with HIS.

2.2.8 Results

After the implementation of VistA and its integration with HIS the system will be working as the patient information will be easily passing from one system to the other through the integration engine – Mirth.

2.2.8.1 Outbound Messages from HIS

HIS user will interact with HIS for normal business process. Whenever any HL7 message is generated and sent to VistA then automated HL7 message is generated using generic HL7 message builder framework and sent to VistA through IE.

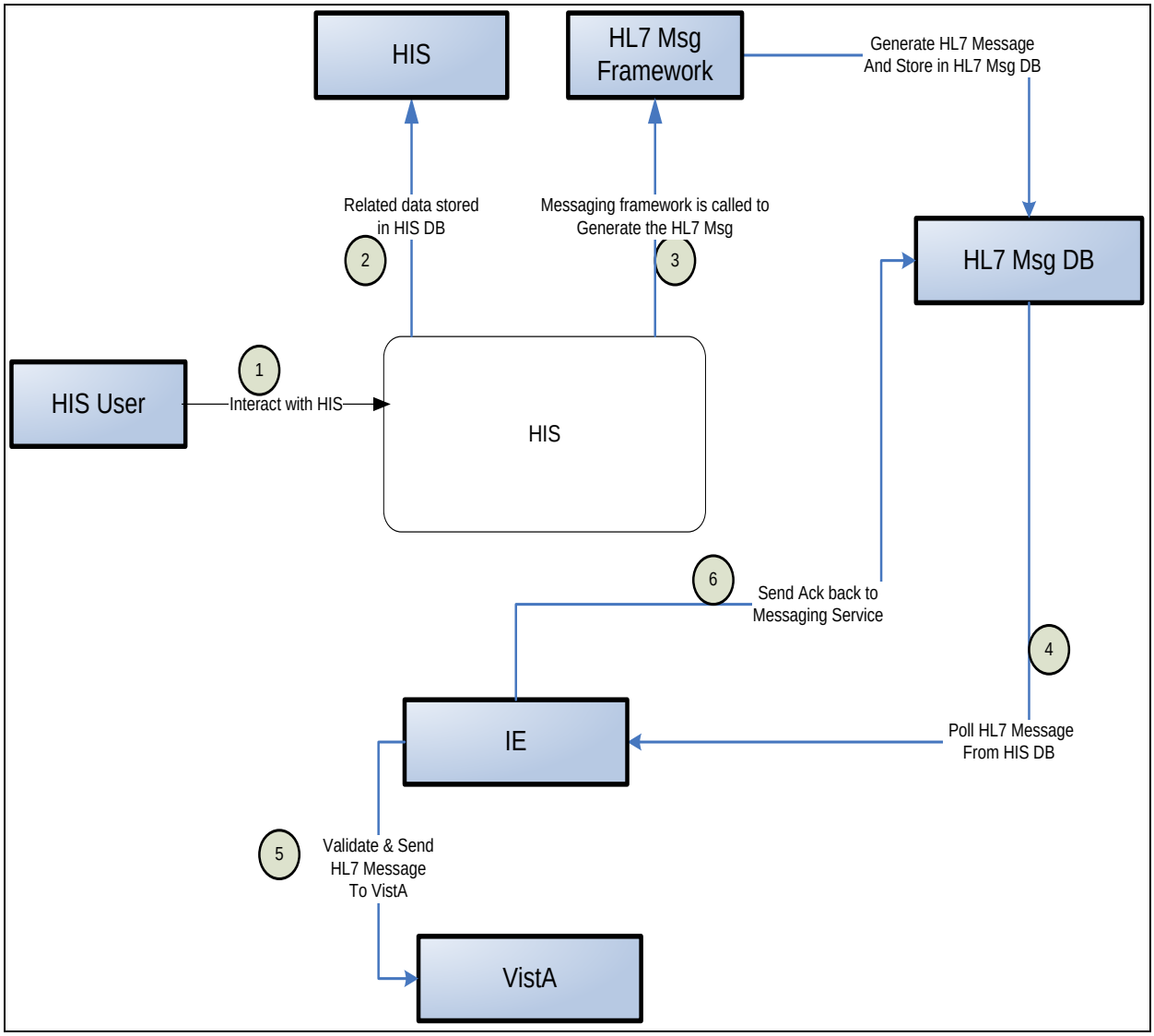


Figure 11. Outbound Messages from HIS

The process will be as follows :

- User will interact with HIS for normal operations.
- All the business data will be stored in HIS centralized DB.
- HL7 trigger point will be fired to generate the HL7 message.
- HL7 message framework will generate the appropriate HL7 message.
- Message will be stored in HL7 DB.
- Message will be picked up by IE SQL Data Adapter / sent via TCP Port.
- IE will validate the HL7 message and pass it to VistA.
- VistA will receive/validate the HL7 message and store the information in VistA DB and send the ACK to IE.

2.2.8.2 Inbound Messages to HIS

In case of any process taking place in VistA, then VistA is responsible to generate the HL7 messages and pass to IE. IE receives the HL7 message from VistA and passes it to HIS.

VistA user interacts with VistA for normal business process. Whenever any HL7 message is generated, VistA generates the appropriate message based on the identified trigger points and sends it to IE. IE validates the message and sends to HIS for further processing.

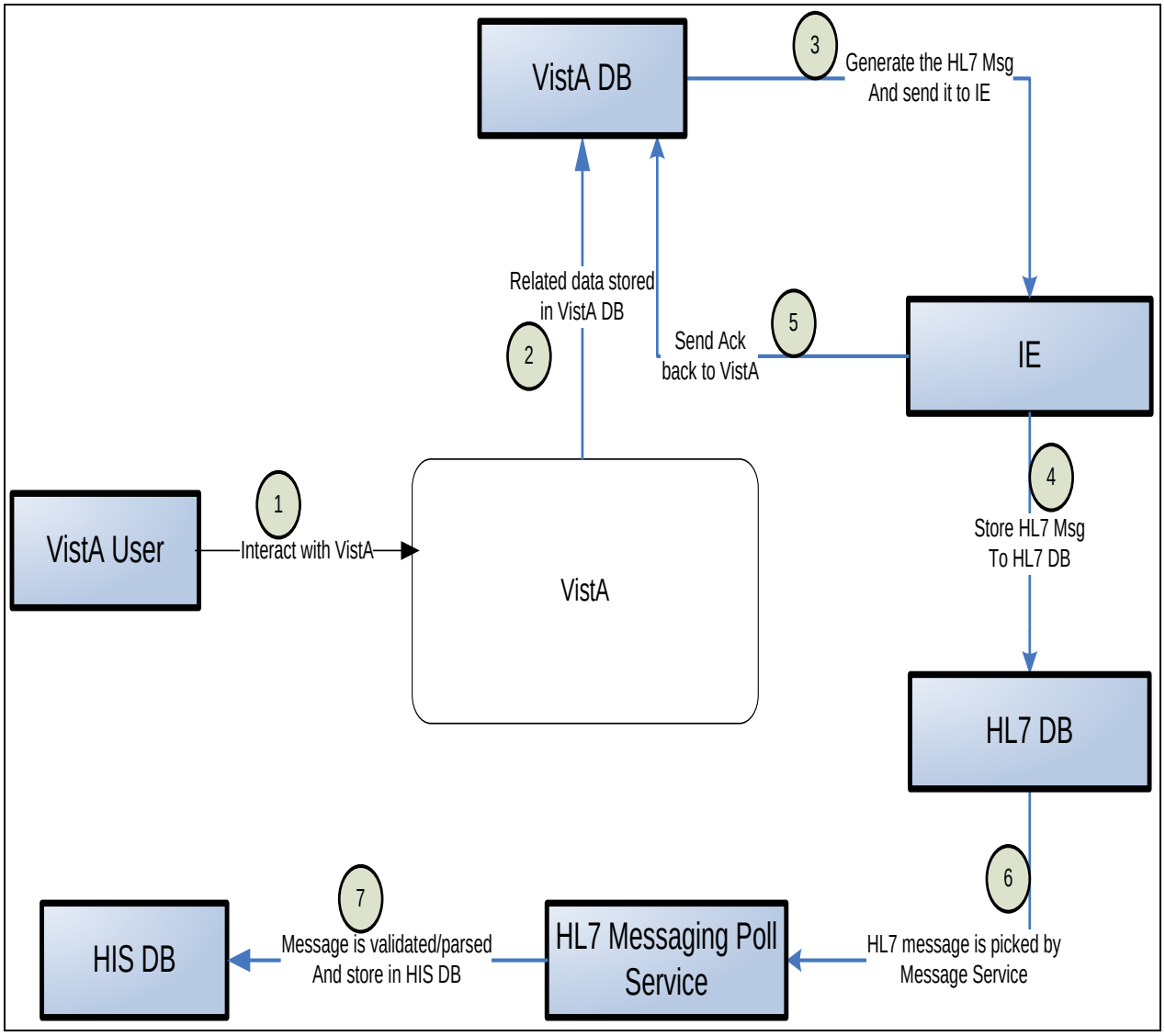


Figure 12. Inbound Messages to HIS

The process will be as follows :

- User will interact with VistA for normal operations.
- All the business data will be stored in VistA centralized DB.
- HL7 trigger point will be fired to generate the HL7 message.
- Message will be sent to IE.
- IE will validate the HL7 message and store in HL7 DB and send the ACK back to VistA. There will be no dependencies on HIS database.
- Message Poll Service will pick and validate the HL7 message and transform the HL7 message to store the information in HIS DB.

An HL7 (messaging standard for exchange of information in healthcare) engine generates messages from HIS to PACS transmitting the patient demographics, order details to the respective modality worklist.

The following is the diagram showing the overall system after the implementation of VistA and the integration engine :

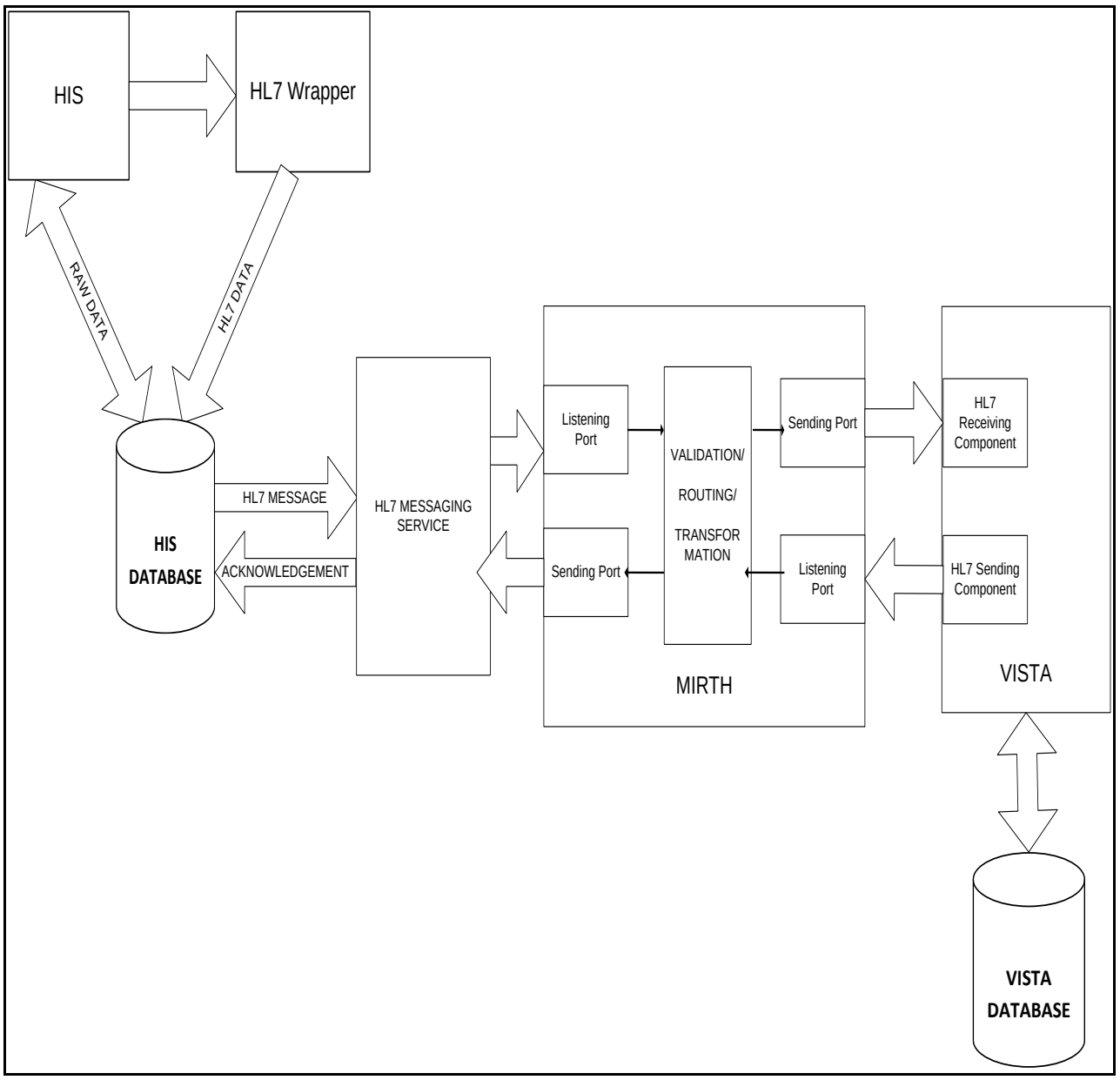


Figure 13. System after integration of HIS and VistA

2.2.9 Conclusion

There is a successful integration of these two different systems, HIS and VistA, by means of an Integration Engine. The Open source Integration Engine Mirth helps sending the messages between these two applications – HIS and VistA. Also, an HIS wrapper converts data from HIS into an HL7 message and vice versa.

With the integration of the Hospital HIS and VistA, patient administration related data is maintained in both the systems. This data is being transferred at near real-time between the two systems in the form of HL7 messages.

This process involves the transformation of data between messaging standards and requires support for multiple transmission protocols.

“Mirth’s ability to support multi-channel messaging modes, multi-protocol connectors, multiple languages for transformer scripting, and a full complement of end-point technologies make it an attractive interface engine for VistA-based solutions,”

When the trigger events take place, the information is being exchanged between the two systems.Process like Patient registration, admit/Visit notification, transfer, discharge, cancel admission and cancel discharge are performed at the Hospital HIS and this information flows to VistA PIMS through integration using HL7 messages.

After the implementation of VistA and its integration with HIS the system will be working as the patient information will be easily passing from one system to the other through the integration engine – Mirth.

As HIS and VistA are two different software, there are many problems identified in their integration process. The challenges faced during the integration process were identified through interviewing the people who were actually involved in the process.

They were as – HL7 incompatibility of HIS, different data storage formats in both the systems, modifying VistA according to the Indian context and many more.

And these challenges can be resolved by the following recommendations.

2.2.10 Recommendations

The following are the recommendations for a seamless integration process to be achieved successfully:

- A system or an HER which is suitable and adaptable to the Indian Scenario should preferably be implemented.
- Both the systems should be HL7 compatible so that it is easy to enable the interoperability.
- Complete requirements should be taken from the client side and they should be documented and fixed before working on them.

2.3 References

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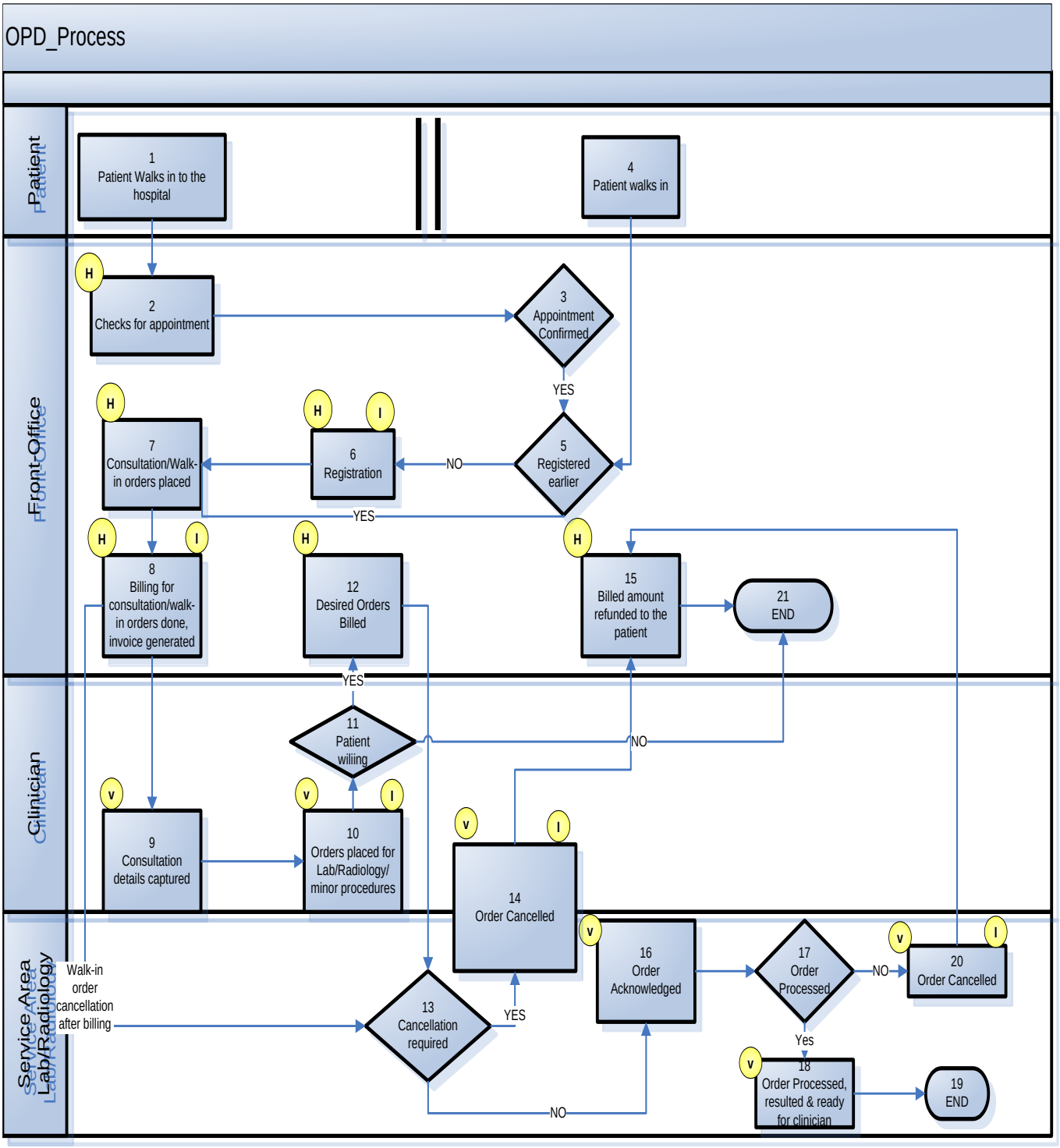
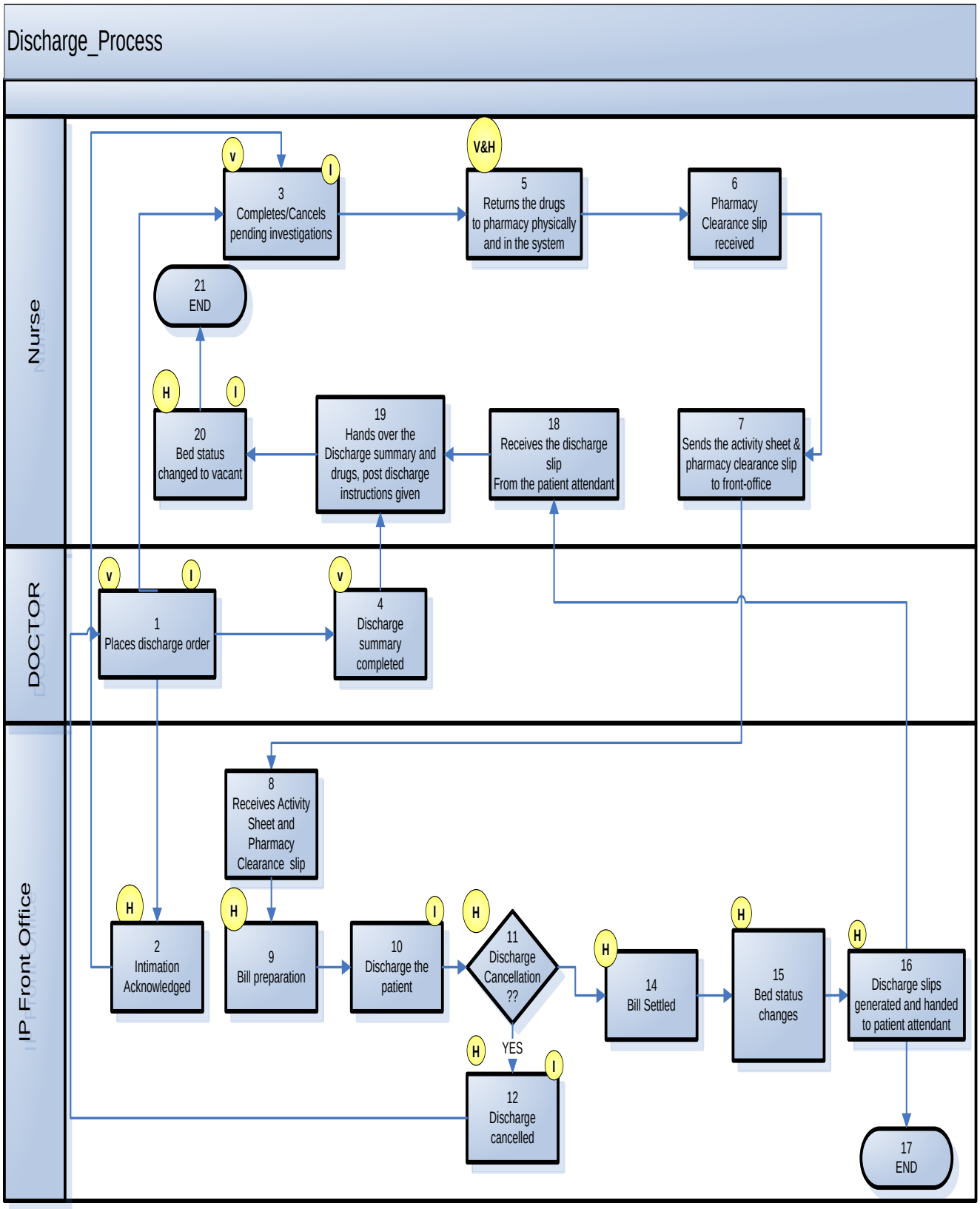
2.4 Annexure

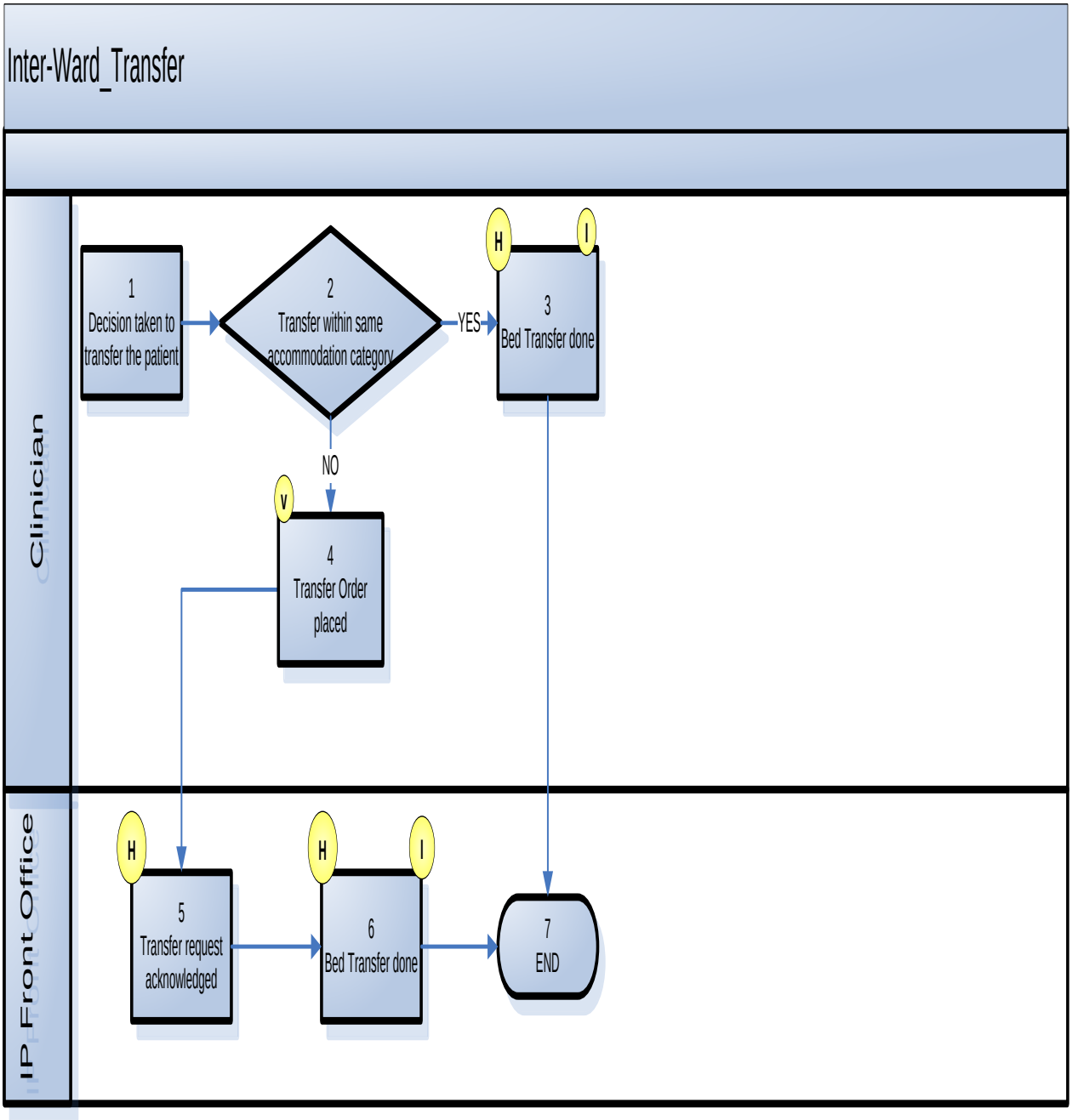
2.4.1 Process Work Flow of OPD



2.4.2 Process Work Flow of Discharge Process



2.4.3 Process Work Flow of Inter-Ward Transfers



2.4.4 Questionnaire

Following is the questionnaire attached for the integration team on how well they are doing on the project :

HOW WELL ARE YOU DOING ?

Please complete the questionnaire below.

Key :

1. Strongly disagree
2. Tend to disagree
3. Undecided
4. Tend to agree
5. Strongly agree

Attract & Align

	1	2	3	4	5
1. The purpose of the team is clear to me.	○	○	○	○	○
2. The right people are on the team to enable it to achieve it's purpose.	○	○	○	○	○
3. People have the skills necessary to the success of the team.	○	○	○	○	○
4. Everyone on the team shares the same purpose.	○	○	○	○	○
5. The team is about the right size.	○	○	○	○	○

Build Productive Relationships

	1	2	3	4	5
6. Team members know and trust each other.	○	○	○	○	○
7. I can rely on my colleagues in the team to do what they say they will do.	○	○	○	○	○
8. Our team has about the right level of diversity it needs to be effective.	○	○	○	○	○
9. We value a range of styles and types of people and behaviour in the team.	○	○	○	○	○

10. Reporting structures and relationships in the team are clear to me.

11. I feel I have the authority I need to get my job done within the team.

Agree Dependencies

	1	2	3	4	5
12. My personal goals and objectives within the team are clear to me.					
13. I know and understand the goals and objectives of others in the team.					
14. We have about the right balance of control and autonomy in the team.					
15. I can count on the co-operation of the others in the team to meet my/our objectives.					
16. We usually meet our objectives.					
17. The objectives of team members do not conflict with each other.					

Manage Yourself / Add Value to Others

	1	2	3	4	5
18. The amount of travel we have to do is ok.					
19. I see other team members as often as I need to.					
20. I see my manager as often as I need to.					
21. I think the activities of the team are visible to the organisation.					
22. I am clear about the expectations that other members of the team have of me.					
23. I get about the right level of performance feedback from my manager.					

Improve Connections

	1	2	3	4	5
24. We communicate well in the team.	○	○	○	○	○
25. We use the available communication technologies effectively in the team..	○	○	○	○	○
26. Language and culture are not barriers to communication in the team.	○	○	○	○	○
27. The members of the team have the right level of communication skills.	○	○	○	○	○
28. We work together well as a team	○	○	○	○	○

Facilitate Learning

	1	2	3	4	5
29. Members of the team learn effectively from one another.	○	○	○	○	○
30. The team is good at continuously improving it's performance.	○	○	○	○	○
31. We regularly review the process of how we work as well as the content of what we do.	○	○	○	○	○
32. The team has good contacts with the rest of the organisation.	○	○	○	○	○
33. Team members are generally receptive to outside ideas and new initiatives.	○	○	○	○	○

Other Comments :

_____

_____

_____

Your Name : _____

Team Lead Name : _____