Internship Training

At

HiSP INDIA
Society for Health Information Systems Programmes

Customization of Open Source Hospital Information System from India to Kenya National EHR System

By

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Under the guidance of

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Post Graduate Diploma in Hospital and Health Management

Year 2012-2014

IIHMR DELHI

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HISP INDIA SOCIETY FOR HEALTH INFORMATION SYSTEMS PROGRAMMES

Date: 3rd May, 2014

TO WHOMSOEVER IT MAY CONCERN

Subject: Internship Completion

This is to inform that Ms. Aditi Singh, student at International Institute of Health Management Research (IIHMR), New Delhi successfully completed internship with HISP INDIA (Society for Health Information Systems Programmes) India, Noida, UP from February, 2014 to April, 2014. Her contributions have been in Requirement Analysis and Customization of Open Source Integrated Hospital Information System from India to Kenya National Electronic Health Record System.

Overall her performance has been good. She came across as a good team member with potential of being an asset to the organization. I wish her every success in future.

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TO WHOMSOEVER MAY CONCERN

This is to certify that **Aditi Singh,** student of Post Graduate Diploma in Hospital and Health Management (PGDHM) from International Institute of Health Management Research, New Delhi has undergone internship training at **Society for Health Information Systems Programmes, HISP India**from 03/02/2014 to 03/05/2014.

The candidate has successfully carried out the study designated to her during internship training and her approach to the study has been sincere, scientific and analytical.

The Internship is in fulfillment of the course requirements.
I wish her all success in all her future endeavors.

12/5/14

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12/05/2014

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Certificate of Approval

The following dissertation titled **"Customization of Open Source Hospital Information System from India to Kenya National EHR System"** at **"Society for Health Information Systems Programmes, HISP India"** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily 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
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Dr. ABHIJIT CHAKRABORTY	12/05/14

Certificate from Dissertation Advisory Committee

This is to certify that **Ms. Aditi Singh,** a graduate student of the **Post- Graduate Diploma in Health and Hospital Management** has worked under our guidance and supervision. She is submitting this dissertation titled **"Customization of Open Source Hospital Information System from India to Kenya National EHR System"** at **"Society for Health Information Systems Programmes, HISP India"** 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.

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CERTIFICATE BY SCHOLAR

This is to certify that the dissertation titled **"Customization of Open Source Hospital Information System from India to Kenya National EHR System"** and submitted by **Aditi Singh**, Enrollment No. PG/12/03, under the supervision of Abhijit Chakrabarty for award of Postgraduate Diploma in Hospital and Health Management of the Institute carried out during the period from 03/02/2014 to 03/05/2014 embodies my original work and has not formed the basis for the award of any degree, diploma associate ship, fellowship, titles in this or any other Institute or other similar institution of higher learning.

Signature

FEEDBACK FORM

Name of the Student: Aditi Singh

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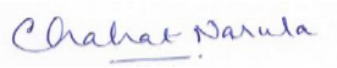
Attendance: 96 %

Objectives achieved: Yes

Deliverables: Customization and Testing of Kenya EHRS

Strengths: Ardent learner, good communication skills, able to comprehend instructions well

Suggestions for Improvement: Should always be a good learner, work more on the areas of core competence.



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ABSTRACT

Problem Statement & Its Importance to study

Pre-implementation assessment helps in reducing the uncertainty, acquiring local knowledge, and thus increasing the likelihood of success of the implementation. Understanding as much as possible before implementation is initiated, is important to ensure that implementation strategies are appropriate and take into account the socio-economic realities.

Hospital-based customization provides a mean of achieving this timeliness with maximum user satisfaction. It, however, requires a major commitment in personnel time as well as additional software and also proper steps and processes for customizing .The enhanced control of system modifications and overall flexibility in planning the change process result in enthusiastic support of this approach by many hospitals. The key factors for success include careful selection of local personnel with adequate technical support, extensive QA control, and thorough auditing /validation and user involvement. Customized data delivery technology provides real and tangible value to end users, accentuates workflow. Thus it is necessary to understand the customization process.

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Thank You

Aditi Singh

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ACRONYMS/ABBREVIATIONS

- **HISP-** Health Information System Programmes
- **GIS-** Geographical Information System
- **WHO-** World Health Organization
- **MRS-** Medical Record System
- **HIV-** Human Immunodeficiency Virus
- **AIDS-** Acquired Immunodeficiency Syndrome
- **API-** Application Programming Language
- **HTML-** Hyper Text Markup Language
- **HL7-** Health Level Seven
- **IT-** Information Technology
- **HIS-** Hospital Information System
- **MoH-** Ministry of Health
- **EMR-** Electronic Medical Record
- **CIMS-** Current Index of Medical Specialties

1. ORGANIZATION PROFILE

HISP India is a not for profit NGO specializing since more than a decade in designing and implementing solutions in health informatics for the public health sector in Indian states, and also recently in Bangladesh and Sri Lanka. They are not a solely technology focused organization, and pride ourselves for being multi-disciplinary and seeking to the knowledge domains of public health and informatics. They have a strong commitment to free and open source technologies, and work with a global perspective of the Health Information Systems Programmes (HISP) network, coordinated by the University of Oslo, Norway, and active in more than 20 countries in Africa and Asia.

HISP India is both a node in a global network called HISP Global coordinated from University of Oslo, Norway, and is helping to create a regional node around Health Information Systems for South East Asia. It is comprised of a dedicated team of professionals from the domains of informatics and public health, and also draws upon the global HISP network for specific expertise as and when needed. Likewise, HISP India contributes to strengthening the global HISP network when its expertise is required. It subscribes to and supports the broader HISP agenda of creating "networks of action" which seeks to strengthen collaborative action by learning and sharing about health information systems, including around software, training material and implementation experiences, in a collective network. Learning in collectives is more effective than that done in singular sites, as we learn from each other and don't reinvent the wheel. This supports Global HISP and HISP India's strategy towards addressing challenges of scale and sustainability.

1.1 Vision

HISP India's vision is to strengthen the development and use of integrated health information systems within a public health inspired framework in India and the South Asian region.

1.2 Mission

The mission is to enable networks of collaborative action with like-minded actors who aspire to the ideology of open source software, open standards and decentralized decision-making to create complementary strengths in providing integrated and public health friendly health information systems.

1.3 Objectives:-

- Create and contribute to advocacy networks that promote Open Source software and Open Standards in Public Health Systems.
- Contribute towards research related to integrated Health Information architecture that has at its core, routine aggregate reporting systems, patient-based integrated District Hospital systems, Human resource for health information system, mobile-based reporting systems, and Geographic Information Systems (GIS).
- Contribute towards the design, development and implementation of integrated Health Information architecture including the core components described above.
- Processes of design, development and implementation are based upon and guided by principles supporting participatory design and mutual learning.
- Actively promote the cultivation of an information culture in Public Health Systems, such that health information becomes a strategic resource that contributes towards improving health outcomes, and is not just used for upward reporting.
- Contributing to building internal capacity in health systems, such that they are able to internally sustain systems of assured quality, and scale them geographically and functionally based on their evolving needs.

1.4 Products

HISP India provides services around a suite of health informatics products for the public health sector. All these products are based on f*ree and open source platforms* to provide the users with the freedom of having full control of their applications without the risk of vendor lock-ins to high-cost proprietary licenses. All the products are global leaders, in use in various countries and also acknowledged and accepted by international organizations like WHO and Health Metrics Network. These different products represent the components of an "ehealth architecture" suited to needs of the health sector within a "health systems" framework, and reflecting the effort of the WHO towards creating a Public Health Information Toolkit - a suite of integrated systems suitable for a national health system architecture.

Our world continues to be ravaged by pandemics of epic proportions, as over 40 million people are infected with diseases such as HIV/AIDS, multi-drug resistant tuberculosis, and malaria – most (up to 95%) of these afflictions are present in developing countries. Prevention and treatment interventions on this scale require efficient information management, which is critical as clinical care must increasingly be entrusted to less skilled providers. Whether for lack of time, developers, or money, most health care programs in developing countries manage their information with simple spreadsheets or small, poorly designed databases. To help them, we need to find a way not only to improve management tools, but also to reduce unnecessary, duplicate efforts.

As a response to these challenges, the Open Medical Record System (OpenMRS®) was created in 2004 as an open source medical record system platform for developing countries. OpenMRS is a multi-institution, non-profit collaborative led by Regenstrief Institute, a world-renowned leader in medical informatics research, and Partners in Health, a Boston-based philanthropic organization with a focus on improving the lives of underprivileged people worldwide through health care service and advocacy. These teams nurture a growing worldwide network of individuals and organizations all focused on creating medical record systems and a corresponding implementation network to allow system development self-reliance within resource constrained environments.

1.5 Where is OpenMRS?

OpenMRS is now in use around the world, including South Africa, Kenya, Rwanda, Lesotho, Zimbabwe, Mozambique, Uganda, Tanzania, Haiti, India, China, United States, Pakistan, the Philippines, and many other places.

This work is supported in part by many organizations including international and government aid groups, NGO's, as well as for-profit and non-profit corporations.

1.6 What is OpenMRS?

OpenMRS is a software platform and a reference application which enables design of a customized medical records system with no programming knowledge (although medical and systems analysis knowledge is required). It is a common platform upon which medical informatics efforts in developing countries can be built. The system is based on a conceptual database structure which is not dependent on the actual types of medical information required to be collected or on particular data collection forms and so can be customized for different uses. It is based on the principle that information should be stored in a way which makes it easy to summarize and analyze, i.e., minimal use of free text and maximum use of coded information. At its core is a **concept dictionary** which stores all diagnosis, tests, procedures, drugs and other general questions and potential answers. OpenMRS is a client-server application, which means it is designed to work in an environment where many client computers access the same information on a server.

There are several layers to the system.

- The data model borrows heavily from the Regenstrief model, which has over a 30-year history of proven scalability and is based on a concept dictionary.
- The API (Application Programming Interface) provides a programmatic "wrapper" around the data model, allowing any developer to program against more simplified method calls rather than having to understand the intricacies of the data model.
- The web application includes web front-ends and modules that extend the core functions — these are the user interfaces and applications themselves built upon the lower levels.

1.7 Features

This is an incomplete list of OpenMRS features "out of the box". Many add-on modules make it easy to infinitely expand and extend the system.

- **Central concept dictionary:** Definitions of all data (both questions and answers) are defined in a centralized dictionary, allowing for robust, coded data.
- **Security:** User authentication.
- **Privilege-based access:** User roles and permission system.

- **Patient repository:** Creation and maintenance of patient data, including demographics, clinical observations, encounter data, orders, etc.
- **Multiple identifiers per patient:** A single patient may have multiple medical record numbers.
- **Data entry:** With the FormEntry module, clients with InfoPath can design and enter data using flexible, electronic forms. With the HTML FormEntry module, forms can be created with customized HTML and run directly within the web application.
- **Data export:** Data can be exported into a spreadsheet format for use in other tools (Excel, Access, etc.).
- **Standards support:** HL7 engine for data import.
- **Modular architecture:** An OpenMRS Module can extend and add any type of functionality to the existing API and webapp.
- **Patient workflows:** An embedded patient workflow service allows patient to be put into programs (studies, treatment programs, etc.) and tracked through various states.
- **Cohort management:** The cohort builder allows you to create groups of patients for data exports, reporting, etc.
- **Relationships:** Relationships between any two people (patients, relatives, caretakers, etc.).
- **Patient merging:** Merging duplicate patients.
- **Localization / Internationalization:** Multiple language support and the possibility to extend to other languages with full UTF-8 support.
- **Support for complex data:** Radiology images, sound files, etc. can be stored as "complex" observations.
- **Reporting tools:** Flexible reporting tools.
- **Person attributes:** The attributes of a person can be extended to meet local needs.

2. INTRODUCTION

Over the last few decades, medical sciences have made significant progress leading to improvements in the modes of investigations, therapeutic activities and surgical procedures. This has enhanced the need to have authentic and accurate medical records of the patients. **Health Information System (HIS)** is one of the most promising applications of Information Technology (IT) in the Health Care Sector. The aim of HIS is to use a network of computers to collect, process and retrieve patient care and administrative information from various departments for all hospital activities. It also helps in decision-making for developing comprehensive health care policies.

Pre-implementation assessment helps in reducing the uncertainty, acquiring local knowledge, and thus increasing the likelihood of success of the implementation. Understanding as much as possible before implementation is initiated, is important to ensure that implementation strategies are appropriate and take into account the socio-economic realities.

The HIS comprises of an electronic patient record which forms the core of the system and links it to all other departments in the hospital where every department can be viewed as an information-processing agency. The management of Kenya MoH feels HIS assists in decision making, and medical audit. It is also felt that the existing manual process flow resulted in longer time for OPD consultation and delay in investigation results. So to evaluate the system efficiently a pre-implementation survey was conducted to understand the outpatient and inpatient process waiting time and also to judge the computer proficiency of the hospital staff so as to formulate a training plan. The data was collected in form of a questionnaire, the sample was the end-users of the system. This would be helpful in not only analyzing their needs but also to judge their level of understanding and their expectation and eventually after implementation the efficiency of our system.

Hospital-based customization provides a means of achieving this timeliness with maximum user satisfaction. It, however, requires a major commitment in personnel time as well as additional software and also proper steps and processes for customizing .The enhanced

control of system modifications and overall flexibility in planning the change process result in enthusiastic support of this approach by many hospitals. The key factors for success include careful selection of local personnel with adequate technical support, extensive QA control, and thorough auditing /validation and user involvement.

Customized data delivery technology provides real and tangible value to end users, accentuates workflow. Thus it is necessary to understand the customization process.

One of the Technical report by J. Sarivouyioukas* – A. Vagelatos on Introduction of Clinical Information System In a Regional General State Hospital of Athens, Greece said that in the implementation plan customization is done according to the specific requirements of the hospital. So the contents of the customization are only 10% different for various hospitals to be integrated which is found in the special sub-divisions in the hospital.

The purpose of a pre-implementation assessment is to provide a picture of the past and present situation in order to inform future decisions. That is, it is the "the construction of a possible future" by inscribing it into the present and future decisions of the organizations (Smithson & Tsiavos 2004).

3. REVIEW OF LITERATURE

The goal of the implementation is to provide the beginnings of an EMR that is suitable for all groups involved with healthcare in developing countries. In a study, The OpenMRS System: Collaborating toward an Open Source EMR for Developing Countries, the people created a collaborative network between the Regenstrief Institute and Partners in Health (PIH) and developed an initial code base. This free and open source code base provides simplified access to a complicated backend database. Researchers and Ministries of Health enjoyed clean, definable data coming back out of the database. The open source collaboration serves the funding agents and Ministries of Health with a low-cost installation that can be quickly adapted for use in multiple locales. They have implemented and tested the OpenMRS system in western Kenya. Future installations include Rwanda, South Africa, Tanzania, and Uganda.

Another study was done to examine those experiences of OpenMRS implementers who work in resource constrained settings throughout the world, in order to draw conclusions regarding factors stimulating implementation, barriers and facilitators to implementation, and successful strategies for implementation and sustainability.

Successful strategies, included understanding and addressing the needed infrastructure and human costs involved, training current personnel or hiring personnel who understand the software and how to modify it, and integration of the system into the daily work flow and meeting clinicians' workflow needs.

To understand about capacity building from the OpenMRS implementer's network, a study was carried out with objective to evaluate methods to strengthen the OpenMRS community by creating network that target specifically OpenMRS implementer's need; facilitate community participation and design help forum for issues regarding implementation; and to support worldwide user for implementation and mentoring and training as well. The methods used to achieve the objectives were one to one interaction, providing online support, community oriented programs and extensive program to reach every area.

As a result it was noticed that with community involvement OpenMRS implementers' network has been grown. The collaboration tools, mentoring and training strategies increased the functionality and sustainability of health oriented OSS. Conclusion drawn out of it was that to develop a successful community oriented OSS, community participation is must.

4. OBJECTIVES

4.1 ***Pre-implementation Study:*** This study was done to understand the waiting time at the various steps of the inpatient and outpatient processes.

4.2 ***Customization and Testing of HIS****:* The study was done to understand the following aspects:

1) Formulating the database for the Kenya MoH based on the respective requirements.
2) Customization of HIS according to the hospital requirements i.e. Role based access control, Customizing the modules (managing departments) – Registration, Triage & OPD, IPD, Laboratory, Radiology, and Billing.
3) Defining the Testing protocols.
4) Analyzing the gaps in the customization during the testing. Thus, enlisting the shortcomings and difficulties experienced during the process.

5. METHODOLOGY

5.1 ***Pre- implementation evaluation*****:** This study was a qualitative study which included 30 respondents. The tool used for data collection was questionnaire for interviews. The respondents of the study are the end users of the Hospital Information System i.e. nursing staff, Administrative staff, Medical Professionals, Technical Staff and Clerical Staff and Patients which were selected by random sampling.

5.2 ***Customization and Testing of HIS*****:** This was a qualitative study for which the data was collected by reviewing various papers and manuals and also by hands on experience on customization & testing.

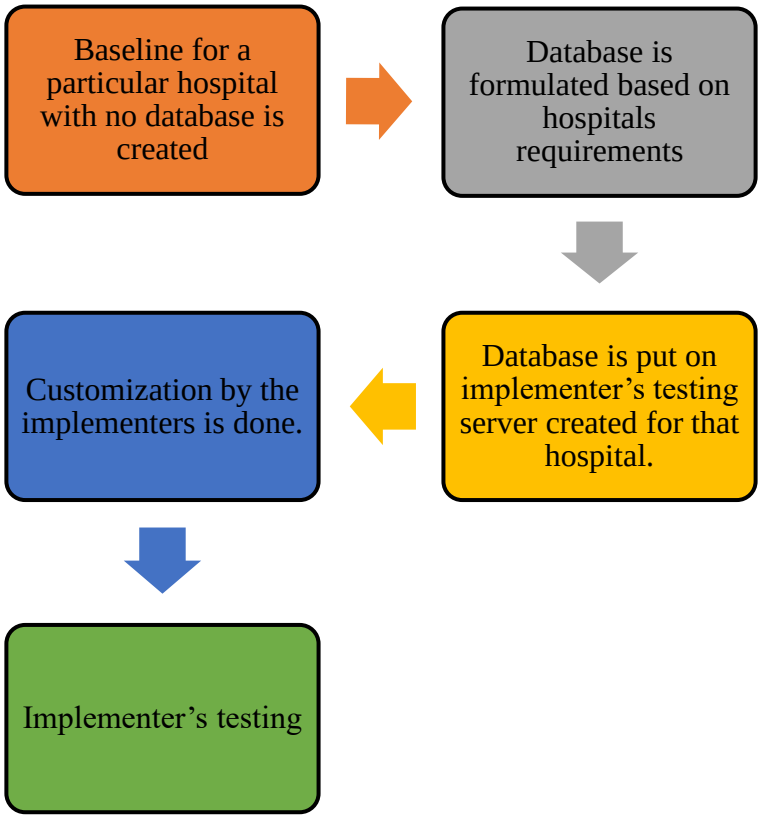
5.3 CUSTOMIZATION & ANALYSIS

So far, there are three versions of the HIS developed by HISP India, both nationally and internationally. The first version, i.e. Version 1, has been deployed at Himachal Pradesh in various districts. Version 2 has been developed for Bangladesh and for Kenya, Version 3 is being developed and customized.

In order to customize the OpenMRS, we must know the needs and requirements of the hospital and in what ways the OpenMRS is customizable.

5.3.1 Customization of HIS

In implementation of hospital information system includes implementing the re-engineered solution including design, construction, testing, and subsequent. In the customization phase of the Hospital Information System, the technical team and the implementation team play a major role. The implementer's role in the customization phase starts after the technical team is done with their role. For the testing phase, to start the customization by the implementers is to be done. The various parts of the customization done by the implementers include the following aspects:



5.3.2 Database Formation Based on the Hospital Requirements:

Database in this HIS is known as '**Concept Dictionary'**. The concept dictionary is the backbone of the Open Medical Records System (OpenMRS). It defines "the name, code, and appropriate attributes for any observations or data collected (including medical tests, drugs, results, symptoms and conditions)". It is also a "collection of coded, unique concepts used to generate forms and encode data within the system". Every medical concept that will be used in the electronic health record system must be defined within the dictionary.

Formation of a database for a HIS includes various aspects:

- Diagnosis
- Procedures – Minor and Major Procedures
- Drugs List
- Referencing of ICD-10 and SNOMED-CT
- Laboratory and Radiological Investigations
- Billable Services like Medical Examination, Ambulance, and License Fees etc.

In this HIS the database contains the following fields which are to be filled for forming a concept in the database.

- **Fully Specified Name-** The primary name is the name by which that concept would be searched for. This could be name of diagnosis, laboratory tests, radiological investigation, procedures, drugs etc.
  - The name should be completely specific. It is HEPATITIS B IMMUNIZATION, not IMMUNIZATION, HEPATITIS B.
  - Use all CAPITALS.
  - Use only alphanumeric characters! (If this was a concept, there would be no exclamation point.)
  - NO ACRONYMS: Abbreviations and acronyms are only used as synonyms!!
  - When necessary, always refer to the generic form, e.g. Ibuprofen, not Advil©
  - When referring to organism or virus, the full taxonomic name is used, e.g. HUMAN IMMUNODEFICIENCY VIRUS, not HIV
  - Adhere to complete granularity! RIGHT UPPER QUADRANT ABDOMINAL PAIN refers to too many observations. This can be tricky in practice and if you're unsure, refer to a geek or someone who can identify mini-clauses within your proposed primary name.
- **Synonym-** Use any other phrases or acronyms that people within your organization may search for when attempting to use this concept. If you're at a loss, conduct a survey of possible end users.
- **Short Name-** Be smart and only use alphanumeric characters, avoid long phrases, and acronyms that may have several meanings.
- **Description-** Without question, at the end of reading this statement, a lay person should have a decent idea of the concept meaning. This is always REQUIRED, no exceptions.
- **Concept Class-** The classification of a concept. This classification details how a concept will be represented (i.e. as a question or an answer). The current list of classes includes:
  - Test – lab tests (e.g. CD4 Count) or physical exam maneuver (e.g. Babinski)
  - Procedure – spinal tap, lumbar puncture, etc.
  - Drug – medications, prescriptions and over the counter

- Diagnosis – defined medical conclusion (usually in ICD), e.g. diabetes, AIDS
- Finding – physical or exam findings (shortness of breath, systolic murmur, LLL infiltrate)
- Anatomy – body part, e.g. right arm, frontal lobe, abdomen, etc.
- Question - query to which there are either open-ended or coded responses
- LabSet – a group of several test concepts, e.g. I-Stat Chem8+
- MedSet – a group of several medications, e.g. cardiac medication
- ConvSet – a group of concepts, typically questions, assembled for convenience, e.g. vitals signs
- Misc. – unclassifiable concepts, typically general descriptions of location or rankings, e.g. left, severe, positive
- Symptom – any sign or indication of a possible conclusion, e.g. chills, increased heart rate.
- Symptom/Finding – any sign or indication, not specifically linked to one conclusion
- Specimen – a sample of any larger part, e.g. tissue, blood sample
- Misc. Order – orders typically not utilized by the organization
- Program – a specific plan, or set of plans, that a patient may be enrolled in, e.g. first line TB treatment
- Workflow – a process, as described by the organization
- State – a general description of a patient or body's status, e.g. comatose
- Diet- for any type of diet to be advised

❖ **Concept Data Type-** The structured format you desired the data to be represented as. The current types are as follows:

- Numeric – any data represented numerically, also allows you to classify critical values and units, e.g. age, height, and liters consumed per day.
- Coded – allows answers to be only those provided, e.g. Blood type can only be "A," "B," and "O"
- Text – Open ended responses
- N/A –the standard data type for any non-query-like concepts, e.g. symptoms, diagnoses, findings, anatomy, misc., etc.
- Document
- Date – structured day, month, and year
- Time – structured time response

- Date Time – structured response including both the date and the time
- Boolean – checkbox response, e.g. yes or no queries
- Rule – rule-based response
- Structured – Complex numeric values possible (i.e., <5, 1-10, etc.)

❖ **Version-** A method to keep track of the number of updates applied to a specific concept

5.3.3 Creating a New Concept in HIS Concept Dictionary

The creation of a new concept is usually done by domain experts. A domain expert "is a person with special knowledge or skills in a particular area of endeavor.

There are many things to consider when creating a database for HIS:

- First and foremost: Language. Depending on what country you're in, what version of English is used as the medium of instruction, one must choose the language for the database. In India, we use British English as the spoken English, and also as the medium of instruction for education. Therefore the baseline concepts are created in British English, with American English as synonyms (e.g.: diarrhea vs. diarrhea, edema vs. edema)

No use of duplicates, as they disturb the functioning of the modules. Some concepts have been hard-coded, so do not disturb these (e.g. 'Global Obs')

- Conventions: What kinds of conventions:

a) Other than the hardcoded concepts that are in upper case and lower case both, all the other concepts are in UPPER CASE

b) All vaccines are mapped to a single vaccine concept (e.g. all vaccines related to polio vaccine will be mapped to polio vaccine concept in dictionary)

- References: **ICD-10:** International Statistical Classification of Diseases and Related Health Problems. The ICD is the international standard diagnostic classification for all general epidemiological, many health management purposes and clinical use. These include the analysis of the general health situation of population groups and monitoring of the incidence and prevalence of diseases and other health problems in

relation to other variables such as the characteristics and circumstances of the individuals affected, reimbursement, resource allocation, quality and guidelines. It is used to classify diseases and other health problems recorded on many types of health and vital records including death certificates and health records. In addition to enabling the storage and retrieval of diagnostic information for clinical, epidemiological and quality purposes, these records also provide the basis for the compilation of national mortality and morbidity statistics by WHO Member States. Work on creation of ICD-10 began in 1983 and was completed in the year 1992.

SNOMED CT – the Systematized Nomenclature of Medicine Clinical Terms - is a comprehensive and precise clinical reference terminology designed to make healthcare information useable and accessible. Global in scope SNOMED CT provides a common language of great depth that enables a consistent way of capturing, sharing and aggregating health data across clinical specialties and sites of care. (http://snomed.dataline.co.uk)

Thus, as is evident from the description, both ICD-10 and SNOMED provide a systemic universal classification of diseases. Thus the diagnoses made using OpenMRS in the hospital can also follow universal conventions. There are however, exceptions to this use. If there is a colloquial term used by doctors, or if doctors do not wish for such specificity in their diagnoses (granularity), a more common, collective term can be used.

Example: Just 'Carcinoma' may be used instead of D01 Carcinoma in situ of other and unspecified digestive organs, D02: Carcinoma in situ of middle ear and respiratory system etc. (According to the 10th revision, that is, ICD-10), if the doctor does not wish for such specific nature of the diagnosis. So depending on the size of the hospital, granularity is selected. For a Medical College and Hospital, such specific details may be required, while for an FRU, such granularity may not be required.

- Nomenclature: In case of disease conditions that have acute and chronic state, the word acute or chronic is used first, followed by the disease condition (ex: Acute Sinusitis, Chronic Sinusitis)
- Drugs: Drug nomenclature differs in different parts on the world, based on the pharmacopoeia that is used. Indian drug industry follows the Indian pharmacopoeia, whereas there are other pharmacopoeia that are also used like US and British (USP and BP). The reference used is CIMS (Current Index of Medical Specialties). This

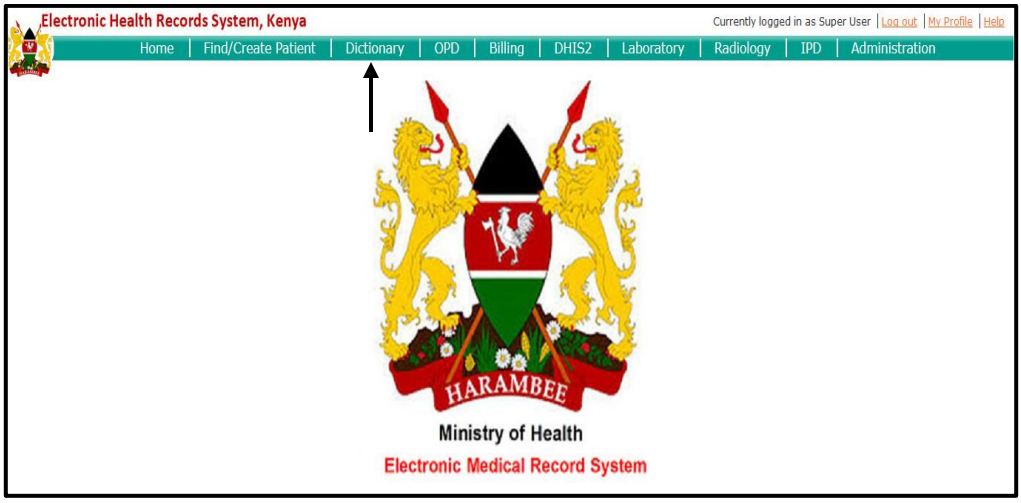
reference lists drugs in their generic salts forms, and also provides brand names containing that generic salt as an active ingredient. In OpenMRS dictionary, we use the generic salt as the concept name, and do not add any brand name (ex: We add the antiretroviral Zidovudine as concept and not its brand name Retrovir). If there are different salts of the same generic drug molecule that have the same pharmacological properties, these are included as synonym concepts. However, if a different salt has different pharmacological properties and therefore different indication in therapy, then it is listed as a separate concept.

The steps to make a new concept are as follows:-

STEP 1. Log into the HIS as the **"Administrator"** by entering the Username and Password.

Figure 1. Login Screen

STEP 2. Click **"Dictionary"** in the main tab.



STEP 3. Click **"Add New Concept".**

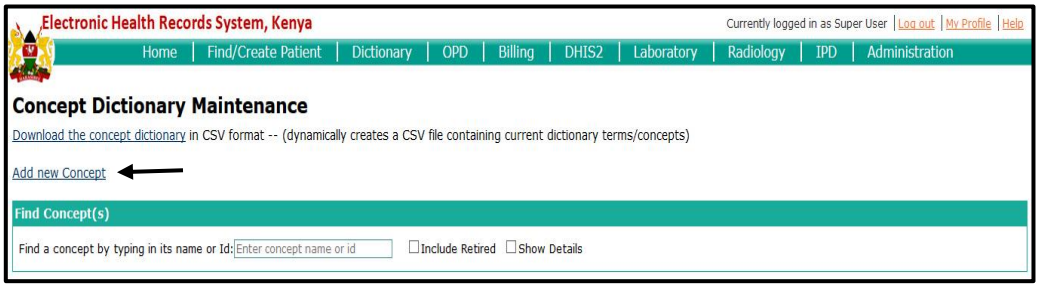
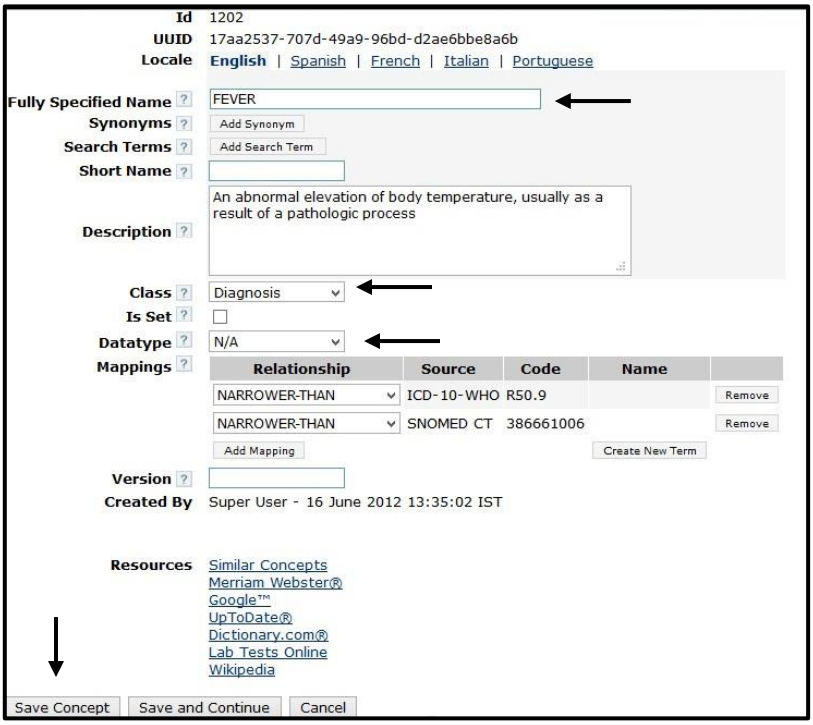


Figure 2. Add New Concept

STEP 4. Write the important properties/attributes of the new concept and click **"Save".**



5.3.4 Customization based on the hospital requirements:

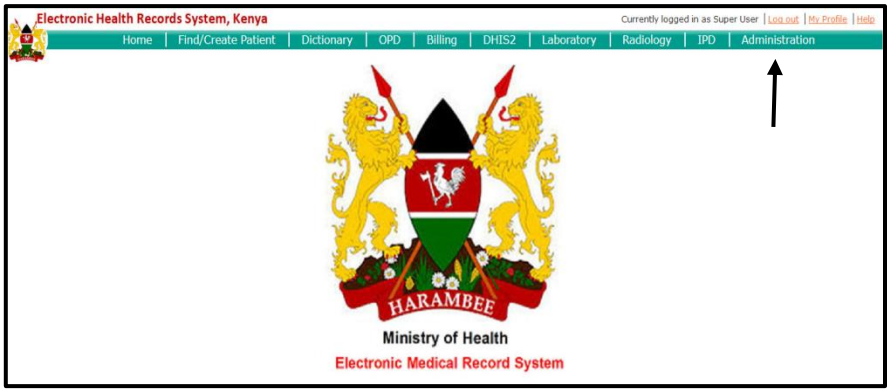
Role and User development-

HIS uses roles to manage permissions. Typical roles include:

- **System administrator** - configures Open MRS, installs and updates modules, manage user accounts
- **Registrars** - adds new patients to Open MRS at check-in; adds patients to programs
- **Data entry clerk** - creates and updates encounters after a visit
- **Care providers** - views patient records at point of care; creates or updates orders or encounters; assigns regimens
- **Content editors** - creates or updates the forms that collect encounter data; adds or changes concepts in the concept dictionary; adds or updates programs

Steps for adding Users:

Step 1. Log into the HIS as administrator, click on the **"Administration"** menu link.



Step 2. Click on **"Manage Users".**

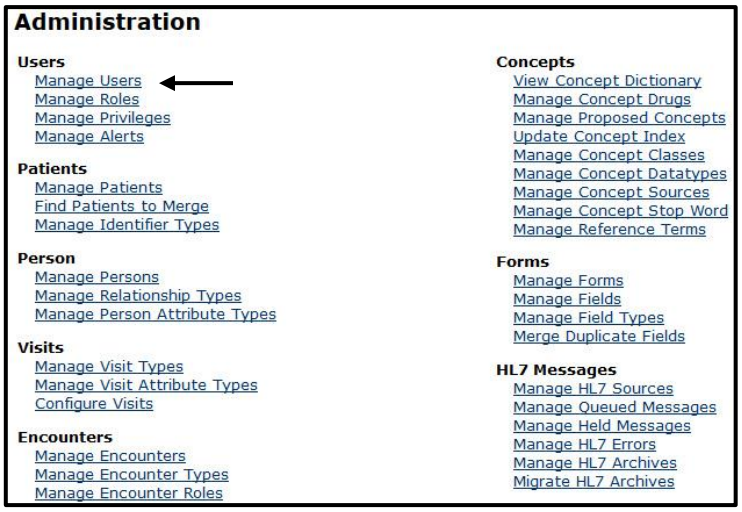


Figure 3. Manage Users

Step 3. Click on **"Add User"** and then click "Next" under Create New Person

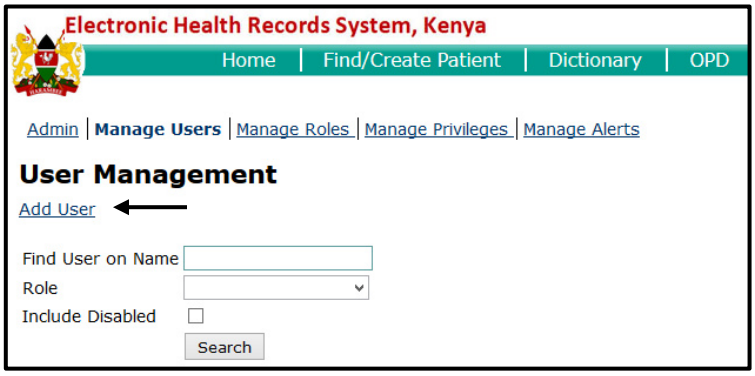
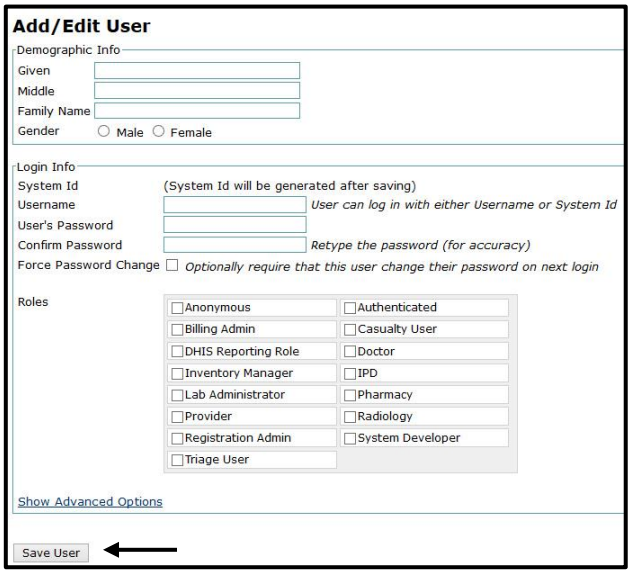


Figure 4. Add New User

Step 4. Type in the name of the person and the person's gender. Set up a username and password for the person. The password has to be at least 8 characters long. The password has to have uppercase, lowercase, and at least one number. Select a Role for the person. Click on **"Save User"** to add the person.



6. MODULES INTERCONNECTIVITY

The following diagram explains the connectivity of various modules in the hospital information system-

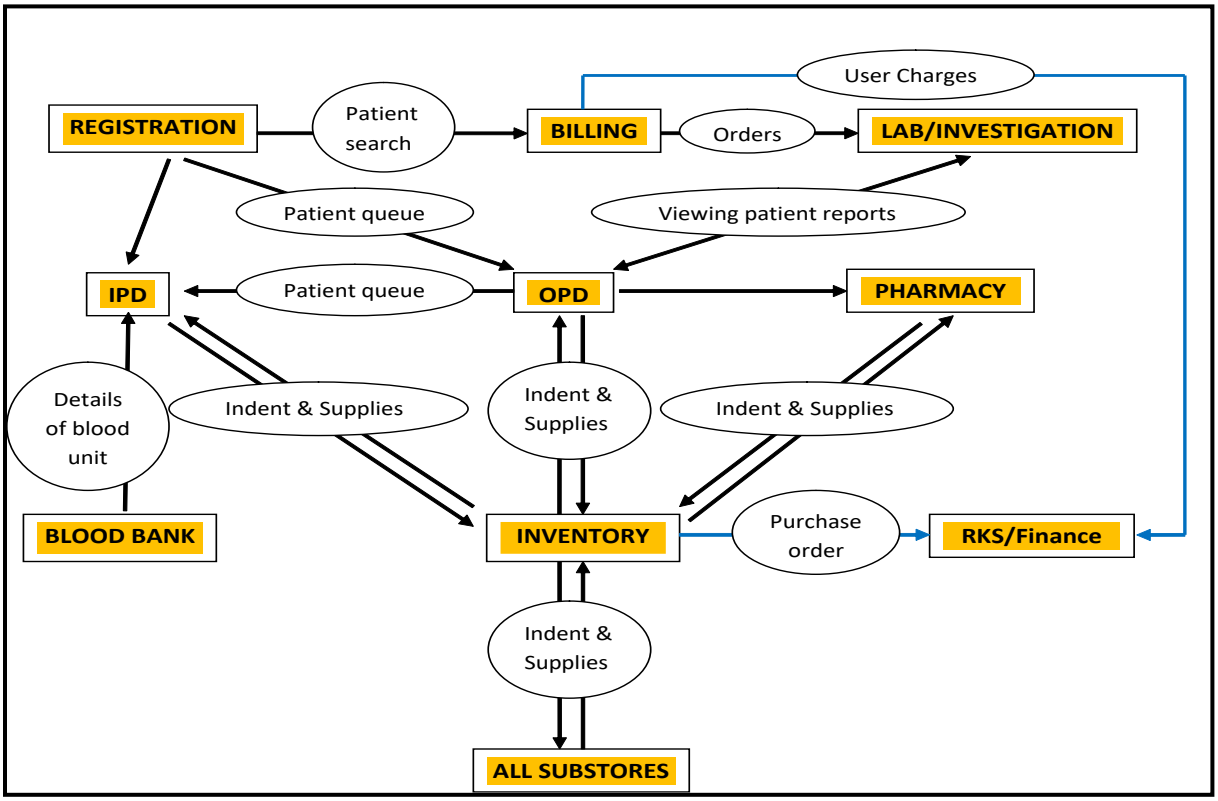


Figure 5. Modules Interconnectivity

7. FEASIBILITY STUDY

The purpose is to describe the existing workflow of various departments in the hospital, the proposed processes as well as the envisaged process re-engineering required. This document will also list the current manpower at various points and suggestions for the same, if required. Infrastructure requirements for the proposed hospital information system are also provided.

Registration Module

Table 1. F.S. - Registration

As-is Process: Existing	To-be Process: Proposed	Process Re-engineering envisaged
• Registration consists of 6 counters, one counter each for Medicine, Surgery, Child, ENT, Gynae and Dental/Skin. • Registration numbers begin with 1 from the 1st of January every year. Each counter has a separate serial order of registration numbers. • Once the patient is registered, an OPD slip is given to him. This same receipt is usable for the next few revisits, up until the receipt gets filled, after which the patient has to go to the registration counter again and get a new receipt. Since this receipt has a number on it, the patient is given this as a new registration number. • Data captured at the time of registration : o Patient demographics o The triage that he is supposed to visit. • Daily patient load: 1000 approx. • Daily Reports generated at registration : o Total number of patients registered o Total number of free patients o Total cash collected	• Online Registration module should operate for OPD Registration & Emergency Registration (if exists) • OPD Registration should have 6 counters & 1 counter for Emergency (if exists). • All referral patients should be directed to central registration • System will generate patient identifier/ unique registration number (also called CR number) - this is will be a 16 digit number • Registration date and time for each patient should be printed on OPD slip • Fields included in registration module will include: ▪ **Patient details**: Name, Age, Gender, Marital Status, Phone Number, National ID (if any) ▪ **Address** ▪ **Referral information:** ▪ Referred case : Y/N ▪ Referred from ▪ Reason for referral ▪ **Triage room to visit** – List of two types of triage will appear, i.e. OPD Triage and Casualty Triage	• Pre-printed registration slip • Free text box for patient's address • Patient fee collection at Registration (wherever applicable) • Single identifier that does not lapse.

OPD

Table 2. F.S. - OPD

As-is Process: Existing	To-be Process: Proposed	Process Re-engineering envisaged
• Functional OPDs: Medicine, Surgery, Ortho, Eye, Dental, Skin, Child, and Gynae. • There is one doctor in an OPD at	**Patient process:** • As the patient registers, firstly he goes through the triage where he is directed to the specific OPD. Then he falls in	• Provision to see Reports of Laboratory & Radiology (X-ray

any given time. • During consultation, the following information is captured on the OPD slip: o Chief complaint o Investigations, if required o Medication , if required • A patient is directed to an OPD from the registration, his name is called out in the respective OPD and the doctor provides the consultation. • Data that is recorded for each patient in the OPD register is : o Registration number, Serial Number for that day, Name, Age, Father's name, Address • Report generated : o A daily report is generated at the end of the day.	the queue of the respective OPD he was directed for. • As the patient comes, doctor clicks on patients name in the queue & dashboard for patient's medical record opens, where doctor can enter the following in the OPD entry screen: ▪ During consultation, doctor enters provisional diagnosis of the patient ▪ There's provision for free text to enter doctors notes if any ▪ Doctor can post the patient for any procedure (minor & major OT) ▪ To end the visit- doctor can call the patient for follow-up visit whenever due, or cured, reviewed (if no follow-up visit is required), or admit a patient, or to internally refer a patient to the Consultant or any other department. **Clinical history/Medical Record** • Clinical Summary (Details of the previous encounters- chronological visits of the patient, name of doctor & OPD consulted) • Laboratory (Full report) • Radiology (Full report) • IPD (Details of current and previous admission- summary of inpatient stay) • Pharmacy (Details of the drugs issued to the patient by the Pharmacy) ❖ *Since cash/billing is not done, as services are free, either of the following could be done,* • *Billing module is introduced (with zero billing) centrally or with each department.* • *Queues are generated when the*	and Ultrasound) reports on the Patient Dashboard. This will appear as the results are entered by the technicians in the respective departments. • As the drugs are issued to the patients in the Pharmacy or in the indoor (by the nurses), the details of the drugs appear in the Pharmacy record of the patient.

	tests are selected by the doctor in the OPD module.	

IPD

Table 3. F.S. - IPD

As-is Process: Existing	To-be Process: Proposed	Process Re-engineering envisaged
• Number of sanctioned beds : 120 • A patient can be directed to the	• In case of admission, OPD doctor will click on admit patient and select	• All essential information right

IPD either through the OPD or the Emergency. • Registration for IPD takes place at the Emergency ward. • Information captured on Bed head ticket : Patient's name, Father's/Husband's name, Address, Registration number, Date of admission, Time of admission, Date of discharge, Diagnosis. Progress notes are maintained on the bed head ticket itself. • At the time of discharge, the above discharge summary is given to the patient. The details of this as well as of the bed head ticket are maintained as records in the IPD. • Only one patient is admitted on each bed. • IPD maintains a stock of its own. For this, a stock register and an indent book is maintained. There is no periodic indenting, the nurse indents as and when required. • Stock is indented only from the Hospital Mainstore. • On a routine basis, the doctor visits patients once daily. • In case the doctor wants to order any investigation, he does so, on a coupon meant for the purpose. This coupon is handed over to the patient/attendant and he gets the tests done. Details captured are Patient name, Registration no, test prescribed. • No reports are generated in the IPD	ward to which the patient needs to be admitted • In this way the doctor sends admission request to the ward and name of patient will fall in the admission queue for that ward • Patient goes to the billing to pay the fee for admission along with the ward charges. • As soon as the patient reaches the ward, ward sister allocates bed number to the patient and admits the patient into the ward • Once the patient is admitted, his movement within the hospital is maintained in the system – i.e. – if the patient is posted for any surgery, transferred from one ward to the other • Vitals of the patient & input/output charts are not maintained in the system • At time of discharge, discharge summary is filled in the system with final diagnosis and the patient is discharged.	now is being captured in registers, this can be taken as output/report from the system

Laboratory

Table 4. F.S. - Laboratory

As-is Process: Existing	To-be Process: Proposed	Process Re-engineering envisaged
2 labs exist in the hospital- - Free Lab - General Lab (Outsourced to Central Diagnostics) **Free Lab** • Following tests are	• After being advised investigations by OPD doctor, patient goes to billing, pays for respective tests and gets bill receipt • As soon as patient pays, Lab order for respective investigation goes to labs,	**Sample number:** • To keep the hospital process of allocating sample number, same sample ID

performed in the free lab- • TC, DC, ESR, Hb, BT, CT, Widal, RA Factor, Urine Routine • If a patient is advised any of these tests ONLY, which are free for all patients, then he visits this free lab and gets these investigations performed. • Patient visits the free lab with the doctor's prescription, his details are recorded in the lab register, sample is collected, tests are performed and results are entered in the same register. Report given to the patient is a printed template on which findings are hand written. **General Lab** • It has a workload of 10-20 patients each day. • Free tests are performed while other tests are billable. • Once the billing is done, the sample for the patient is then collected, is labelled. • Reports are given next day to the patient. In emergency cases, reports are given in 2-3 hrs. • The technician enters the findings in system on a predesigned report template and the printed report is handed over to the patient.	i.e. patient gets into queue in lab • Daily Patient queue is formed and a patient stays in queue till his sample is collected & result is entered or one month from paying of bill (whichever is earlier). • When patient reaches to give sample, the test is accepted from the queue and allocated a sample number which is a daily serial number. • This sample number is written on the vial • After all samples are collected, work-list for each lab/department can be generated which will give list of patients who've given sample for respective labs. This can be taken before entering the results or after entering the results. • After all tests are complete, results are entered into the system for each test. • Patient report can be printed. **Lab work flow Process:** • Data being captured in registers can be taken as output from Lab module/system • System will generate all essential reports required by lab/hospital **Non-functional status** In case a test is not being done in the lab, lab administrator will have right to make it dysfunctional so that billing person is not able to bill for that particular test. **Adding/ deleting tests** Lab administrator will have the right to add additional test, if are being done in the hospital. Similarly can	should be given to all the tests of the same patient, irrespective of the number of tests. **Additional labs:** • Hospital has additional labs, which will be customized, with tests, ranges and respective lab requirements

	delete the tests which are not done.	

Radiology

Table 5. F.S. - Radiology

As-is Process: Existing	To-be Process: Proposed	Process Re-engineering envisaged
Radiology Module 3 radiology units- 1 for Ultrasound and 2 for X- ray **X-Ray** • 2 units 1 for X-ray of OPD and IPD patients. 1 for X-ray of MLC/ Accident cases. • X Rays are done only for the hospital patients and not for any referred cases. • There is a patient load of 40-50 patients each day. • Once the doctor prescribes any X-ray investigation to a patient, the patient visits the X-ray department a slip is given to him. Then the patient is queued for X-ray. The Report is given same day which is hand written No standard reports are sent through X-ray department. **Ultrasound** It has workload of 30-40 patients/day. Once the doctor prescribes any USG investigation to a patient, the patient visits the USG department a slip is given to him. Then the patient is queued for USG. The Report is given same day which is generated from the system. There is a template for normal report which is modified as per patient's findings. No standard reports are sent through USG department	**Patient process in x-ray:** • After being advised X-ray/Ultrasound by OPD doctor, patient goes to billing, pays for respective tests and gets a bill receipt • Even free bill category patients to go to billing for zero bill • As soon as patient pays, order to respective investigation goes to X-ray & Ultrasound, i.e. patient gets into queue in respective labs • Daily Patient queue is formed and a patient stays in queue till his tests is performed & result is entered. Details displayed in queue are: Patient ID, Name, X-ray, and Accepting Status. • When patient reaches for the test, he is accepted from the queue • After all tests are complete, results are entered into the system for each patient and patient report for respective patient can be printed. **Patient process in ultrasound:** • Up to patient queue process is same as above. Details displayed in queue are: Patient ID, Name, Ultrasound, and Accepting Status. • When patient reaches for the test, he is accepted from the queue, doctor will click on 'enter result' option. This will open form to enter ultrasound result on required parameters.	• Billing will send orders for all X-Rays and Ultrasounds. Doctor to write X-Ray with view/ Ultrasound to be done, and after being advised, patient should come directly to billing, whether free or paid, where the system will have an exhaustive list of all X-Rays with views, and Ultrasounds done in the hospital.

	• After result is entered, doctor can take print of report for respective patient **Radiology work flow process:** • Data being captured in registers can be taken as output from Radiology module/system • System will generate all essential reports required **Non-functional status** In case a test is not being done, radiology administrator will have right to make it dysfunctional so that billing person is not billed for currently dysfunctional radiology test **Adding/ deleting tests** Radiology administrator will have right to add additional test, if are being done at hospital. Similarly can delete the tests which are not done ❖ *Since cash/billing is not done, as services are free, either of the following could be done,* • *Billing module is introduced (with zero billing) centrally or with each department.* • *Queues are generated when the tests are selected by the doctor in the OPD module.*	

Billing

Table 6. F.S. - Billing

As-is Process: Existing	To-be Process: Proposed	Process Re-engineering envisaged

• Registration, Laboratory Tests, Radiology Tests and IPD are billable.	• Billing Module(HIS) including prices of all billable services , will be done in 4 main categories
	  • **Patient Billing:** charges for all investigations , inpatient admission/ discharge, cabins, medical examination, procedures/operations,
	  • **Ambulance Billing** – charges for use of ambulance
	  • **Tender billing** – charges for tender/auction earnest money
	  • **Miscellaneous** - fee from canteen etc.
	• For all patient services, orders will go from billing once payment for respective service is made.
	• Bill cancellation (Voiding a Bill): Bills can be cancelled or edited by administrator.
	• Patient Bill Print out will have following details:
	Patient Name & Identifier, Bill ID, Date, Services billed (with individual break-up), Total Amount
	• Tender Bill Print out will have following details:
	Name of company & address, Tender name and number , Tender Amount, Date for the particular service
	• Ambulance Bill Print out will have following details: Bill ID, Name of Driver, Date, Patient name, Receipt number, Number of trip, Origin, Destination & Amount
	• Miscellaneous Bill Print out will have following details: Name, Date, Service
		• Preprinted Billing stationary
		• Option to free a patient in the system at the time of Billing.
		
		In cases where current system has no billing/cash counter and if billing module cannot be introduced, then orders should be able to go from OPD/IPD to Laboratory or Radiology as required.

	billed, Amount paid • In case advance for services is taken, the billing clerk should be able to refund the amount and make changes in the bill once printed. • **Non-functional status of billing service:** In case certain tests are not functional (X-Ray or CT Scan machine not working, blood tests not working, reagents not available etc.), Laboratory or Radiology technician will provide feedback of this cessation of functioning to the billing clerk, who will then disable those services, so that those services are not requested **REPORTS** • Daily cash report, along with collected money with details of collections from each service can be printed • Other reports having the details of all bills generated can be printed.	

8. REGISTRATION MODULE

8.1 INTRODUCTION

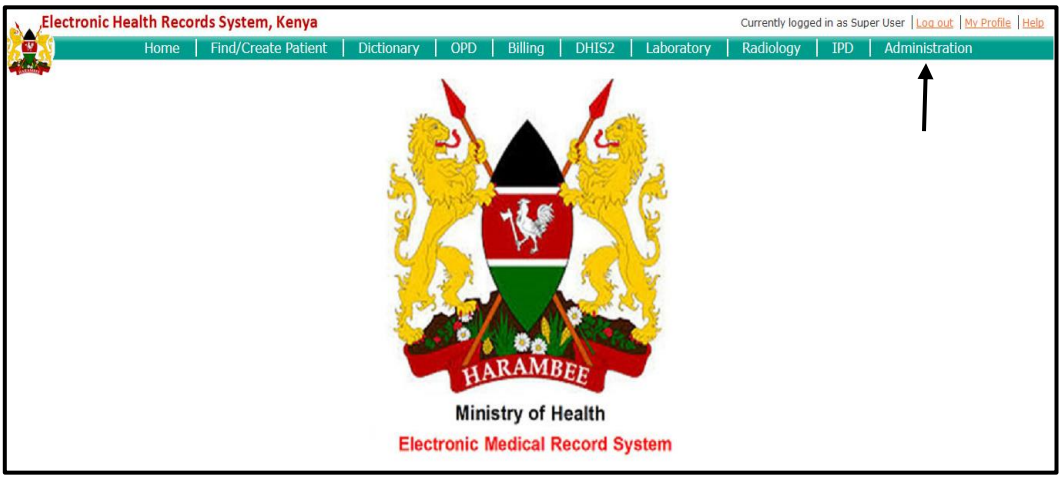
The registration of the patient is the foremost activity a hospital. Every patient who approaches a hospital has to get registered prior to getting any consultation, treatment, and investigations done from the hospital. Registration of patients involves accepting certain general and demographic information, at the end of which the patient is given a unique Computerized Registration Number (CR No.).

The customization of the Registration Module includes the following:

(i) Person Attribute- Person attributes abstracts that define a characteristic of an entity such as the demographic details of the person like Name, Relative's Name, Patient Category, Contact Number etc. that help in identification of the patients from the patient pool. These attributes can be extended to meet the local needs of the hospital system in place.

In the HIS, the person attributes appear on the registration screen. The person attributes can be managed by following the below mentioned steps:

Step 1. To manage person attributes log into the HIS as administrator, once you successfully log in, click on the **"Administration"** menu link.



Step 2. In the Administration Menu, click on **"Manage Person Attributes".**

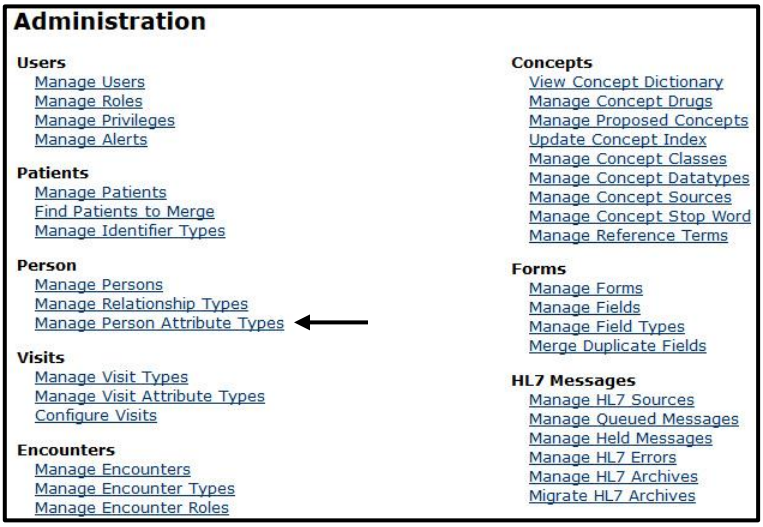


Figure 6. Manage Person Attributes

Step 3. On Clicking Manage Person Attributes Types, click **"Add New Person Attribute Types"** to a new person attribute.

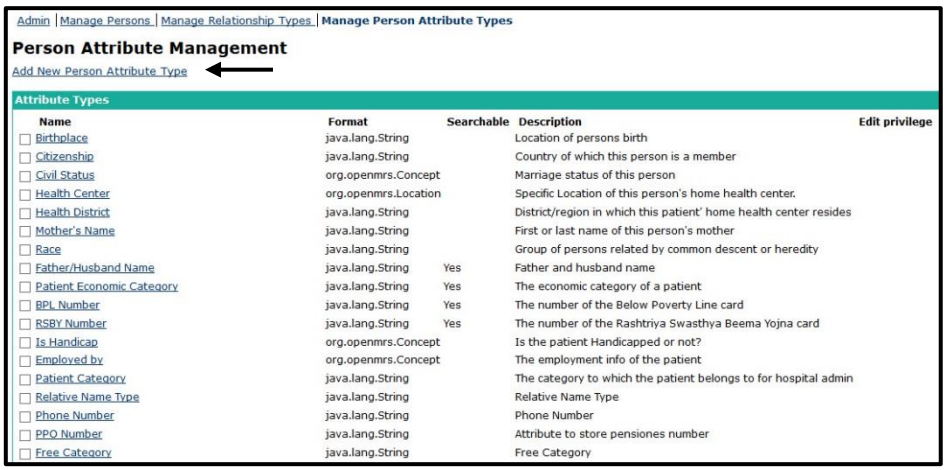


Figure 7. Add New Person Attributes

Step 4. Fill the respective fields in the form and click **"Save Person Attribute Type"**

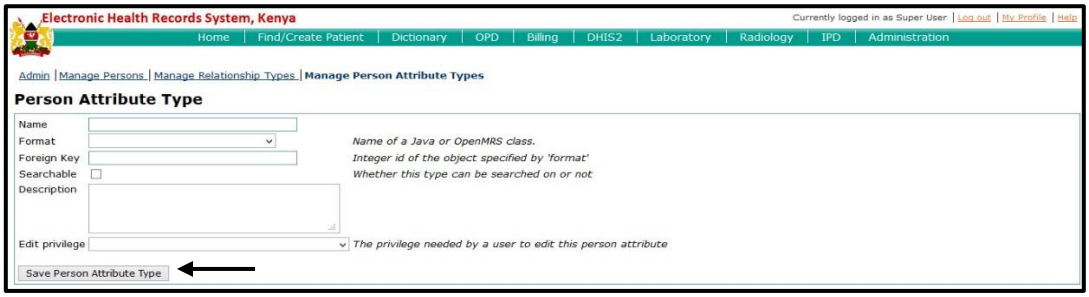
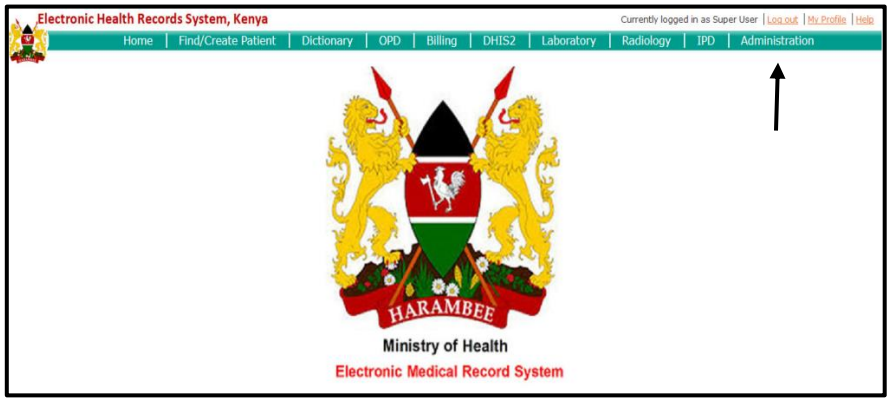


Figure 8. Save Person Attributes

(ii) Identifier Initials- Identifier Initials are the abbreviation or the initials of the hospital name and it can be changed according to the name of the hospital.

The Identifier Initials can be changed according to the hospital and its name. The following steps allow the user to manage the identifier:

Step 1: To manage Identifier Initials log into the HIS as administrator and then click on the **"Administration"** menu link.



Step 2. Click on **"Advanced Settings**" under **"Maintenance"** section.

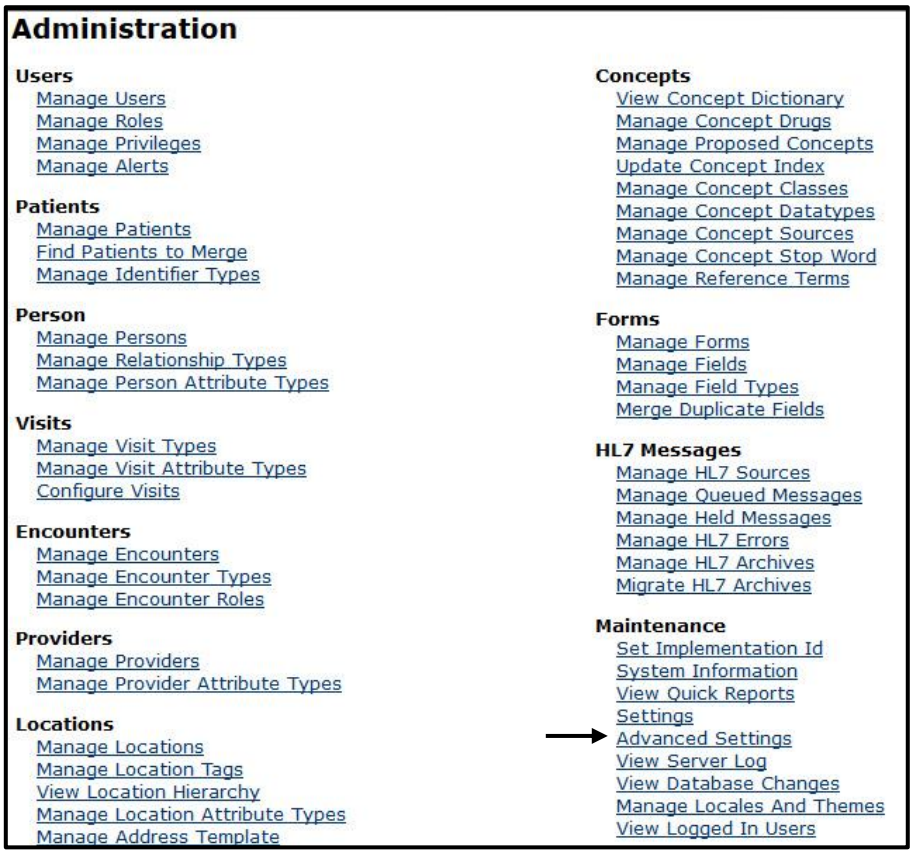


Figure 9. Advanced Settings

Step 3. Locate the **"registration.identifier_prefix"** in the list and type in the desired initial for the identifier. Save by clicking **"Save"** at the end of the page

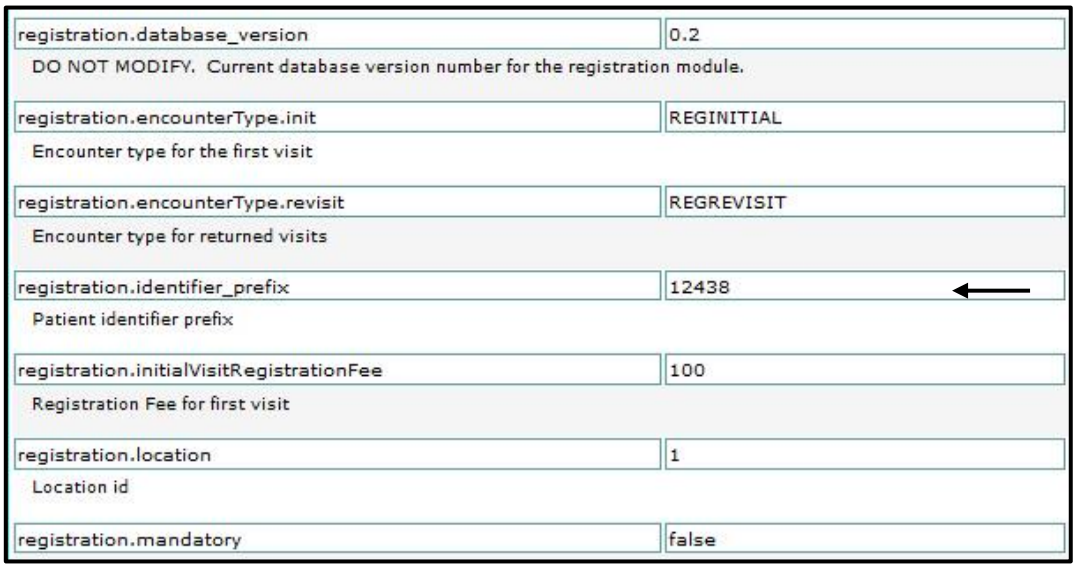


Figure 10. Identifier Initials

The Registration Module varies both by the interface and process in all the three versions of the HIS. The differences are given below-

VERSION 1 (INDIA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
INTERFACE		
➢ Aadhar Card Number ➢ Demographics- Birth date and gender ➢ Postal address with sub-district as "Tehsil" ➢ There are 7 different types of patient categories- ▪ General ▪ Staff ▪ RSBY ▪ BPL ▪ Antenatal Patient ▪ Child >1 Year ▪ Other Free • 'OPD Room to Visit' consists the list of different OPDs	➢ National ID ➢ Demographics- Birth date and gender. Gender has the option to choose 'others' also. ➢ Postal address with sub-district as "Upazila" ➢ There are no patient categories. • 'OPD Room to Visit' consists the list of different OPDs	➢ National ID ➢ Demographics- Birth date, gender and marital status. Gender has no option to select 'others'. ➢ Physical residence & Nationality with sub-districts as "County" • There are 5 types of patient categories- ▪ Child less than 5 years old ▪ Comprehensive Care Clinic (CCC) Patient ▪ Expectant Mother ▪ Waiver ▪ NHIF Card Holder • 'Triage Room to Visit' consists of OPD & Casualty Triage.

Table 7. Registration- Interface Change

Table 8. Registration- Process Change

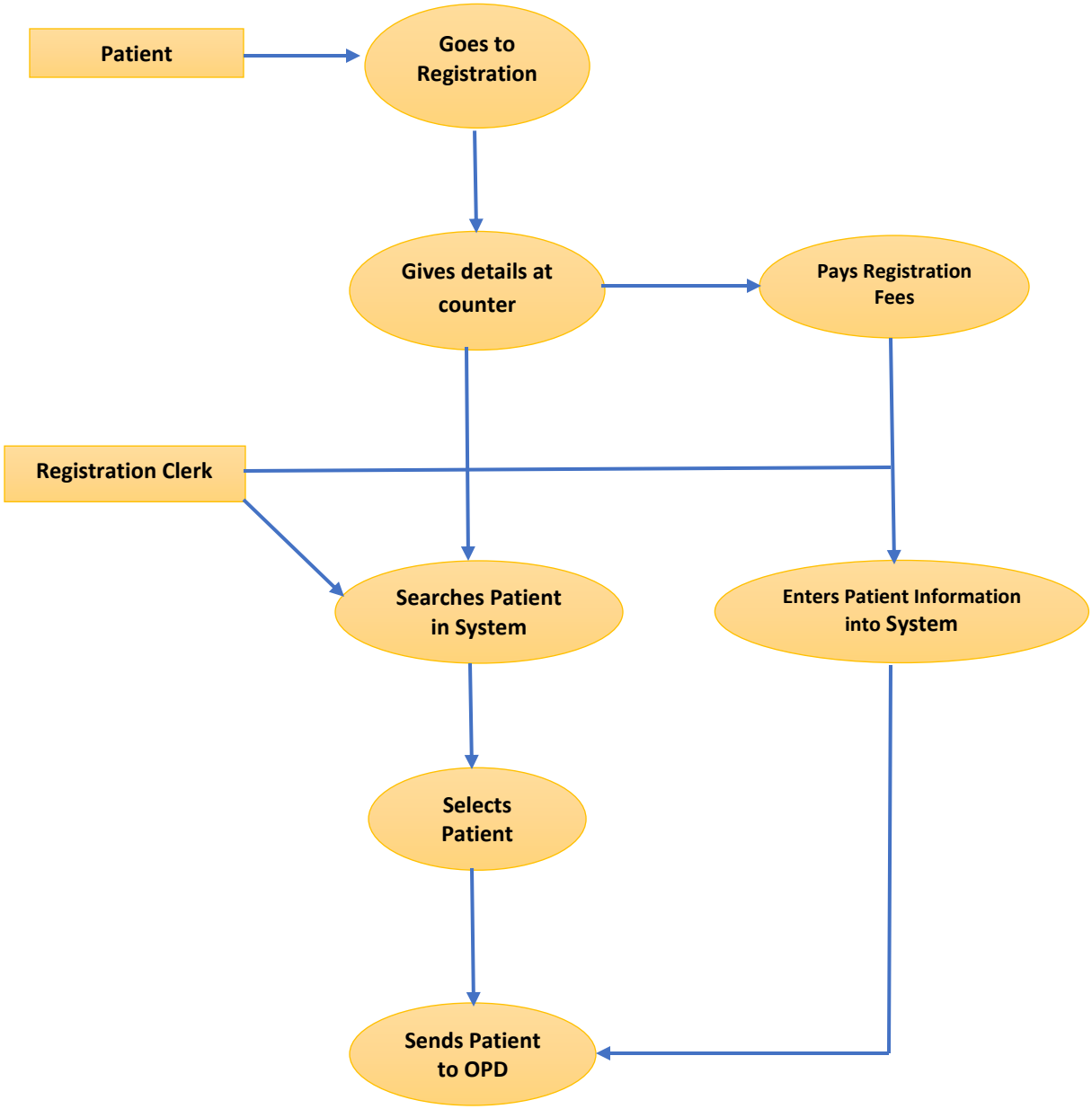
VERSION 1 (INDIA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
PROCESS		
➢ Dependent on patient category.	➢ Fees is of two types- paid or free ➢ If paid is clicked, amount is asked to be collected. ➢ If free is clicked, the reason is asked. ➢ There is no particular category	➢ Dependent on the 5 different categories.

8.2 TRACEABILITY MATRIX

Table 9. Registration- Traceability Matrix

S. No.	NAME	PRIORITY	OUTPUT
	Patient Name	High	The patient is saved in the system with his name, surname, and other name.
	Demographics	High	Basic demographics like age, gender and D.O.B can be entered.
	Physical Residence	High	Patient's address details can be entered.
	Contact No./Email Address	Low	Patient's phone number and email ID is entered here.
	Next of Kin (NOK) Information	Medium	Information regarding patient's relatives can be entered here.
	National ID	High	It has to be different. No two patients can be registered with a same ID.
	Patient Category	High	Different patient categories for bill exemptions
	Temporary Category	Medium	Different types of MLC cases to choose from. Depends on the type of case.
	OPD Triage To Visit	High	From here the patients can be directed to the different OPDs depending on the situation
	Referral	Low	Information about to and from where the patient has been referred.

8.3 DATA FLOW DIAGRAM



9. OPD AND TRIAGE MODULE

9.1 INTRODUCTION

Once the registration of a patient is done, he/she has to go through the Triage, where the patient's vital statistics are captured and he/she is further directed to a specific OPD from here.

The Triage screen looks like as below, in which the arrow marked is showing the specific OPD to choose for the patient.

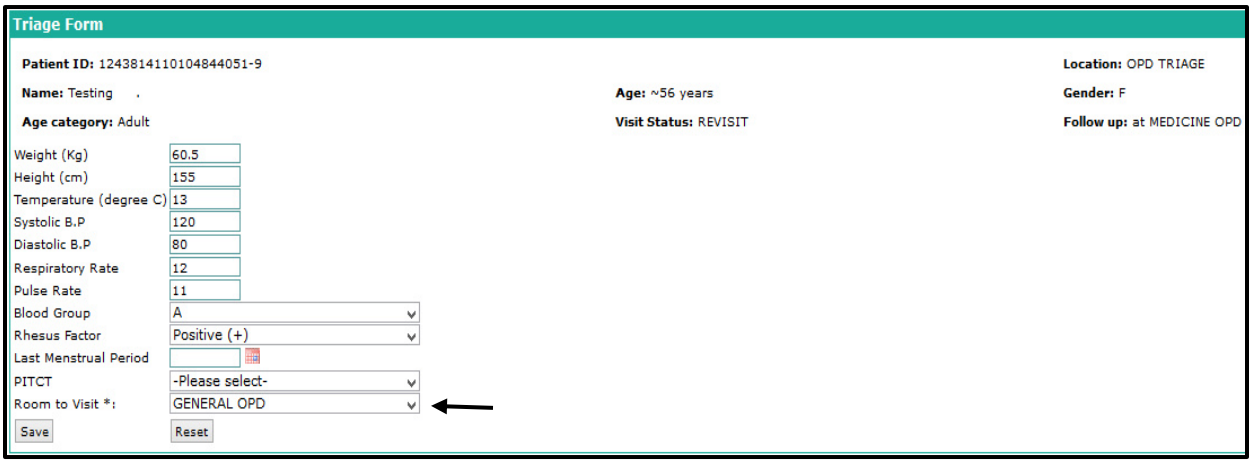


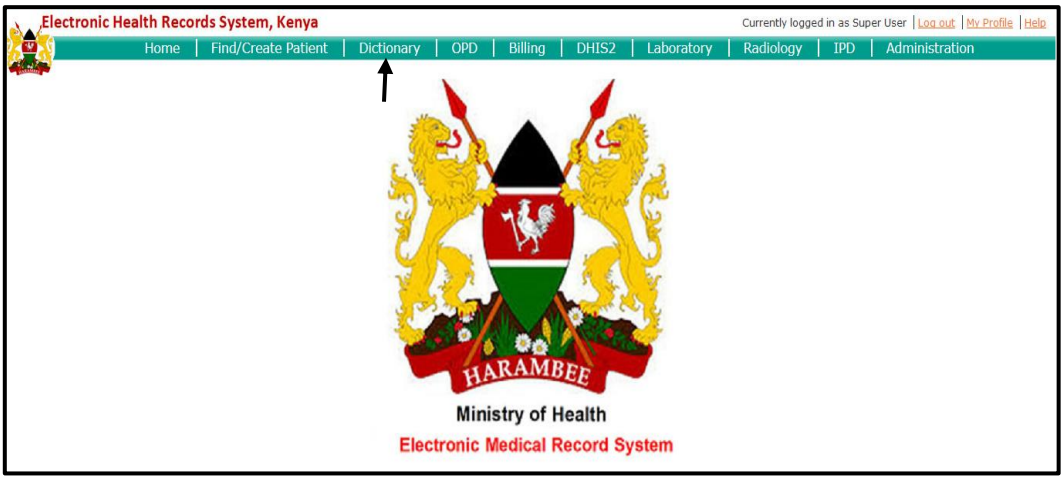
Figure 11. Triage Screen

The OPD module consists of 2 main components – the patient queue and the patient dashboard. As the patients are registered at the registration counter, they are seen in the queue for each of the particular OPD's for which they have been registered after being sent from the triage. The patient dashboard is the main interface for the doctor to do the entry; it is also a record of the clinical details of the patient. Through the patient dashboard, the clinical summary/medical history of the patient can be seen by all the doctors across the hospital. The doctors would also be able to view the results of all the investigations that have been conducted by the patient, as well as the in-patient record of the patient and lots of other records as well.

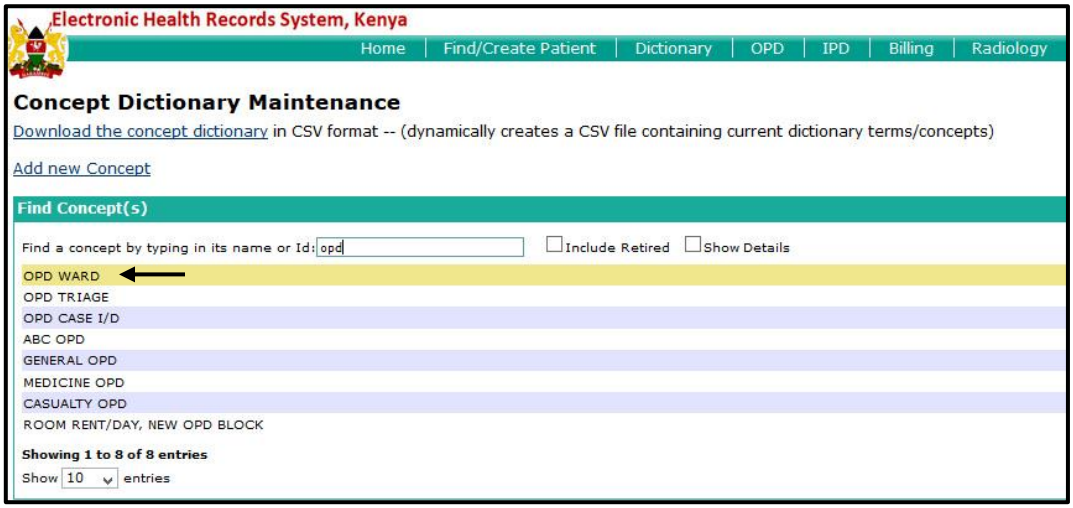
The OPD module and the patient dashboard form the heart of the system that maintains the electronic medical record for each patient.

To begin with, the OPDs have to be mapped in the Concept Dictionary; the following steps are followed to do the same:

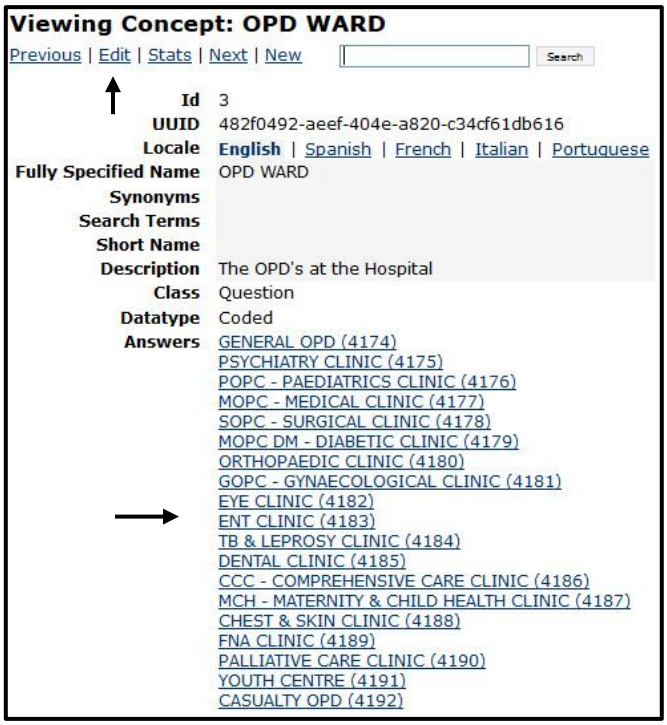
Step 1: To add OPD's, log into the HIS as administrator. Once you successfully log in, click on the **"Dictionary"** in the menu.



Step 2. In the dictionary, search the concept **"OPD Ward"** which already exists in the database (Class is question and Data Type is coded).



Step 3. Click on **"Edit"**, and map the various OPD's as answers to this concepts. Click **"Save".** The Class is **"Misc."** and Data type is **"N/A"** of the answers mapped to the concept.

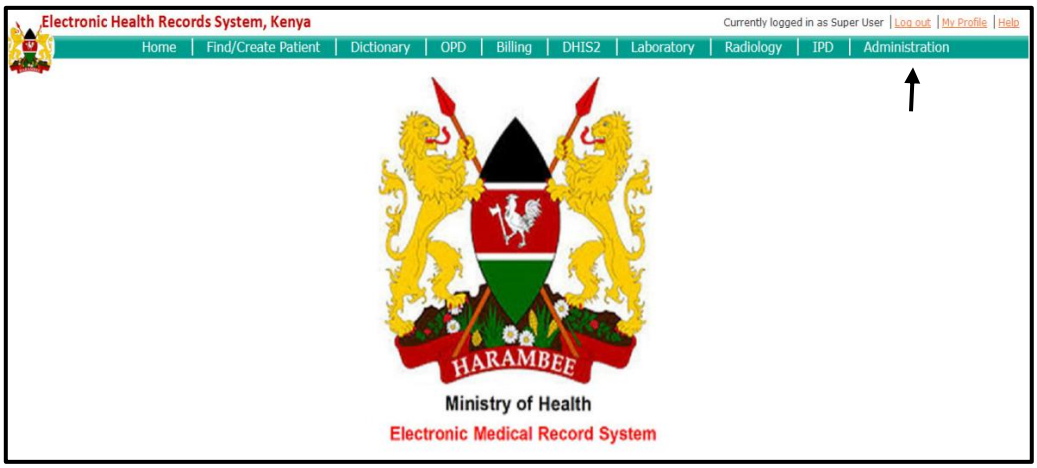


9.2 Manage OPD Department

The next customization level of OPD module includes mapping of the department list so that they appear in their modules. This functionality of Department list enables the OPD user to add the various departments in their module.

The following steps have to be followed in order to map the departments so that they appear in the OPD module:

Step 1. To add OPD Departments, log into the HIS as Administrator and click on **"Administration"**.



Step 2: In the Administration Menu, click on **"Department List"** under **"Hospital Core".**

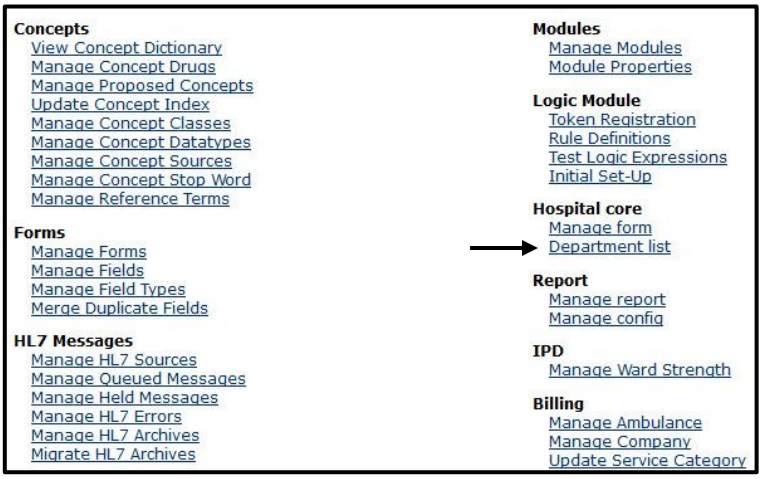


Figure 12. Department List

Step 3: To add new department click on **"Add Department".**

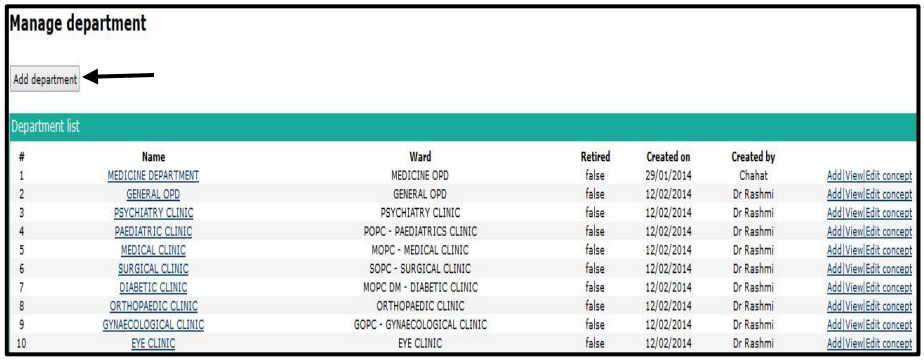
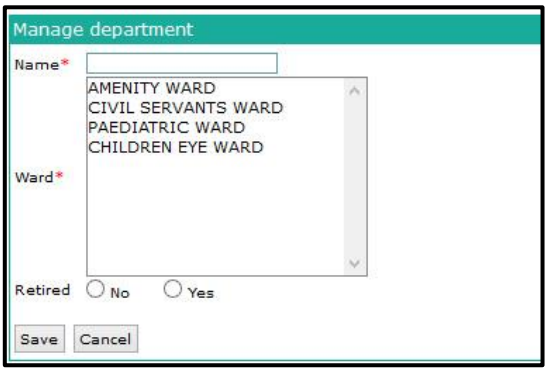
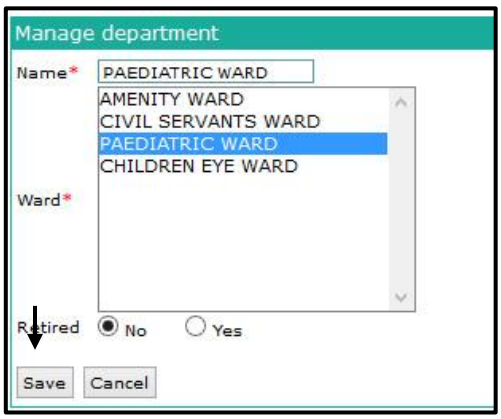


Figure 13. Add New Department

Step 4: It is important here to check the department that you want to create already exists or not. Check the list of departments that already exist or not. If the department that you want to create doesn't exist click on the **"Add department".**



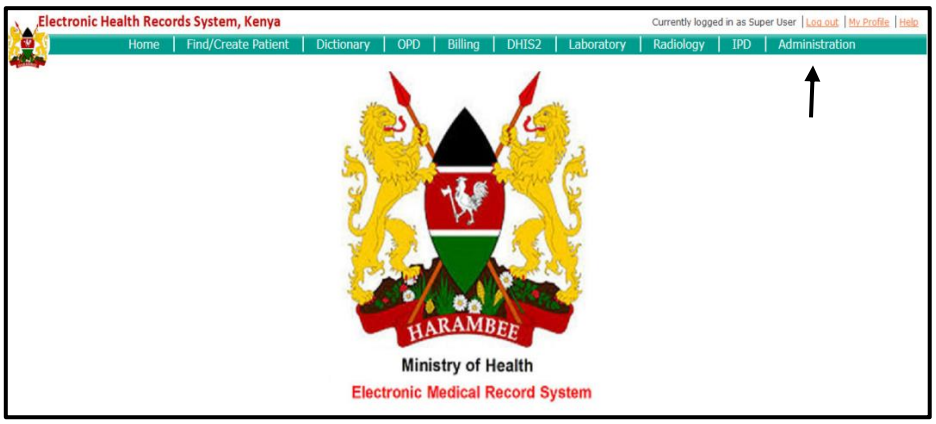
Step 5: Type the name of the department, then select from list that particular OPD (this list is made while preparing the database) and then select retired or not (i.e. the particular concept exists in the database or not). Click on **"Save".**



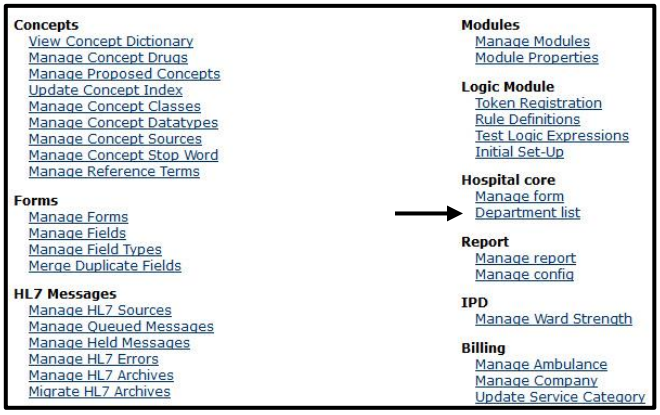
9.3 Adding Diagnosis and Procedures to OPDs

The next level of customization is adding Diagnosis and Procedures to OPDs. The following steps have to be followed in order to do that:

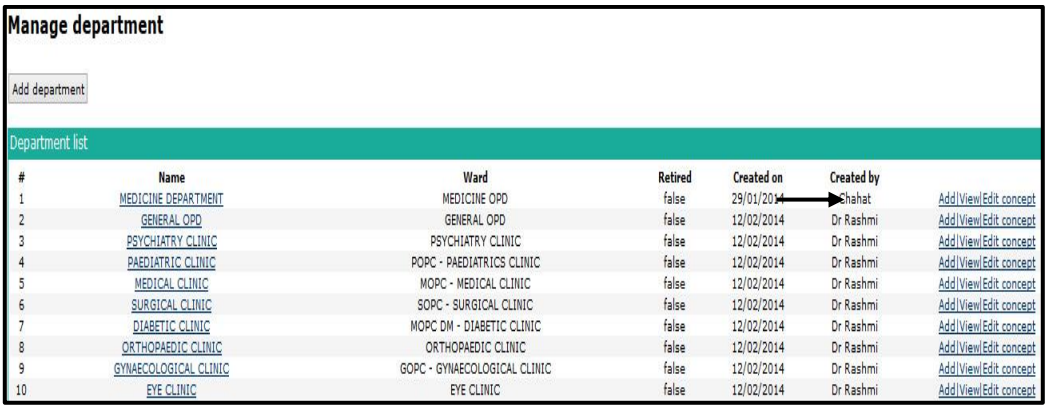
Step 1: To add diagnosis, log into HIS as administrator and click on **"Administration"**.



Step 2: In the Administration Menu, click on **"Department List"** under **"Hospital Core".**



Step 3. In Manage Department Screen, click on **"Add/View/Edit Concept".**



Step 4. Select the **"Diagnosis and Procedures"** to be added for the particular OPD and click on **"Save".**

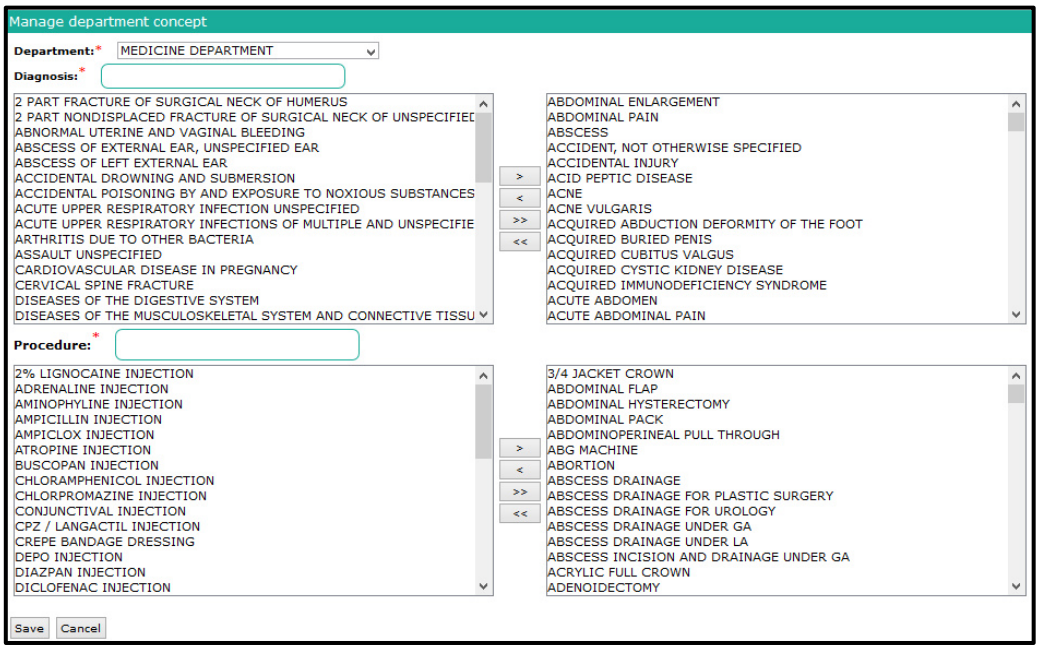


Figure 14. Add Diagnosis & Procedures

The OPD Module varies both by the interface and process in all the three versions of the HIS:-

Table 10. OPD- Interface Change

VERSION 1 (INDIA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
INTERFACE		
For Triage- • No Triage Screen **For OPD-** • OPD Dashboard consists of Diagnosis, Procedures and Visit Outcome • No Vital Statistics seen on the dashboard	• No Triage Screen • OPD Dashboard consists of Diagnosis, Investigations, Drug, Visit Outcome, etc. • No Vital Statistics seen on the dashboard	• Triage Screen is present where vital stats are captured and the patient is further directed to an OPD • History of Illness information is also asked along with Diagnosis, Investigations, Outcome, etc. • Vital Statistics can be seen at one side.

Table 11. OPD- Process Change

VERSION 1 (INDIA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
PROCESS		
For Triage- ➢ N/A **For OPD-** ➢ Not an Order Management Model. It's independent of any other module. The diagnosis and other details are simply entered of a patient.	➢ N/A ➢ It's an Order Management Model- the order given by the doctor goes directly to the billing module. Once the bill is saved, it goes to the lab technician who sees what all tests have to be done. Once the investigation report is uploaded it again goes to the patient dashboard where the doctor is able to view the report.	➢ Vital Stats once entered, the patient is directed to the OPD. ➢ Order Management Model- Any order given by doctor goes to billing. Once the bill is paid by the patient for the investigation or drug, the patient queue appears in the Laboratory, Radiology and Pharmacy Dept.

9.4 OPD DASHBOARD

The OPD Dashboard of a patient is the most important concept of the HIS of Kenya. Basically, here all the patient's clinical details can be entered or viewed. It consists of different tabs like- OPD Entry, Clinical Summary, Laboratory Record, Radiology Record, IPD Record, and Pharmacy Record.

OPD Entry- Under this tab, the patient's diagnosis, investigation, procedure, drug, and visit outcome can be entered. Other details like history of present illness, internal/external referral, and other instructions can also be added.

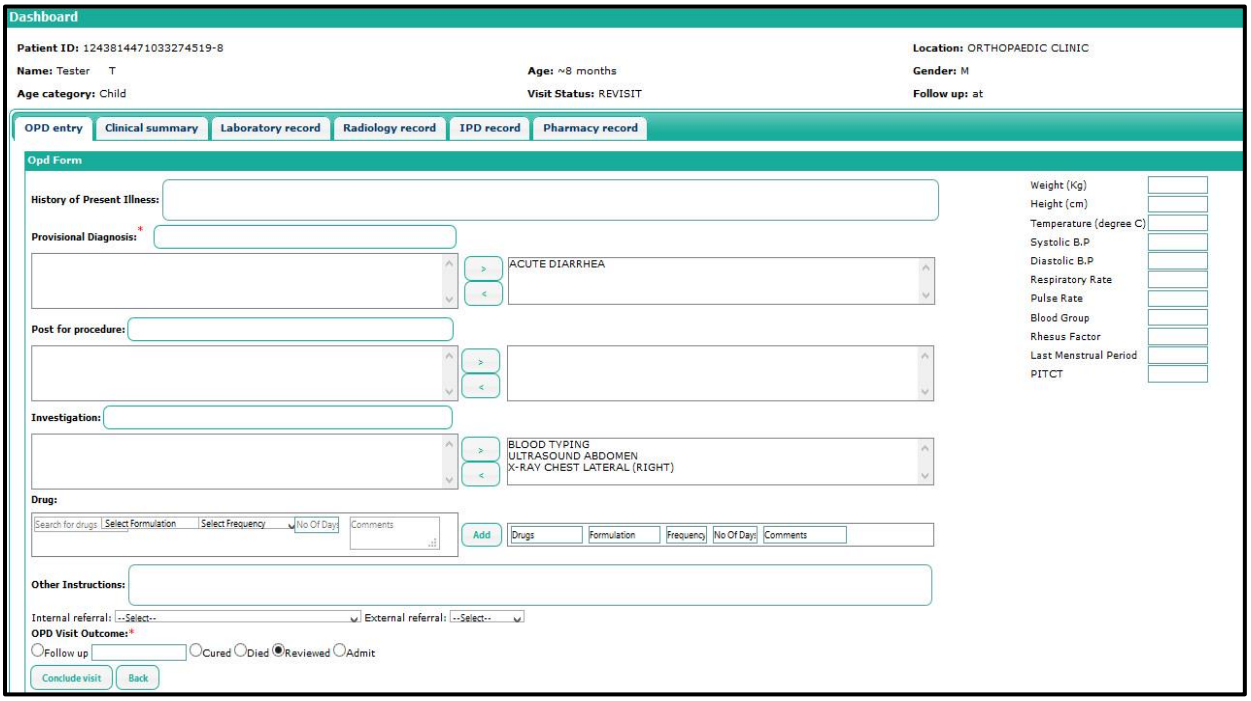


Figure 15. OPD Dashboard

Clinical Summary- In this, all the previous diagnosis and related information can be viewed of a revisiting patient. The patient's date of visit, treating doctor, diagnosis, procedures and visit outcome can be seen.

Figure 16. OPD- Clinical Summary

Laboratory Record- All the details of the laboratory tests conducted of a patient can be seen under this tab.

Figure 17. OPD- Laboratory Record

Radiology Record- Details of all the radiological tests performed on a patient can be viewed under this tab.

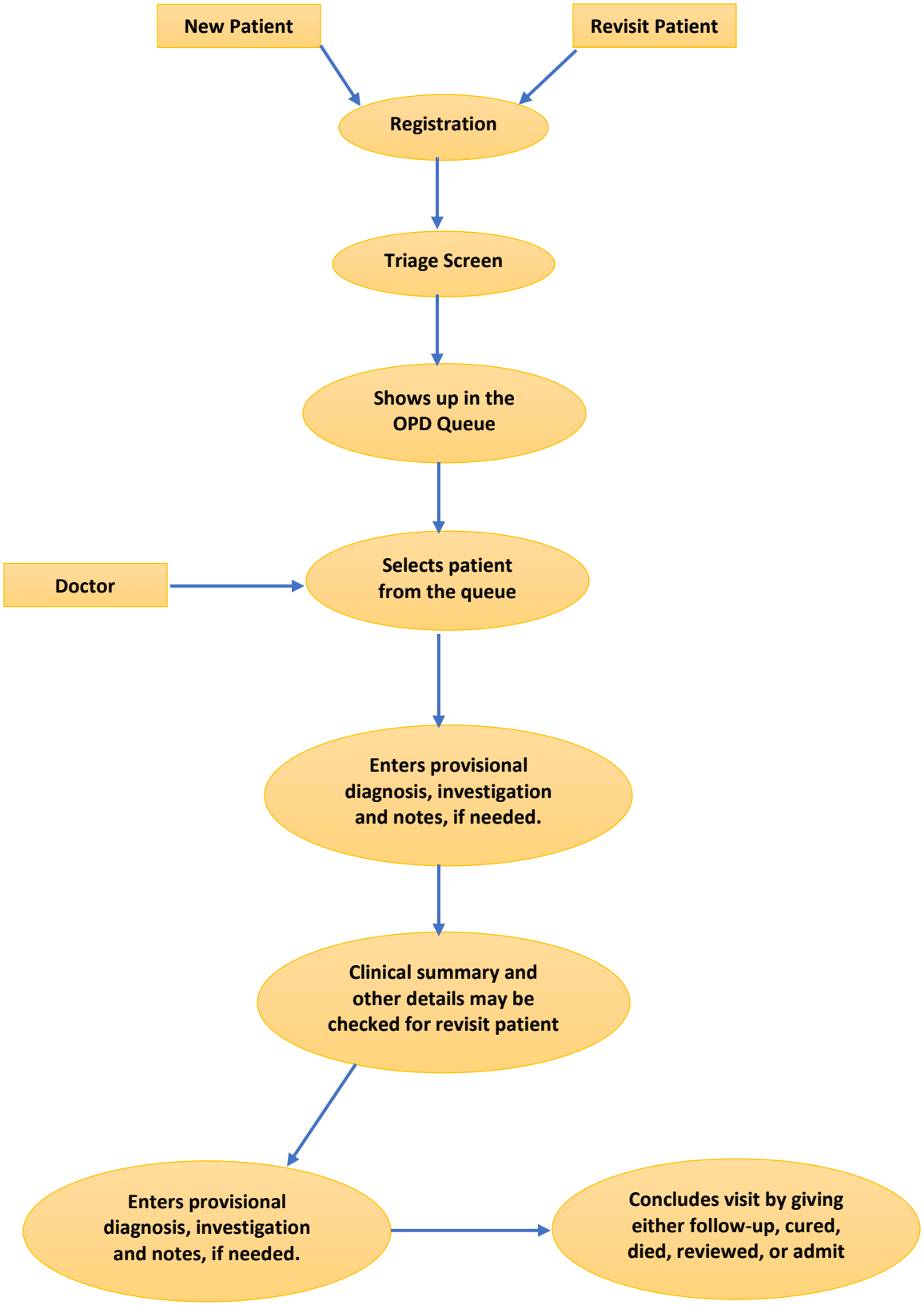
Pharmacy Record- All the drugs prescribed to a patient and their details can be viewed under this tab.

9.5 TRACEABILITY MATRIX

Table 12. OPD- Traceability Matrix

S. No.	NAME	PRIORITY	OUTPUT
TRIAGE			
	Room To Visit	High	The patient is directed to a specific OPD.
	Other Vital Statistics	High	Vital stats can be entered by the nurse
OPD			
	History of Present Illness	Low	For a revisit patient, the history of the illness can be added.
	Provisional Diagnosis	High	The patient's diagnosis is entered
	Procedure	High	Certain procedures can be given to the patient
	Investigation	High	Patients can be given certain tests
	Drug	High	Doctor can prescribe medicines to patient
	Referral	Medium	Either internal or external referral can be given to a patient
	Visit Outcome	High	The patient's outcome can be chosen

9.6 DATA FLOW DIAGAM



10. IPD MODULE

10.1 INTRODUCTION

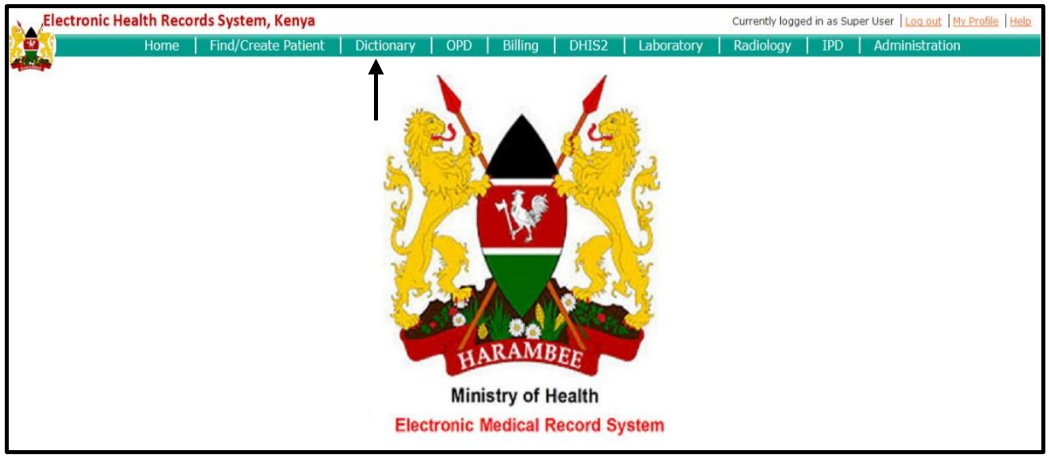
The In-patient department is meant for managing patients who need extended care and have to be kept under observation. Similar to OPD module, the IPD module also has a queue for patients who have been advised admission and an index for already admitted patients.

The IPD Module involves the following customizations:

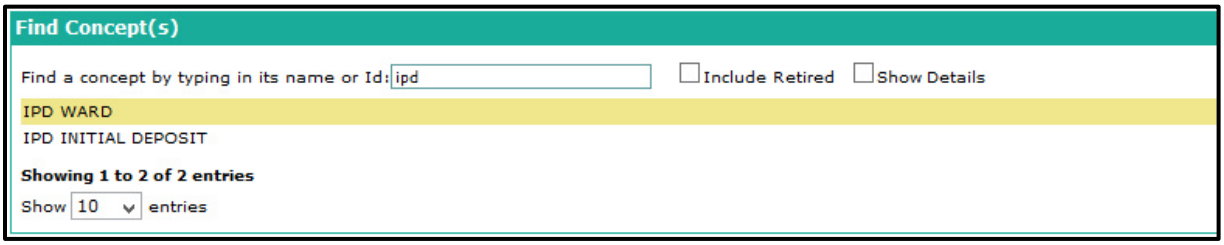
Mapping the IPDs in Concept Dictionary

To begin with, the IPDs have to be mapped in the Concept Dictionary. The following steps are followed to do the same:

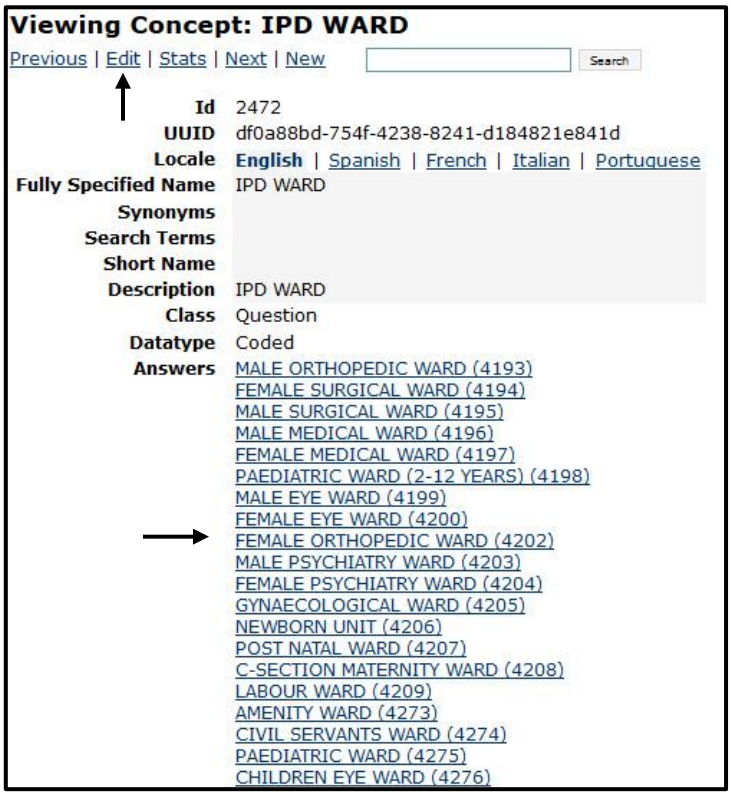
Step 1: To map the IPD's, log into the HIS as administrator and click on **"Dictionary".**



Step 2: In the dictionary, search the concept **"IPD Ward"**, which already exists in the database (Class is Question and Data type is Coded).



Step 3: Click on **"Edit"**, and map the various IPD's as answers to this concepts. Click **"Save"** and the concept will be saved. The Class is **"Misc."** and Data type is **"N/A"** of the answers mapped to the concept.



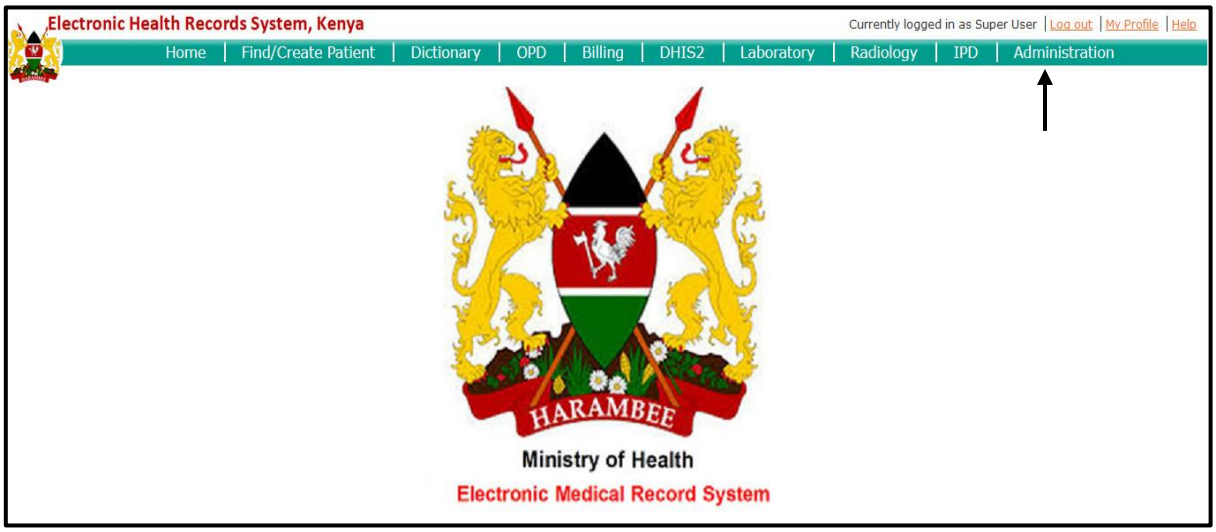
10.2 Manage IPD Department

The customization of the IPD module allows for mapping of the department list so that all departments appear in their modules.

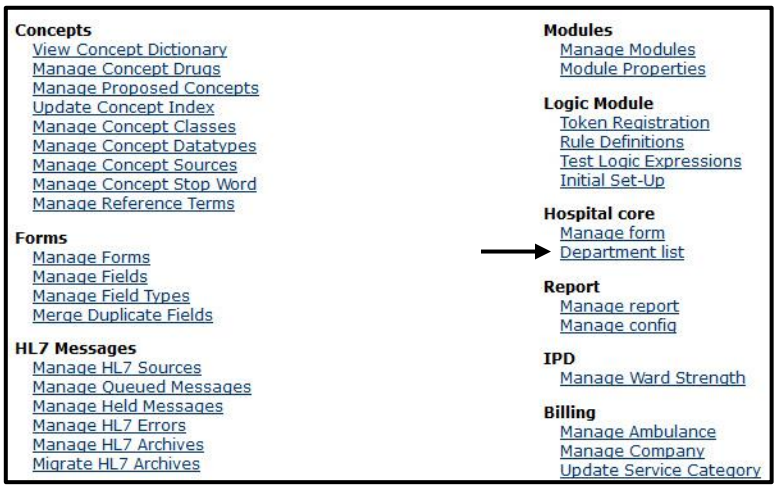
This functionality of Department List enables the IPD user to add the various departments in their module.

The following steps have to be followed in order to add departments:

Step 1: To add IPD Departments, log into the HIS as Administrator and click on **"Administration".**



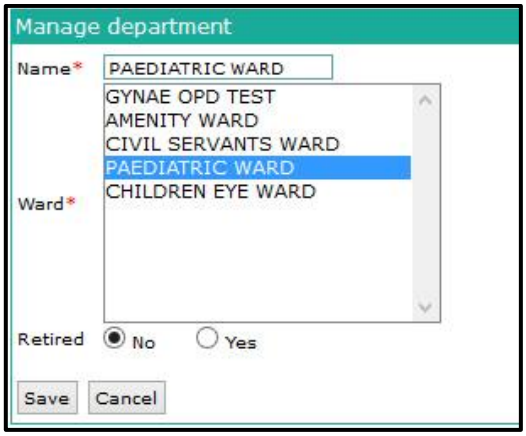
Step 2: Click on **"Department List"** under Hospital Core.



Step 3: To add new department, click on **"Add Department".**

Step 4: It is important here to check the department that you want to create already exists or not. Check the list of departments that already exist. If the department that you want to create doesn't exist click on the **"Add department".**

Step 5: Type the name of the department like **PAEDIATRIC WARD**, and then select from list the particular OPD (this list is made while preparing the database) and then select retired or not (i.e. the particular concept exists or not in the database). Click **"Save".**



10.3 Adding Diagnosis and Procedures to IPDs- The next level of customization is adding Diagnosis and Procedures to the IPDs. The customization process is same as that of the OPD.

The IPD Module varies both by the interface and process in all the three versions of the HIS:-

Table 13. IPD- Interface Change

VERSION 1 (INDIA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
INTERFACE		
➢ Consists of 2 tabs- Patients for admission and Admitted Patient Index. Under 'Admitted Patient Index', 3 types of actions can be performed- Transfer, Discharge, or Print.	➢ N/A	➢ Consists of 2 tabs- Patients for admission and Admitted Patient Index. Under 'Admitted Patient Index', actions that can be done are- Vital Stats, Transfer, Request for Discharge, Discharge, and Print

Table 14. IPD- Process Change

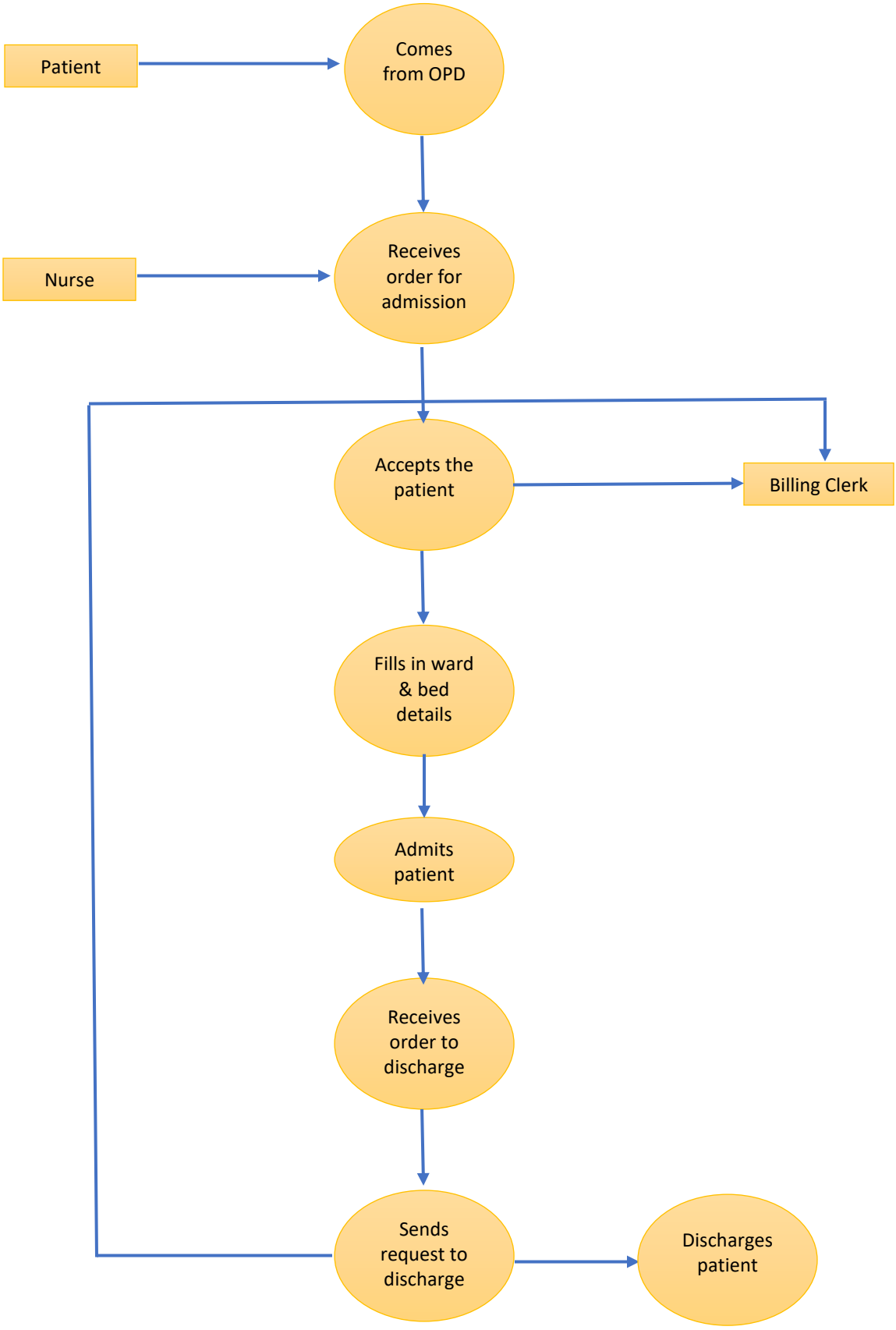
VERSION 1 (INDIA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
PROCESS		
➢ Under the 'Patient for Admission' tab, the patient is admitted by clicking on 'Admit'. Further details are asked to enter and thus the patient gets admitted. ➢ Patient can be discharged by simply clicking 'Discharge'. The discharge summary is filled and thus the patient gets discharged.	➢ N/A	➢ Under the 'Patient for Admission' tab, the patient is firstly accepted to be admitted by clicking 'Accept'. IPD Initial fee is deposited and after that only, the patient is admitted. Vital Stats of the patient can be added in the 'Admitted Patient Index'. ➢ To discharge a patient, firstly 'Request for Discharge' is clicked. Under billing, all payments are done and then 'Discharge' is clicked under 'Admitted Patient Index'. The discharge summary is filled and the patient gets discharged.

10.4 TRACEABILITY MATRIX

S. No.	NAME	PRIORITY	OUTPUT
Patients for Admission Tab			
	Accept	High	Patient is accepted to make payment of the admission fee in the IPD.
	Admit	High	Patient is admitted once the initial fees is paid.
	Remove	Low	Patient is removed from the list.
	No Bed	Low	If there is no availability of any bed, this button can be clicked.
Admitted Patient Index Tab			
	Vital Statistics	Medium	Vital stats can be added of the patient admitted.
	Transfer	Medium	If required, a patient can be transferred to another ward.
	Request for Discharge	High	For a patient to be discharged and to make all final payments, a request can be sent to the billing department.
	Discharge	High	Patient is finally discharged by filling the discharge summary.
	Print	Low	Details of the patient can be printed.

Table 15. IPD- Traceability Matrix

10.5 DATA FLOW DIAGRAM



11. LABORATORY MODULE

11.1 INTRODUCTION

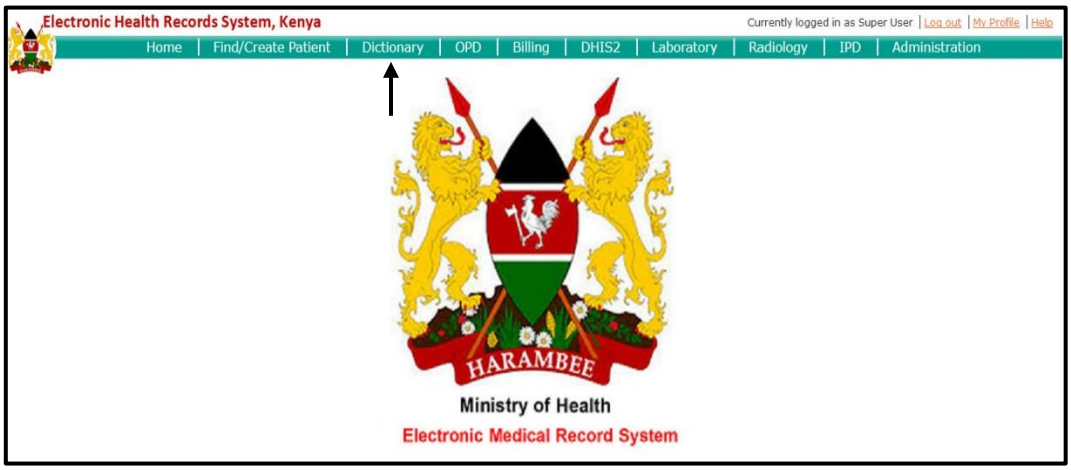
In the HIS the Laboratory Module will operate for Laboratory services, the Investigation Requisitions / Lab orders for tests will be routed to Laboratory module through Billing Module. The user will be able to view the work-list for individual sub-divisions of the general laboratory i.e. Hematology, Bio-chemistry, Serology, Cytology and Urine examination. The test reports will be made available for all tests / investigations for patients as the user can enter results of the investigations conducted and print the patient reports.

The Laboratory Module involves the following customizations:

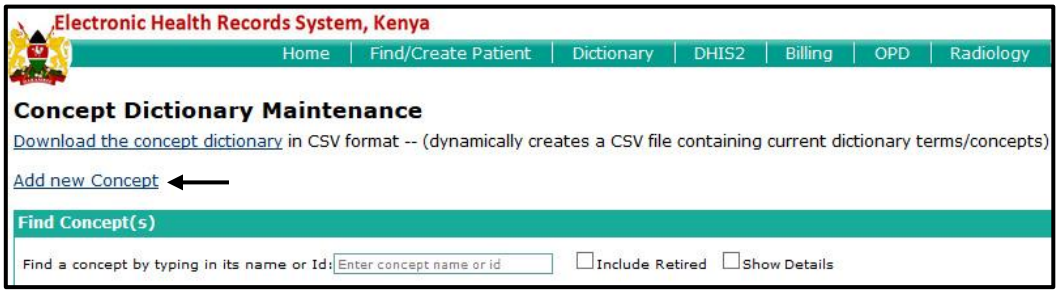
Adding the Laboratory Tests in Concept Dictionary

To begin with, the laboratory tests have to be added in the Concept Dictionary. The steps are:-

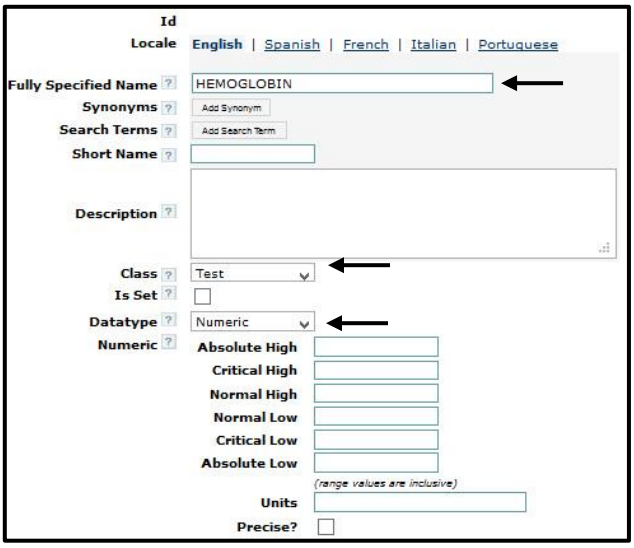
Step 1: To add laboratory tests, log into the HIS as the administrator. Click on **"Dictionary"**.



Step 2: Click on **"Add New Concept".**



Step 3: Type the details about the test. Select the class and data-type i.e. Test and Numeric/Test and Text/Lab-set and Coded. Click **"Save".**

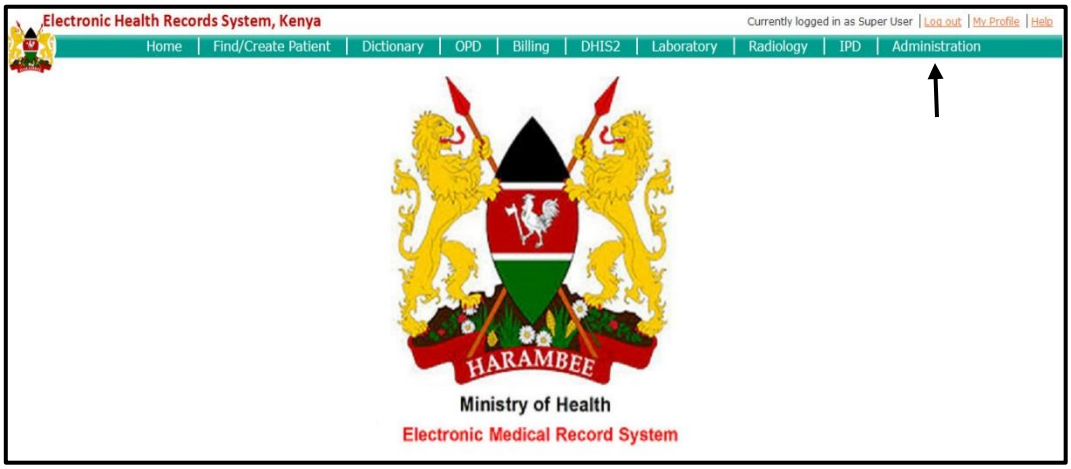


11.2 Manage Laboratory Department

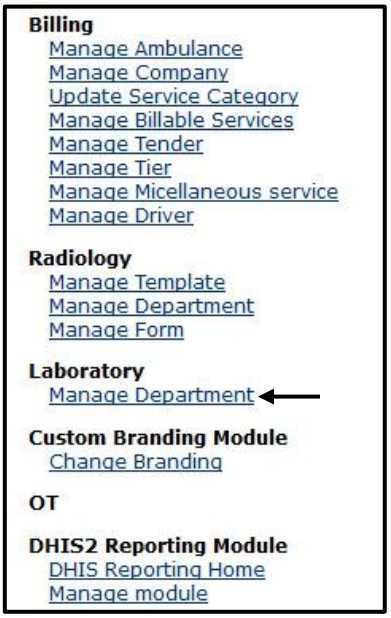
The next customization level of laboratory module includes mapping of the laboratory department list so that they appear in their modules. This functionality of Department List enables the Laboratory user to create, edit and delete Labs.

The following steps have to be followed in order to map the laboratory departments so that they appear in the Laboratory module:

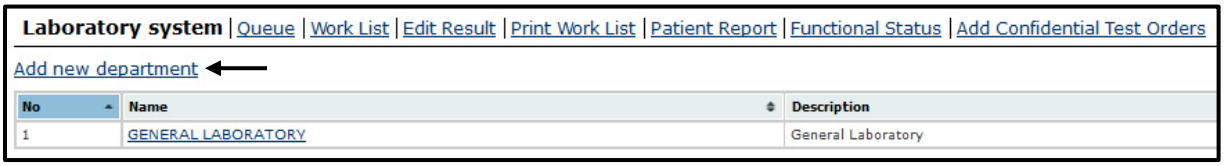
Step 1: To add Laboratory Departments, log into the HIS as then Administrator and click on **"Administration".**



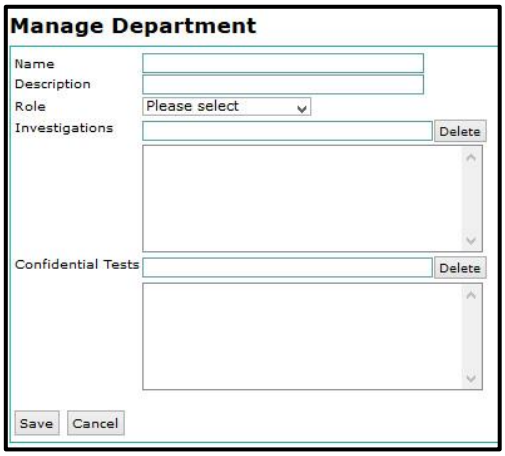
Step 2: Click on **"Manage Department"** under Laboratory.



Step 3: To add new department, click on **"Add New Department".**



Step 4: Type the name, description and role (Lab Technician created for managing lab) and add the investigations by typing the name of lab. The concept window appears, and select the corresponding concept. In the same manner, Confidential Tests (if any) can also be added. Click **"Save".**



11.3 Functional Status

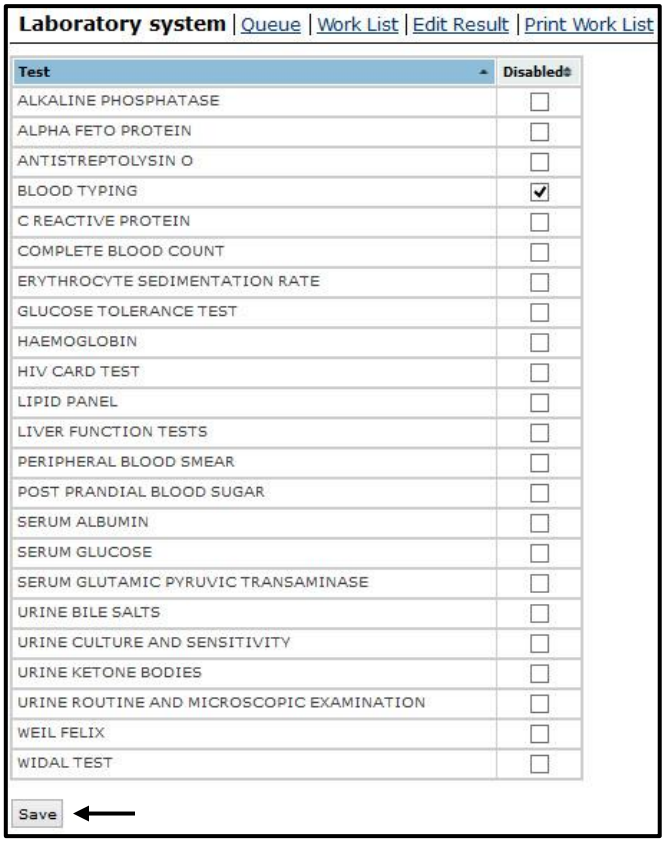
Functional status is an administrative right to deactivate a test from Laboratory, and hence its appearance in the Billing. Once a test has been deactivated, its name does not appear in the billing. The specific test cannot be billed once it has been deactivated.

To deactivate a test the steps are as follows:-

Step 1: Go to the Laboratory Module from the navigation menu and select Functional Status as shown below-

Figure 18. Functional Status

Step 2: Tick the name of the test which needs to be deactivated. Click **"Save".** The disabled test will hence not appear in the billing.



The Laboratory module's interface and process is same for all the three versions of the HIS.

When the lab technician logs in, he/she will see a queue, from where the tests are accepted or reschedule.

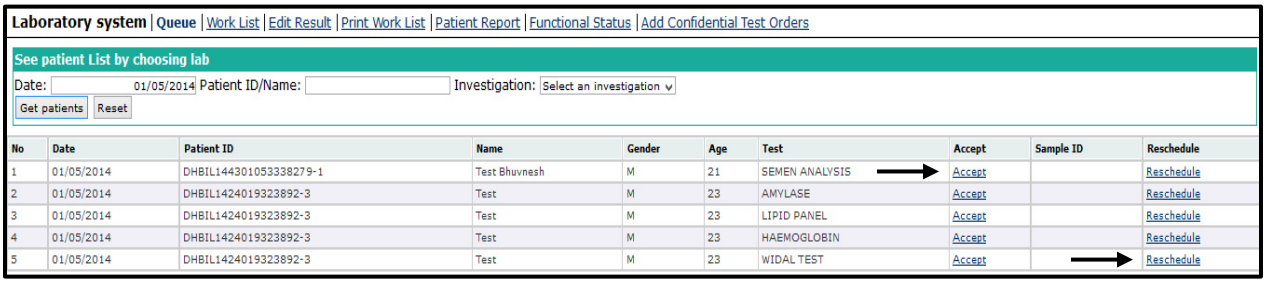


Figure 19. Laboratory Queue

Under the Work List tab, the test results are entered.

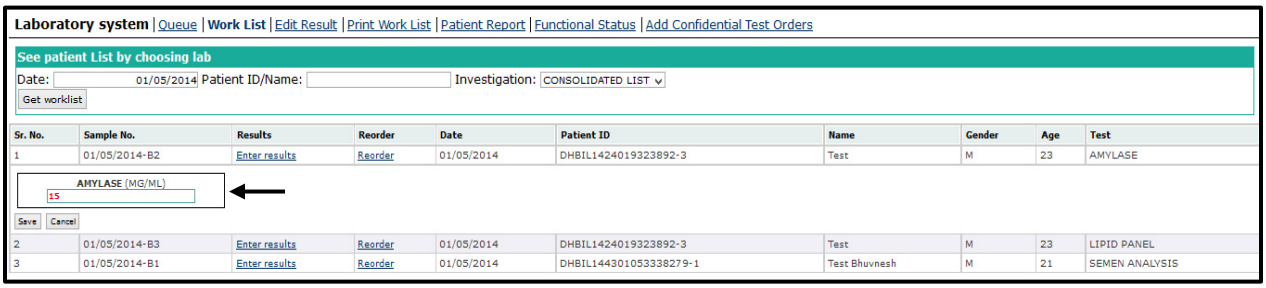


Figure 20. Laboratory Work List

In Print Work List, a list of all the tests conducted and their results for a particular day, can be seen.

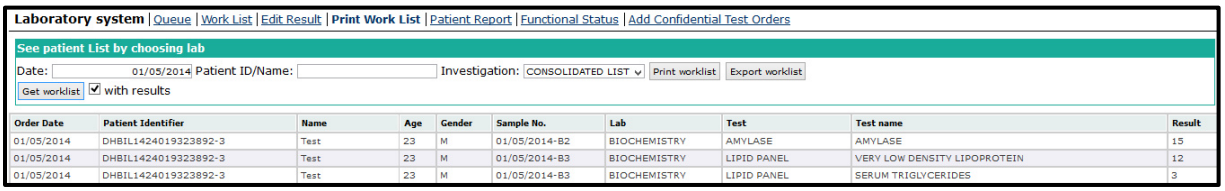


Figure 21. Print Work List

The report of a particular patient can be seen under the Patient Report tab.

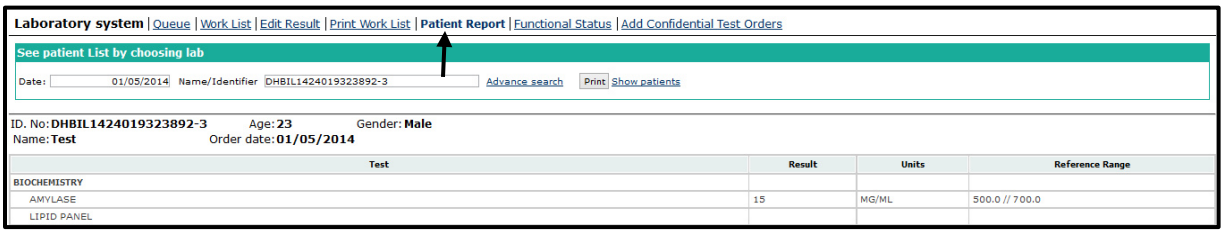


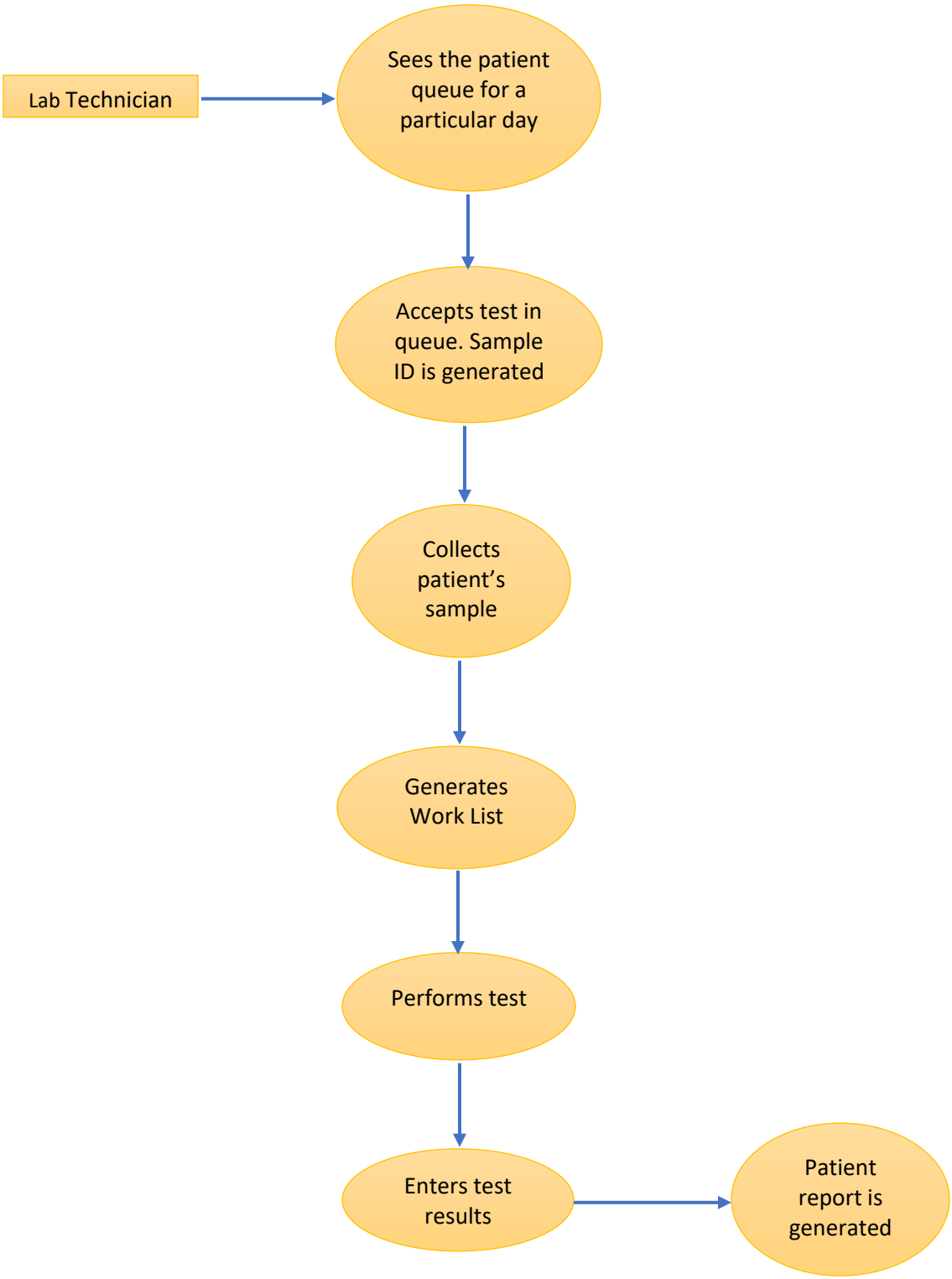
Figure 22. Patient Report

11.4 TRACEABILITY MATRIX

Table 16. Laboratory Traceability Matrix

S. No.	NAME	PRIORITY	OUTPUT
	Queue	High	List of all the patients to be tested for a particular day. The patient can either be accepted for the test or rescheduled for another time.
	Work List	High	Patient's test results are entered. If the results are not proper, they can reordered.
	Edit Result	Low	Test results can be edited.
	Print Work List	Low	List of all the tests conducted on a particular day.
	Patient Report	High	Patient's report of the tests performed can be viewed.
	Functional Status	Low	A particular test can be disabled if it's not functional for any reason.
	Discharge	High	Patient is finally discharged by filling the discharge summary.

11.5 DATA FLOW DIAGRAM



12. RADIOLOGY MODULE

12.1 INTRODUCTION

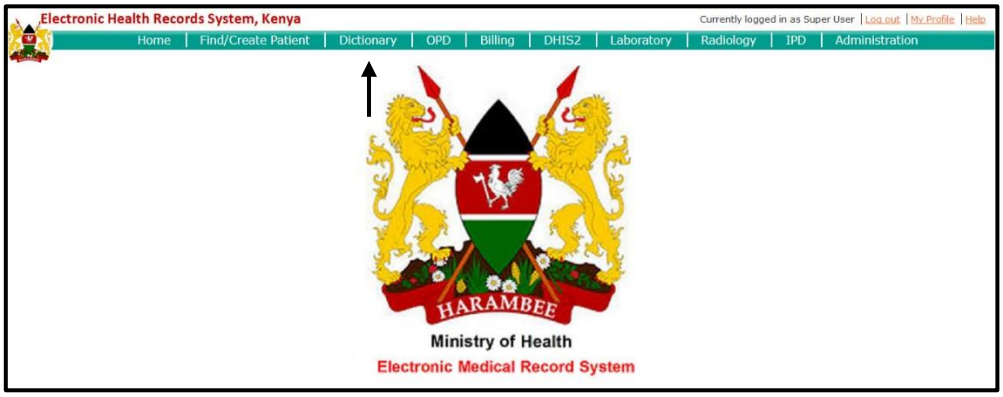
The Radiology Module will operate for Radiology services. The Investigation Requisitions/ Radiology orders for tests will be routed to Radiology module through the Billing Module. The user will be able to view the work-list for individual sub-divisions of Radiology i.e. Ultrasound, X-ray, CT Scan, Doppler etc. The test reports will be made available for all investigations for patients as the user can enter results of the investigations conducted and print the patient reports.

The Radiology Module involves the following customizations:

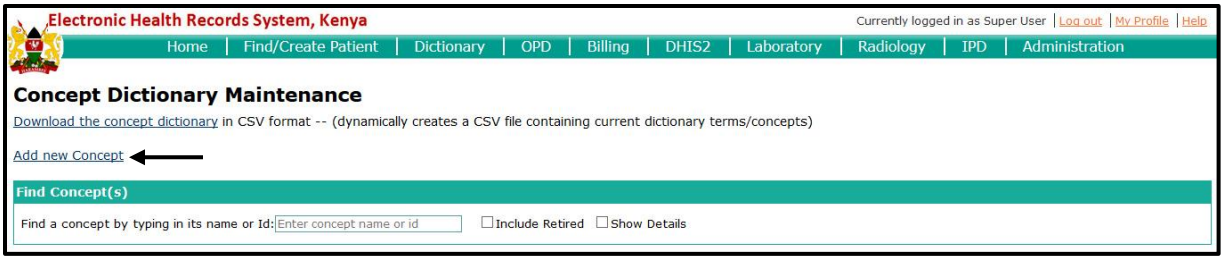
12.2 Adding the Radiology Tests in Concept Dictionary

To begin with, the radiology tests have to be added in the Concept Dictionary. The steps are:-

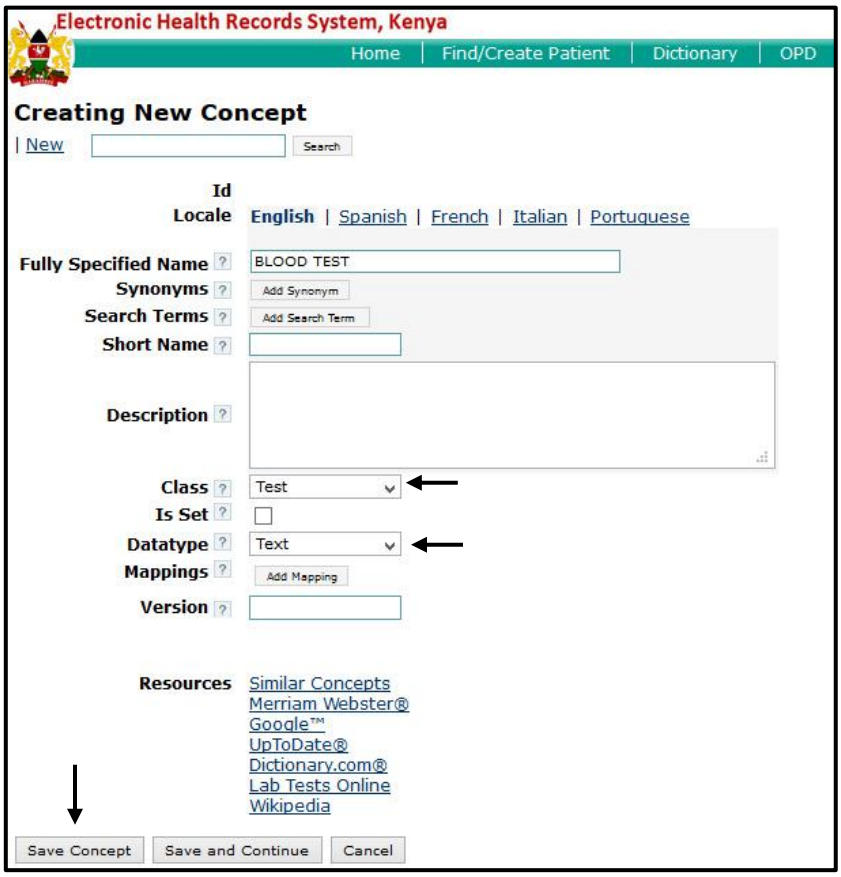
Step 1: To add radiology tests, log into the HIS as administrator. Click on **"Dictionary"**.



Step 2*:* Click on **"Add New Concept".**



Step 3: Type the details about the tests. Select the class and data-type i.e. Test and Coded/Test and Text. Click **"Save".**



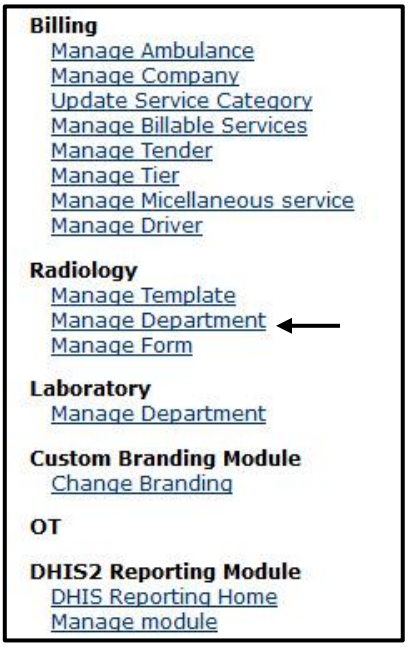
12.3 Managing Radiology Department

The next customization level of radiology module includes mapping the radiology sub-department list so that they appear in their modules. This functionality enables the Radiology user to create, edit and delete sub-departments.

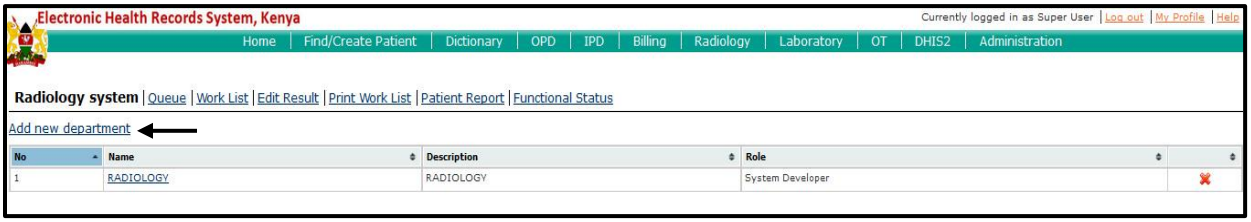
The following steps have to be followed in order to map the radiology departments so that they appear in the Radiology module:

Step 1: To create Radiology Department, log in as the administrator and click on **"Administration".**

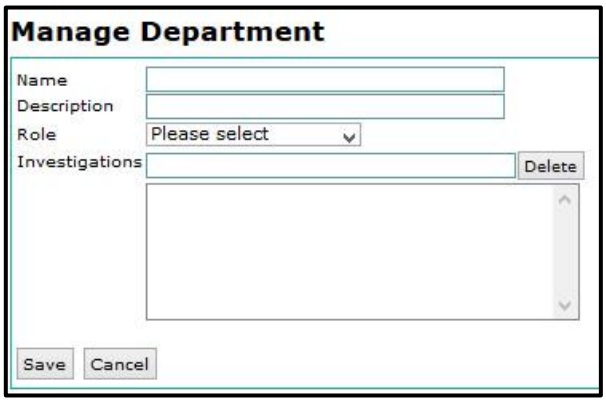
Step 2: Click on **"Manage Department"** under Radiology.



Step 3: To add new department, click on "**Add New Department"**.



Step 4: Type the name, description and role (Radiology role created for managing Radiology) and add the investigations. This can be done by typing the name of the sub-department, for example ultrasound. After a concept window appears, select the corresponding concept.



Step 5: Click on **"Save".**

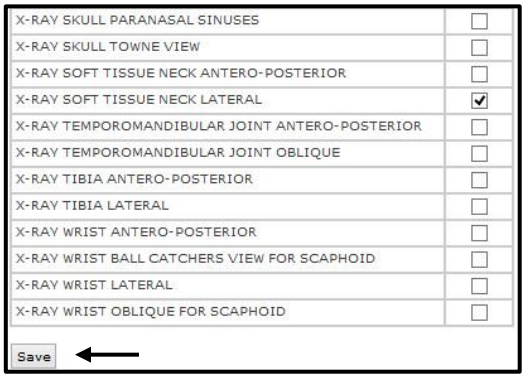
12.4 Functional Status

Functional status is an administrative right to deactivate a test from Radiology, and hence its appearance in the Billing. Once a test has been deactivated, its name does not appear in the billing. Therefore, this particular investigation cannot be billed once it has been deactivated.

To deactivate an investigation:

Step 1: Go to the Radiology Module from the navigation menu and click **Functional Status** as shown below-

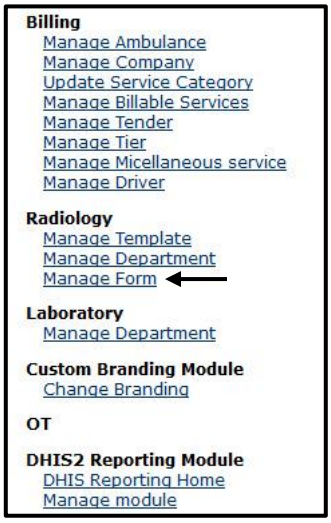
Step 2: Tick the name of the test and click **"Save".** The disabled test will not appear in the billing.



12.5 Managing Radiology Form

Various radiology forms can be created based on formats used in a particular hospital. Radiology forms can be used to define set formats for patient reports of various investigations. These forms are completely customizable. To create radiology forms, the steps are:-

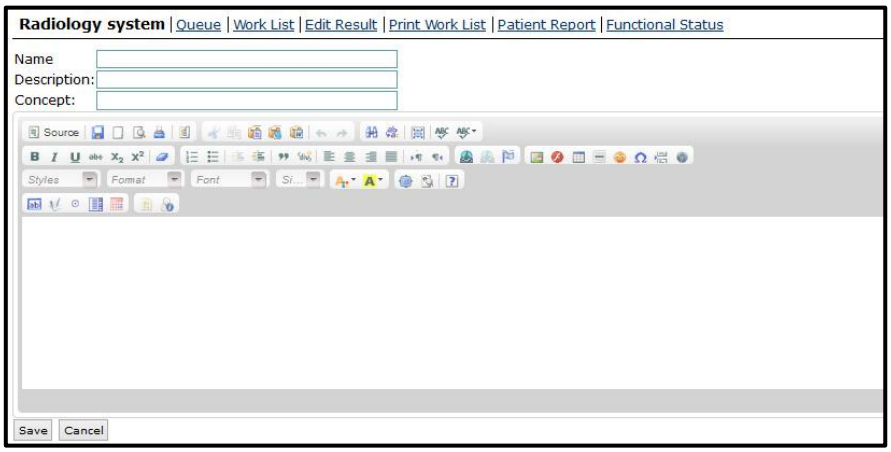
Step 1: Go to **"Administration"** and click on **"Manage Form"** under Radiology.



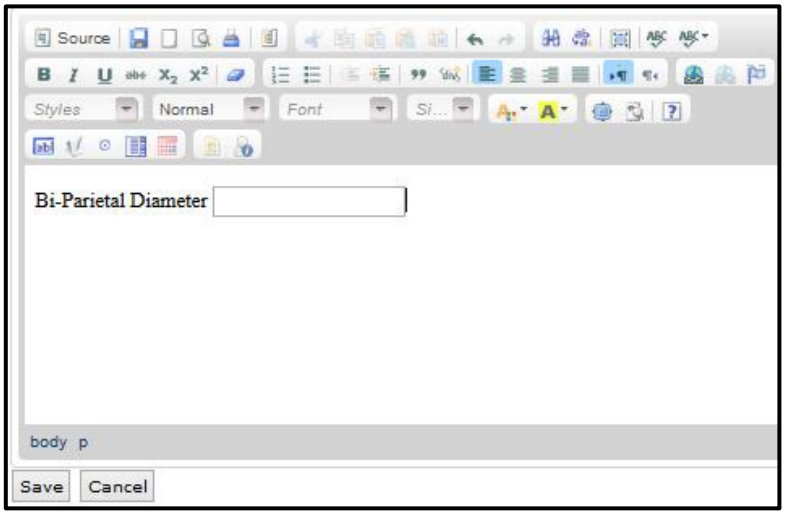
Step 2: Click on **"Add New Form"** to create a new form.

Figure 23. Add New Form

Step 3: On the next page, enter the name of the form and type in a description for the same. Also, here you will need to map the form to a corresponding concept in the concept dictionary. Enter the name of the concept that the form pertains to.



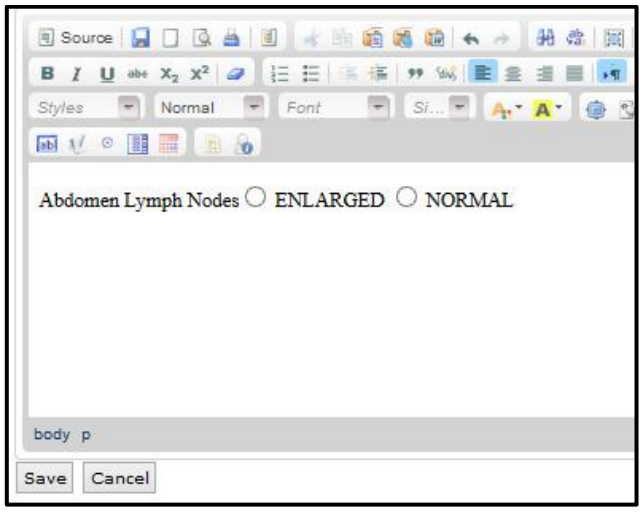
Step 4: Now, enter the content of the form. For adding a text field, concepts of those text fields will need to be mapped here. In this case, the concept should have class as 'Finding' and Data type as 'Text'.



In order to add a radio button too, there needs to be a corresponding concept in the concept dictionary for the term in the form. The terms that you to want to appear as radio button options should be mapped under the concept and the concept should have class as ‘Finding‘ and Data type as ‘Coded’.

Type in the name of the concept that you want to map, then select from the list that appears.

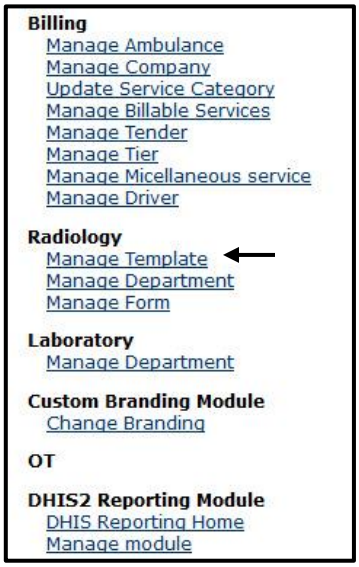
The mapped concept appears on the form as radio-buttons as shown:



12.6 Managing Radiology Template

This feature can be used to design patient reports in the way that we wish them to appear, for example, the title of the report, signature, name of hospital etc. can be defined.

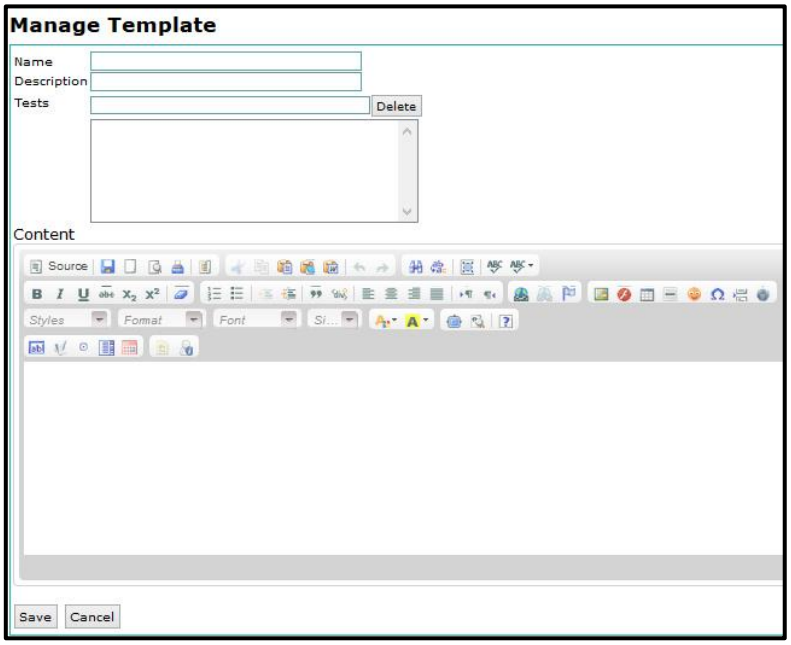
Step 1: Go to **“Administration”** and click on **“Manage Template”** under Radiology.



Step 2: Click on 'Add new template' to create a new template.

Figure 24. Add New Template

Step 3: On the next page, enter the name of the template and type in a description for the same. In case, you're creating a template for a specific test, you will need to map the template to a corresponding concept in the concept dictionary. Enter the name of the concept that the template pertains to.



Step 4: Now, enter the content of the template.

Step 5: Click Save. Your template is now saved.

The Radiology module's interface and process is same for all the three versions of the HIS. When the radiology technician logs in, he/she will see a queue, from where the tests are accepted or reschedule.

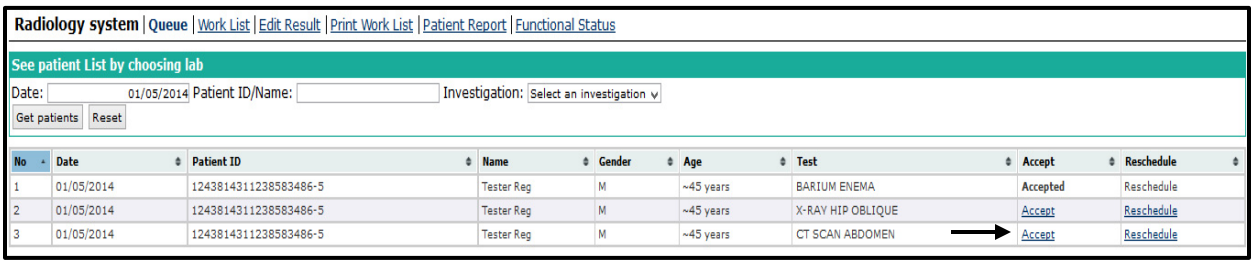


Figure 25. Radiology Queue

Under the Work List tab, the test results are entered

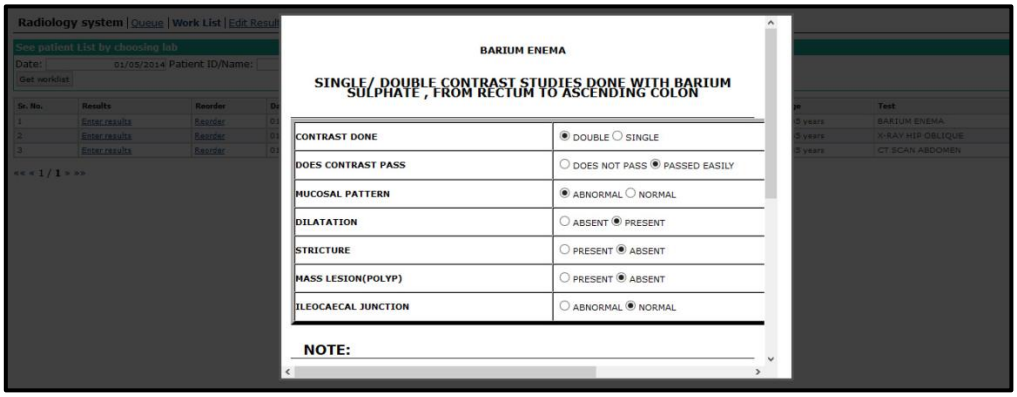


Figure 26. Radiology Work List

In Print Work List, a list of all the tests conducted and their results for a particular day, can be seen.

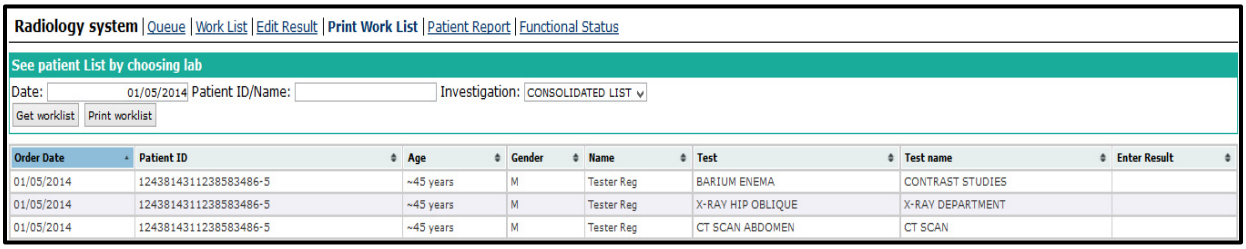


Figure 27. Print Work List

The report of a particular patient can be seen under the Patient Report tab and clicking on the test.

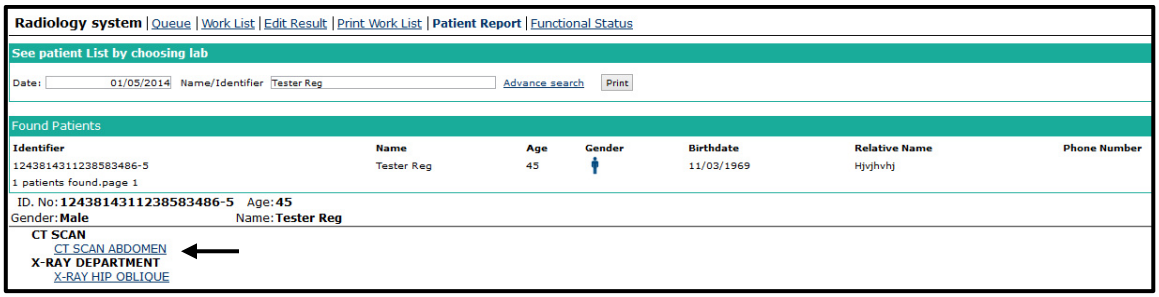


Figure 28. Patient Report

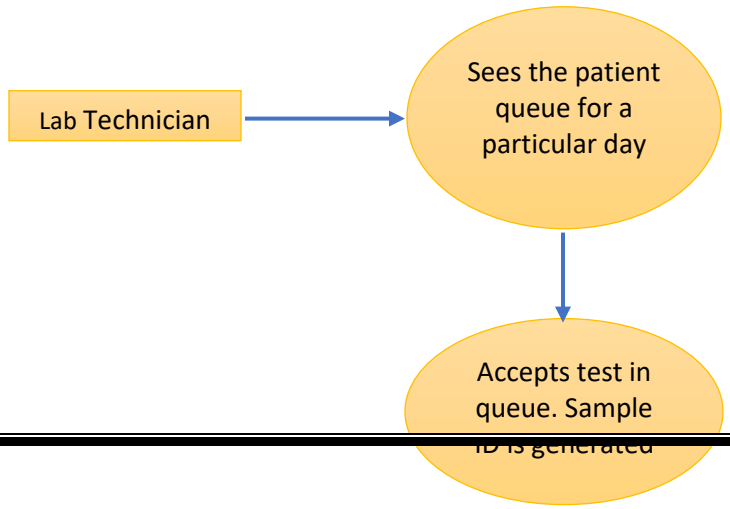
12.7 TRACEABILITY MATRIX

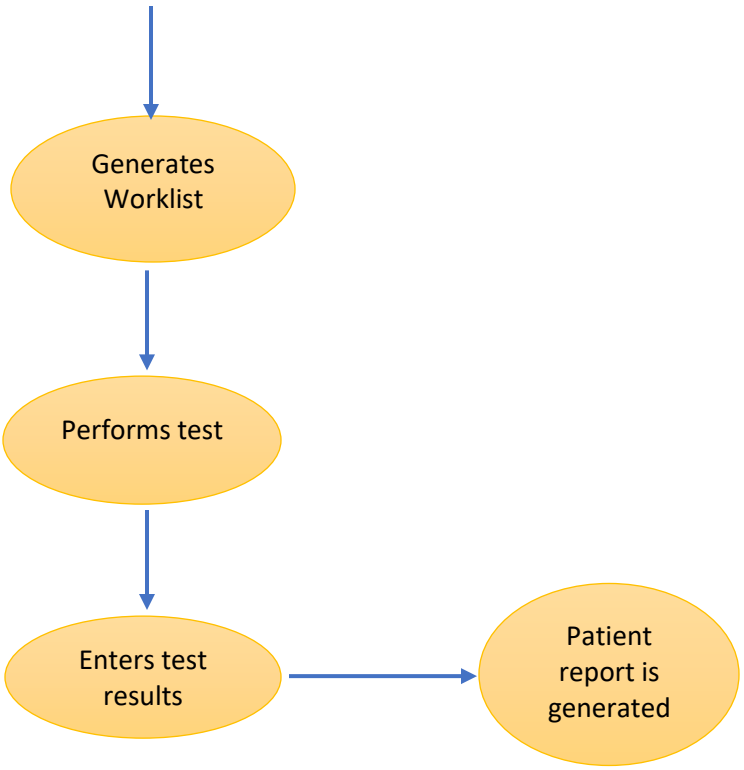
Table 17. Radiology Traceability Matrix

S. No.	NAME	PR 17IORITY	OUTPUT
	Queue	High	List of all the patients to be tested for a particular day. The patient can either be accepted for the test or rescheduled for another time.

	Work List	High	Patient's test results are entered. If the results are not proper, they can reordered.
	Edit Result	Low	Test results can be edited.
	Print Work List	Low	List of all the tests conducted on a particular day.
	Patient Report	High	Patient's report of the tests performed can be viewed.
	Functional Status	Low	A particular test can be disabled if it's not functional for any reason.
	Discharge	High	Patient is finally discharged by filling the discharge summary.

12.8 DATA FLOW DIAGRAM





13. BILLING MODULE

13.1 INTRODUCTION

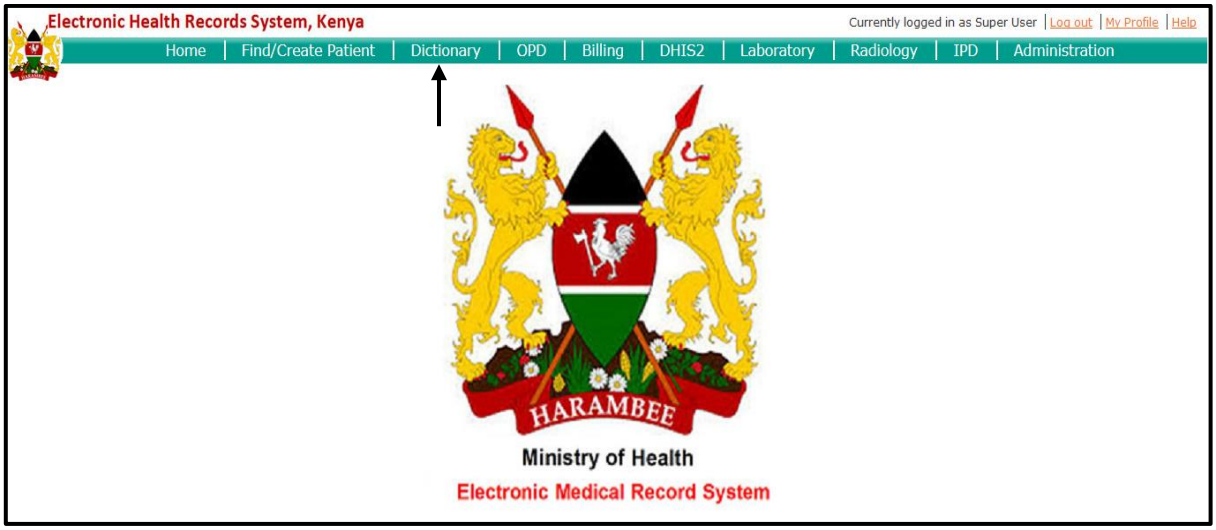
The Billing module deals in collection of money for services availed by a patient and other services available at the hospital for a cost they include:

- Money collected in cash for outpatient services availed.
- Money collected in cash for inpatient services availed.
- Other services like Ambulances, tenders, blood bank, fee for medical examinations.

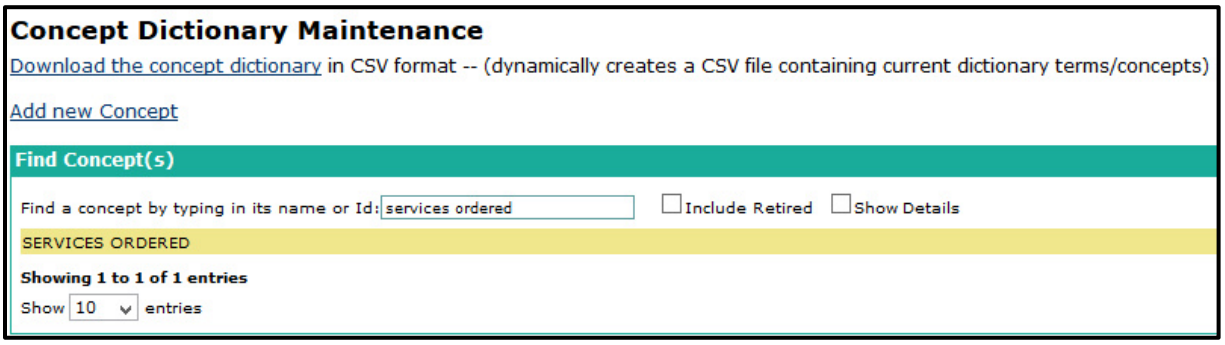
The following elements are involved in the customization of the billing module:

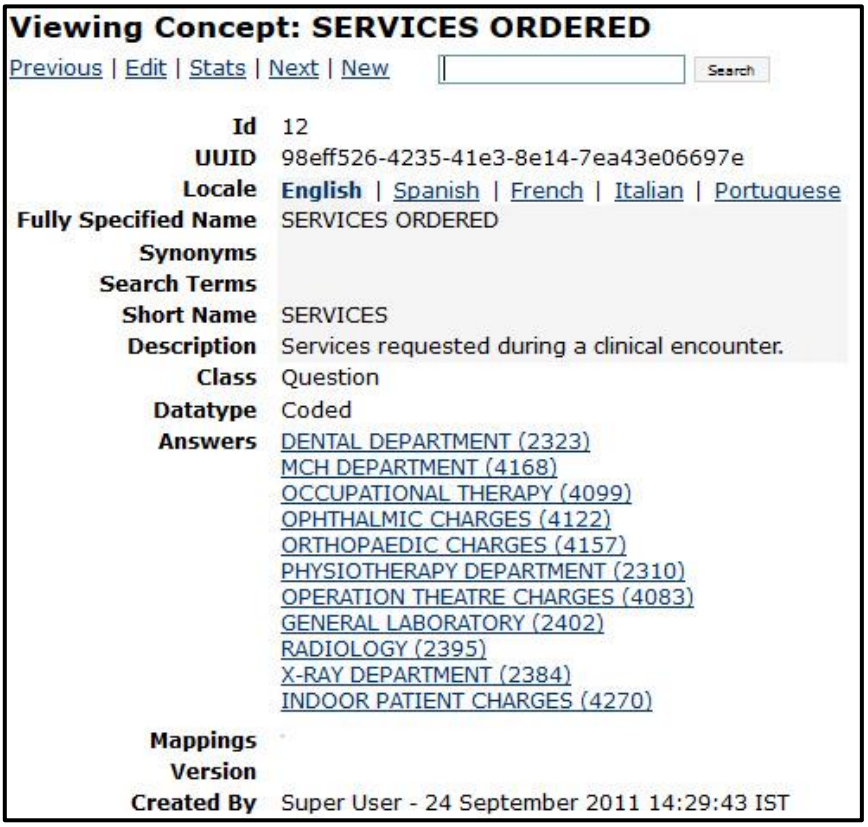
Billing Hierarchy- Billing Hierarchy is created in the concept dictionary. One of the prerequisite for creating a billing hierarchy is creation of concepts for all the services to be included in the hierarchy. The steps for creating Billing Hierarchy in Concept Dictionary are as follows:

Step 1: To create billing hierarchy, log into the HIS as administrator and click on **"Dictionary".**

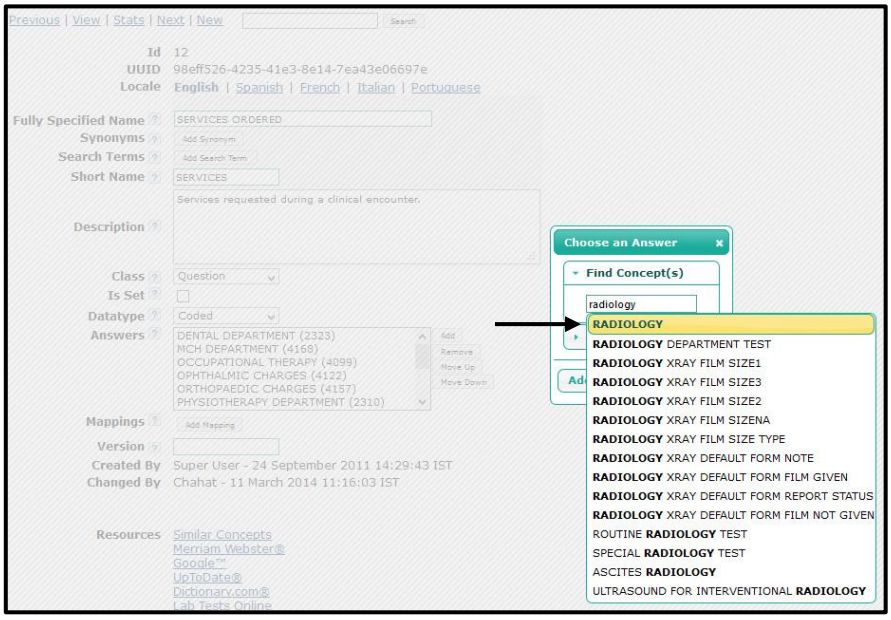


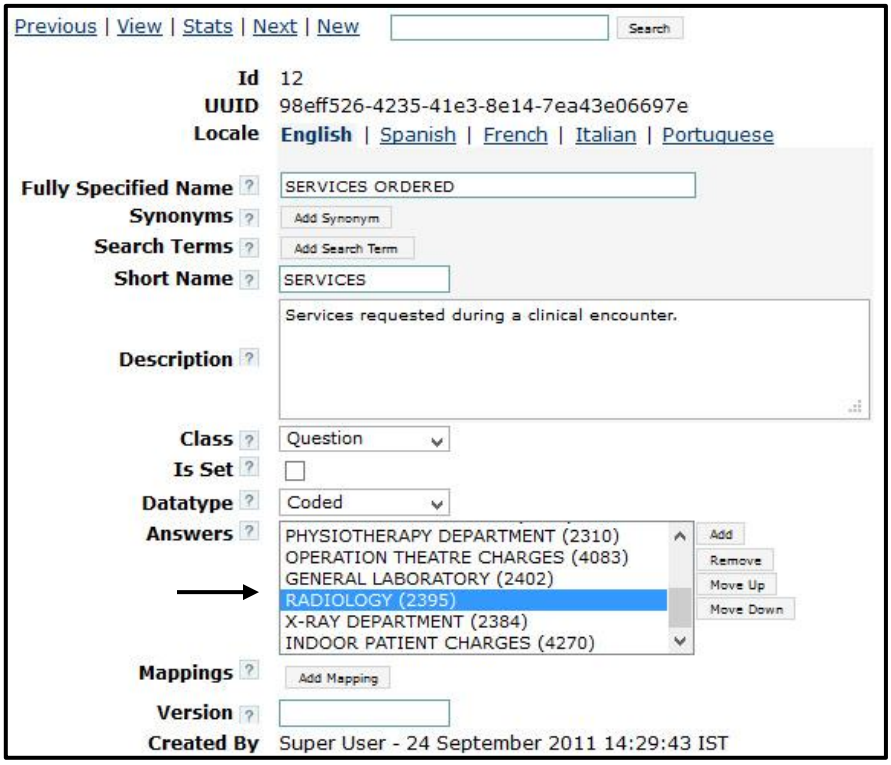
Step 2: In the Dictionary Menu, find concept **"Services Ordered"** (Class and Data-Type is Question Coded).





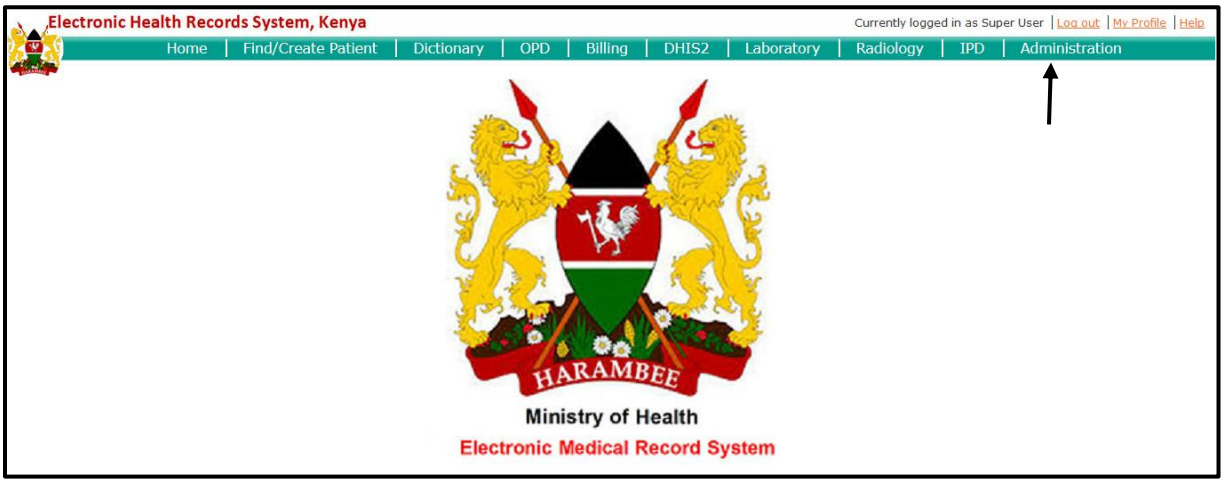
Step 3: Click on **'Edit'** and map the various services that are to be included in billing hierarchy. Click **"Save"** to save the hierarchy.





13.2 Manage Billable Services- This functionality helps to add prices to Investigations/Diagnostics. The followings steps are followed in order to add prices:

Step 1: To add price, log into the HIS as Administrator and click on **"Administration".**



Step 2: In the Administration Menu, click on **"Manage Billable Services".**

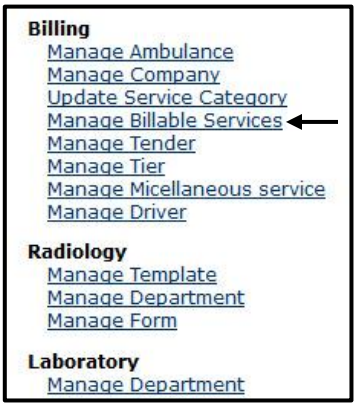
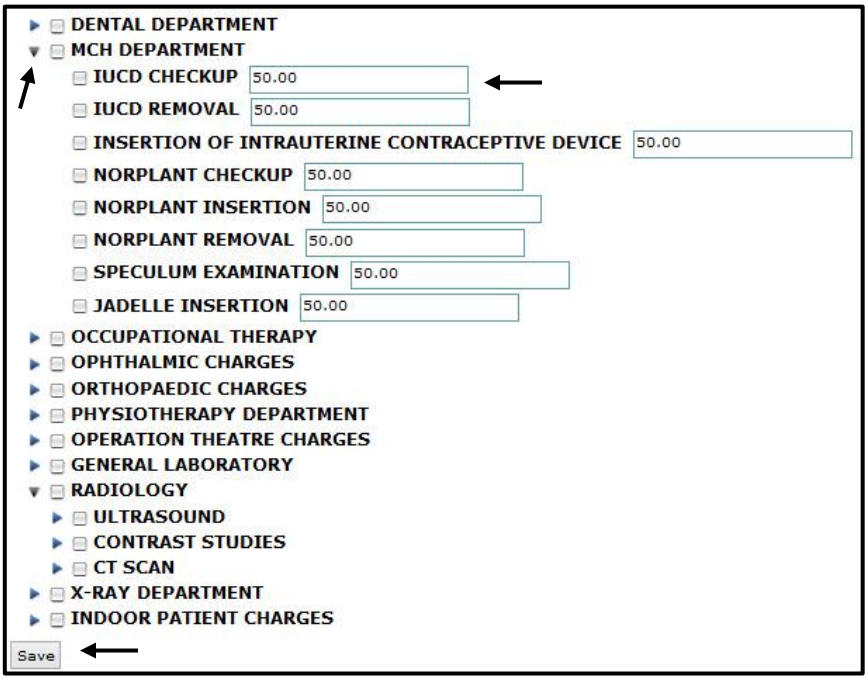


Figure 27. Manage Billable Services

Step 3: Now click on the arrow near the Investigation Name (like MCH Department) and a drop down of procedures under MCH Department available in the Hospital appear. Now enter a price for the procedure and press the same button and then click on **"Save".**

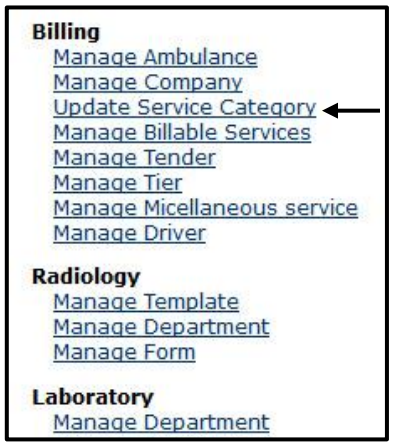


13.3 Update Service Category- Update Service category is an Important Functionality. Whenever we add a new service like Ambulance, Tender, Company Driver or make changes in the Billable services for which a user charge is levied it is important to Update Service category.

The following steps have to be followed to update service category:

Step 1: After adding new services or prices in billable services go to **"Administration".**

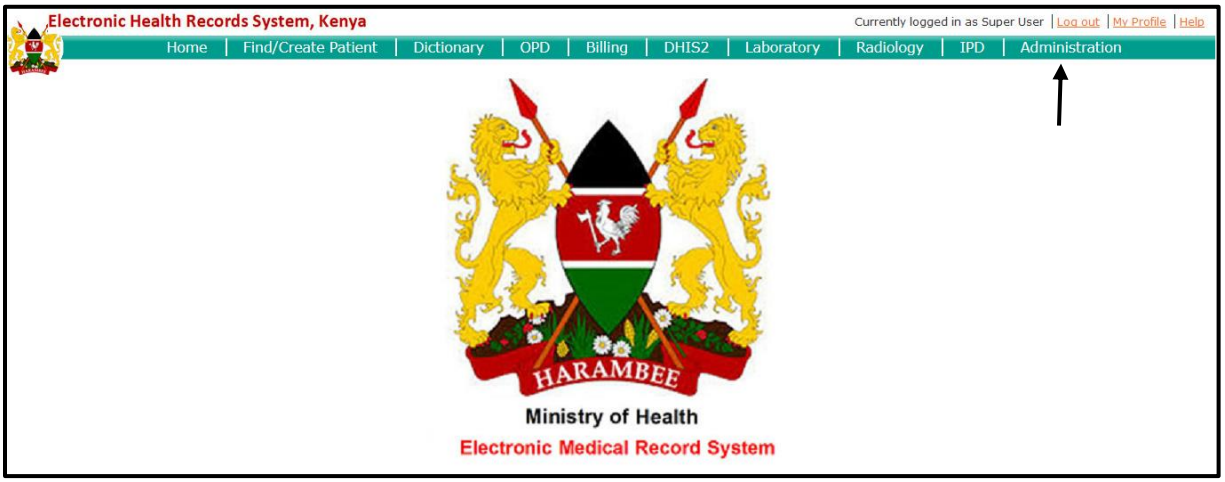
Step 2: Click on **"Update Service Categories",** listed under Billing. It will update all service categories under respective tables in the database.



13.4 Manage Ambulances- This functionality helps to view, add and remove ambulances.

The following steps have to be followed in order to view, add, and remove ambulances.

Step 1: To add an ambulance, login as the Administrator and click on **"Administration".**



Step 2: Click on **"Manage Ambulances",** under Billing.

Step 3: The list of current ambulances will be displayed. To add a new ambulance, click **"Add Ambulance".**

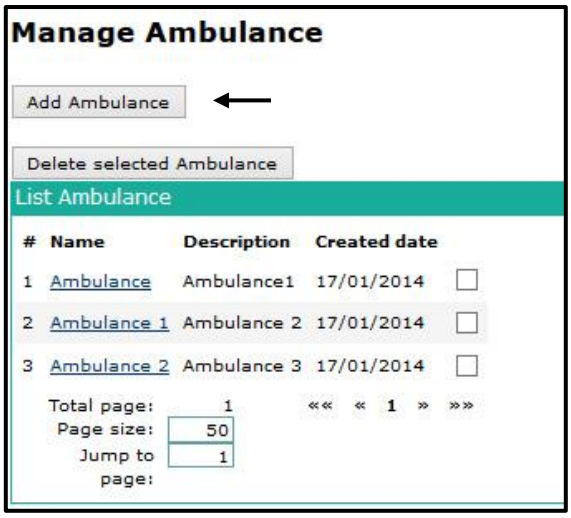
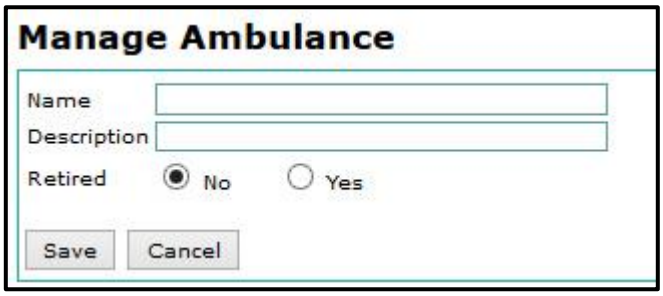


Figure 29. Add Ambulance

Step 4: Type the name and description of the ambulance and then click **"Save".**



Step 5: By selecting the name of the ambulance the user can edit the name and description of the ambulance and then you save it.

Step 6: To delete an ambulance, click on the "check box" and click **"Delete Selected Ambulance".**

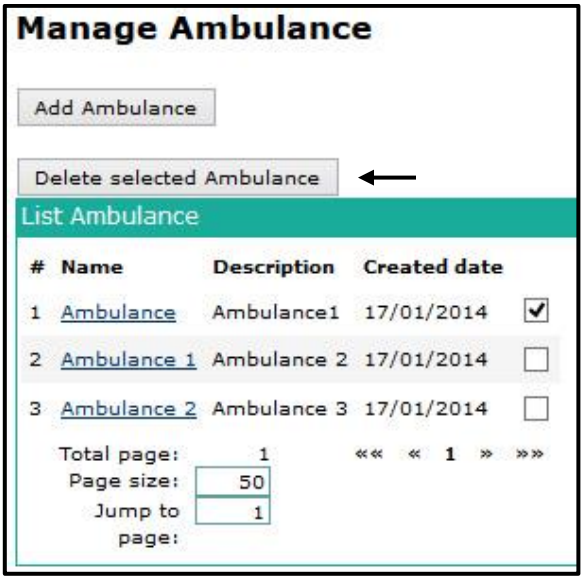


Figure 30. Delete Ambulance

Step 7: After that the ambulance will disappear from the list of Manage Ambulance and it will show the **"Ambulance Deleted"** note on the top of the screen.

13.5 Manage Driver- This functionality helps to view and add drivers.

The following steps have to be followed in order to view, add and delete drivers.

Step 1: To add a driver, login as the Administrator and click on **"Administration".**

Step 2: Click on **"Manage Drivers".**

Step 3: List of all drivers will be displayed. To add new driver, click on **"Add New Driver"**

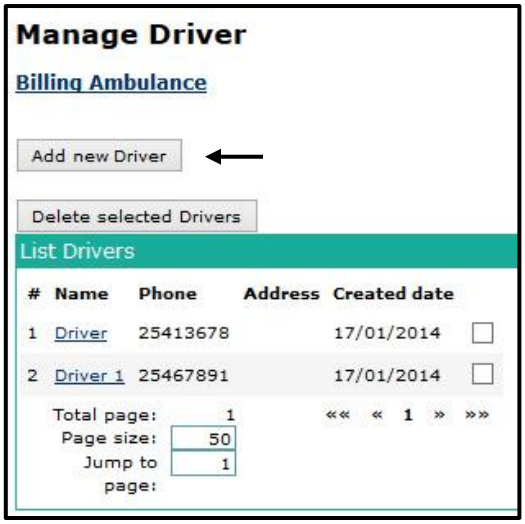
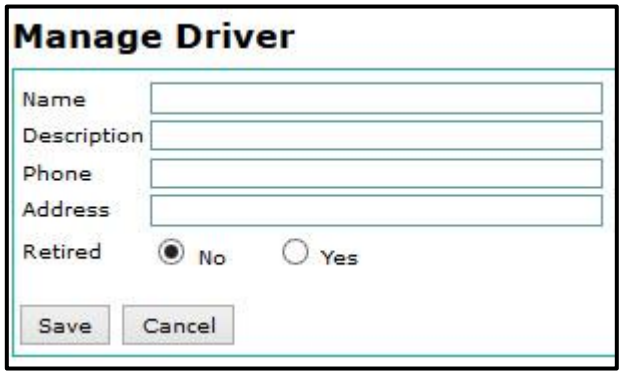


Figure 31. Add Driver

Step 4: Type the details of the driver that you intend to add. Click **"Save".**



Step 5: To delete the driver, click on the check box and then click **"Delete Selected Drivers".**

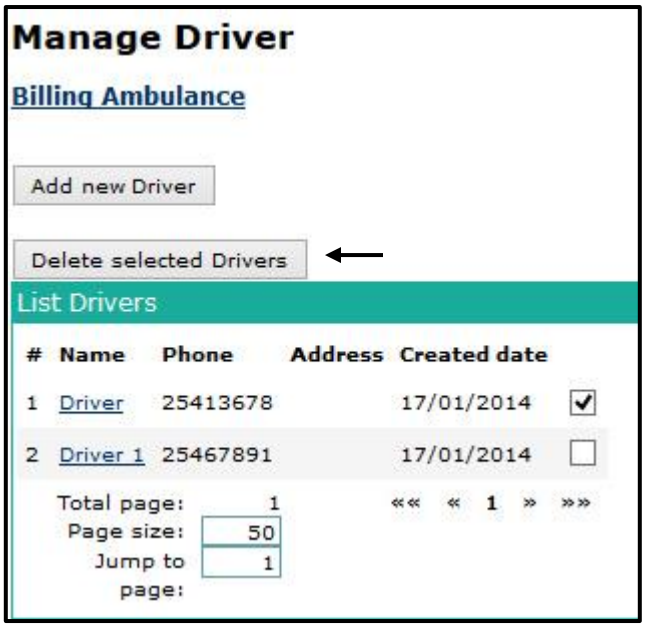


Figure 32. Delete Driver

Step 6: The driver will disappear from the list of Manage Driver and a note will show on the top of the screen.

The Billing Module varies both by the interface and process in all the three versions of the HIS. The differences are:-

Table 17. Billing- Interface Change

VERSION 1 (SHIMLA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
INTERFACE		
➢ Patient can be searched via Advance Search by entering the Aadhar Card no.	➢ Patient can be searched by entering the National ID in the Advance Search ➢ Patient Billing Queue tab is present.	➢ Patient can be searched by entering the National ID in the Advance Search ➢ Patient Billing Queue tab is present ➢ Indoor Patient Billing queue tab is also present (for IPD ward)

Table 18. Billing- Process Change

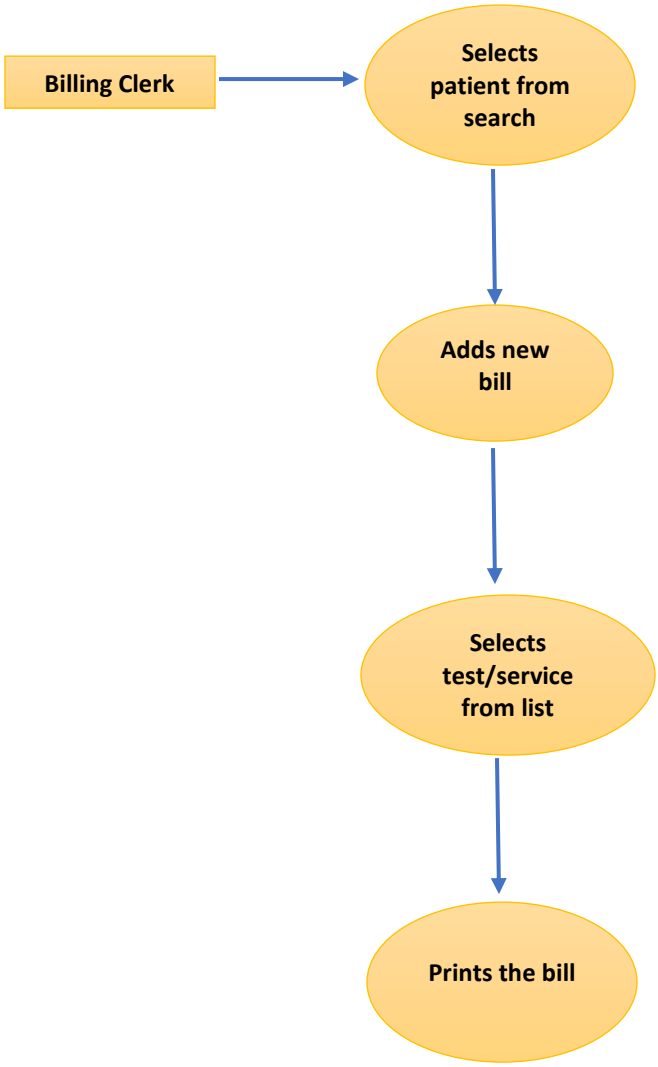
VERSION 1 (SHIMLA)	VERSION 2 (BANGLADESH)	VERSION 3 (KENYA)
PROCESS		
➢ The patient is searched and a new bill is added. The required tests or services are selected and the bill is saved.	➢ The tests ordered from the OPD are sent to the Patient Billing Queue for billing. The clerk searches the patient and makes a transaction. Clicks print which is a trigger to send the tests to either radiology/laboratory department.	➢ For IPD ward, the clerk has to click 'Add Bill' to do billing of a patient. The IPD Initial deposit gets billed. After the patient is admitted, all the investigations prescribed to him/her are billed as a consolidated bill which the patient pays after being discharged.

13.6 TRACEABILITY MATRIX

Table 19. Billing- Traceability Matrix

S. No.	NAME	PRIORITY	OUTPUT
	Find Patient	Low	Patient can be searched by Name/Identifier/Bill ID
	Billing Ambulance	Medium	Ambulance can be billed for a patient
	Billing Tender	Medium	Hospital can bill certain tenders
	Billing Miscellaneous Services	Medium	Other services of the hospital are billed
	Patient Billing Queue	High	Patients given investigations in the OPD are billed under this tab
	Indoor Patient Billing Queue	High	All the billing of admitted patients is done through this functionality.

13.7 DATA FLOW DIAGRAM



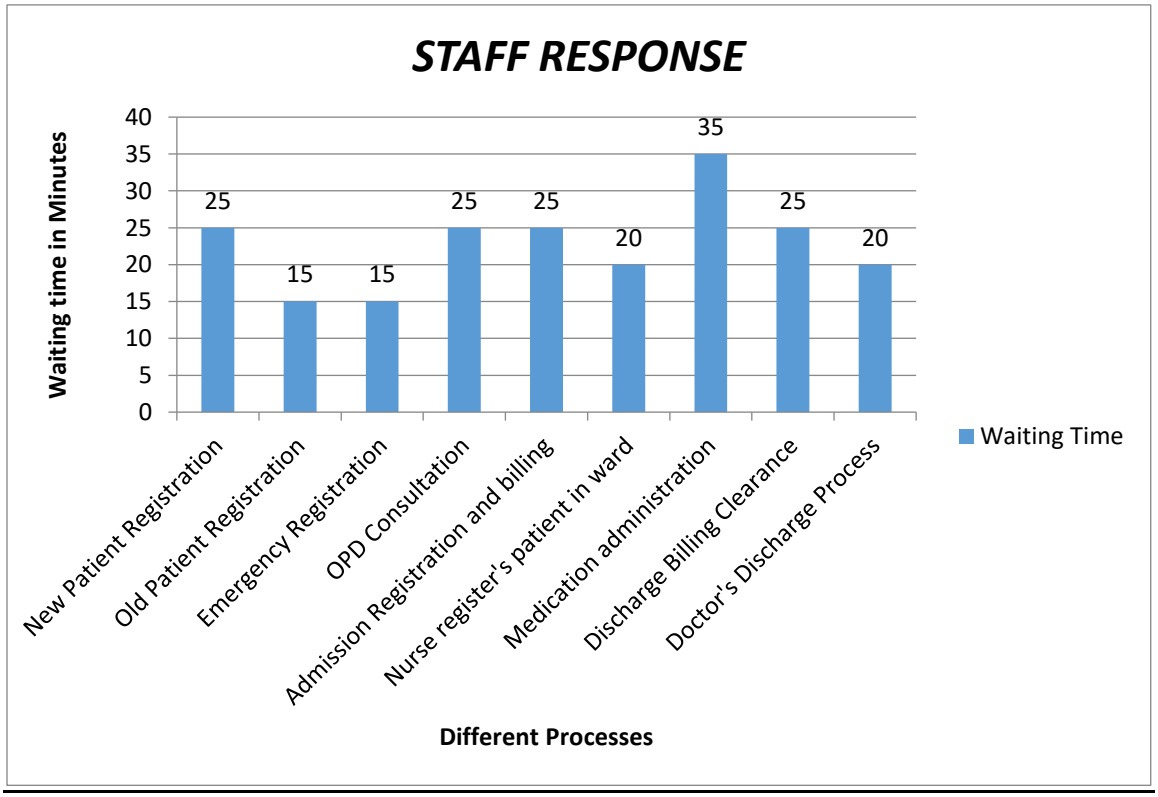
14. RESULTS & FINDINGS

14.1 Pre-implementation Evaluation

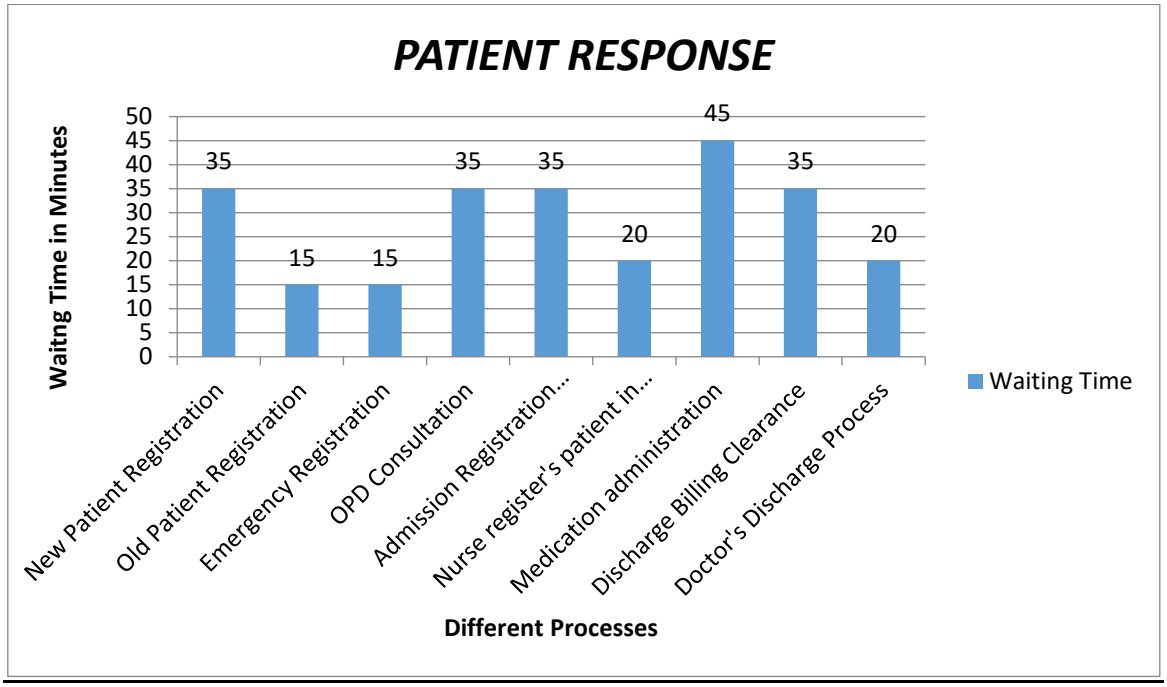
Pre-implementation evaluation of the hospital process is necessary which helps in understanding the various workflows a well as the time taken at each step of the process.

For this the study was conducted among 2 categories of respondents- Staff and Patients. Staff helped in understanding the processes as well as the waiting time. And the patients helped in knowing the waiting time at different levels of the process.

Following graph tells us about the waiting time at different processes.



Graph 1. Staff Response



Graph 2. Patient Response

The total waiting time for the OPD to IPD process flow is 110 minutes, which is broken down as-

- Patient Registration- 30 minutes
- Doctor Consultation- 30 minutes
- Registration and Billing for admission- 30 minutes
- Nurse registering patient and admitting the patient- 20 minutes

Thus, this is a matter of concern for the hospital.

14.2 Outcomes of Customization & Testing:

Phase	Activities	Outcome
Planning	Create high level test plan	Test plan, Refined Specification
Analysis	Create detailed test plan, Functional Validation Matrix, test cases	Revised Test Plan, Functional validation matrix, test cases
Design	test cases are revised; select which test cases to automate	revised test cases, test data sets, sets, risk assessment sheet
Construction	scripting of test cases to automate,	test procedures/Scripts, Drivers, test results, Bugreports.
Testing cycles	complete testing cycles	Test results, Bug Reports
Final testing	execute remaining stress and performance tests, complete documentation	Test results and different metrics on test efforts
Post implementation	Evaluate testing processes	Plan for improvement of testing process

15. DISCUSSION AND OBSERVATIONS

This study includes pre-implementation evaluation, customization of HIS and development of testing protocols for Kenya hospitals. For customization of software it is necessary to understand the various processes as well as have a good requirement study prior to it. The pre-implementation stud helped in understanding the processes. It was also evaluated during the pre-implementation study that the waiting time of a patient is about 200 minute, thereby it would be essential for the hospital to implement a HIS which would help in reducing the waiting time by streamlining the processes. Few of the observation during the study are as follows:

- It takes around 12-15 days for customization of the HIS by implementers. As the developers release the modules phase wise
- A checklist before the testing is necessary which helps in checking whether all the aspects of the customization have been covered or not.
- If any step in customization of any module will be missed pout the module would not function and also it will not allow the other modules to work completely as the modules functionality are linked to each other.
- It was observed during that if the requirements are not gathered properly then there would be problems during the customization process. Customization on the lines of requirements gathered from the hospital.
- Testing of any software is started after the customization of the HIS is complete. In the testing the gaps in the customization can be found out and the changes in the baseline can be made before the system is deployed in the hospital.
- One of the observations during customization and testing was that the client or end – user's keeps on changing the requirements and adding new requirements, there by leading to re-customization and re-testing process.
- Various bugs and issues were found during the testing phases which were reported on the Redmine.

16. CONCLUSION

This study has attempted to show, based on certain parameters, the waiting time of a tertiary hospital in Mohali. From the study we came to know that the total waiting time a patient experiences during the process of OPD to IPD flow is about 110 minute. This is a lengthy waiting time which could also delay the treatment process. Thus it is necessary for the hospital to take some action to reduce the waiting time and streamline the various processes in an organized manner.

17. RECOMMENDATIONS & LIMITATIONS

17.1 Limitations of the study

- Software design limitation- Unmodifiable data fields (hard coded), absence of source code, lack of ownership of source code.
- The test cases were not updated as per the requirements of the hospital.
- End-users always keep on changing the requirements.
- They never agreed for a remote access to the server so changes in the customization with changing requirements had to be done at the end-users site.
- Follow up for filling the gaps of requirement due to patient load.
- Communication with the developers was difficult as, developers were in Vietnam, so resolving the bugs was taking time.
- All the decisions were taken by the state there was no involvement of the hospital.

17.2 Recommendations

- Test scripts should be updated regularly
- Re-processing of the requirement template should be done on regular bases so that the requirements are complete.
- Sign-off should be taken from the users at the end of every step of requirement gathering process as the requirements don't keep on changing.
- Implementation of HIS in hospital is not merely computerization and automation of the existing paper trail but a practice to improve the efficiency and effectiveness of the hospital. This fact should be well delivered and conceived by the users.
- Setting up of a local centralized IT department within the hospital to take care of HIS working.
- Responsibility comes with accountability and hence the client side should be held equally accountable for any kind of changes and additions that has to be made to software.

18. CASE STUDY

COMPUTER LITERACY AMONG THE DOCTORS OF KENYA HOSPITAL

18.1 ABSTRACT

The field of medicine and medical practice requires the use of computers for support in information processing, decision making and records keeping. The success of information and communications technology applications in health is dependent on the level of computer use by health professionals especially doctors. This questionnaire-based study assessed the level of computer and internet usage by doctors in Kenya Hospital well as their perception of the medical recording system in their place of practice.

18.2 INTRODUCTION

The computer as a tool has transformed information and data handling in all fields of endeavor. Computers have been used to manage patients at a distance (telemedicine), to manage hospitals and their patients' records and to search and retrieve information for research and assist in clinical decision making. In general, clinical practice has been tremendously improved by the technological interventions and a new and rapidly growing field of applications called health (or medical) informatics has emerged. In most of the developing world, computer use and literacy, though rising, is still very low. The success of any health informatics program will depend on the skill level and the perception of those who will run it.

18.3 RATIONALE

This case study highlights the level to which doctors apply computers to tasks at their places of work highlighting the level of their knowledge and utilization. The study determines the accessibility of the internet to doctors, the view of doctors regarding the computerization of the medical records and the problems associated with the present paper-based medical recording system. It would also highlight the level of their knowledge and utilization.

18.4 METHODOLOGY

The survey was conducted at Kenya Hospital and the study population consisted of 30 doctors working full-time at the hospital. The questionnaire contained questions regarding the socio-demographic details of the respondents, attitudes towards usage of computer and their view regarding the computerization of records, data were entered into the computer and analysis was done using Microsoft Excel.

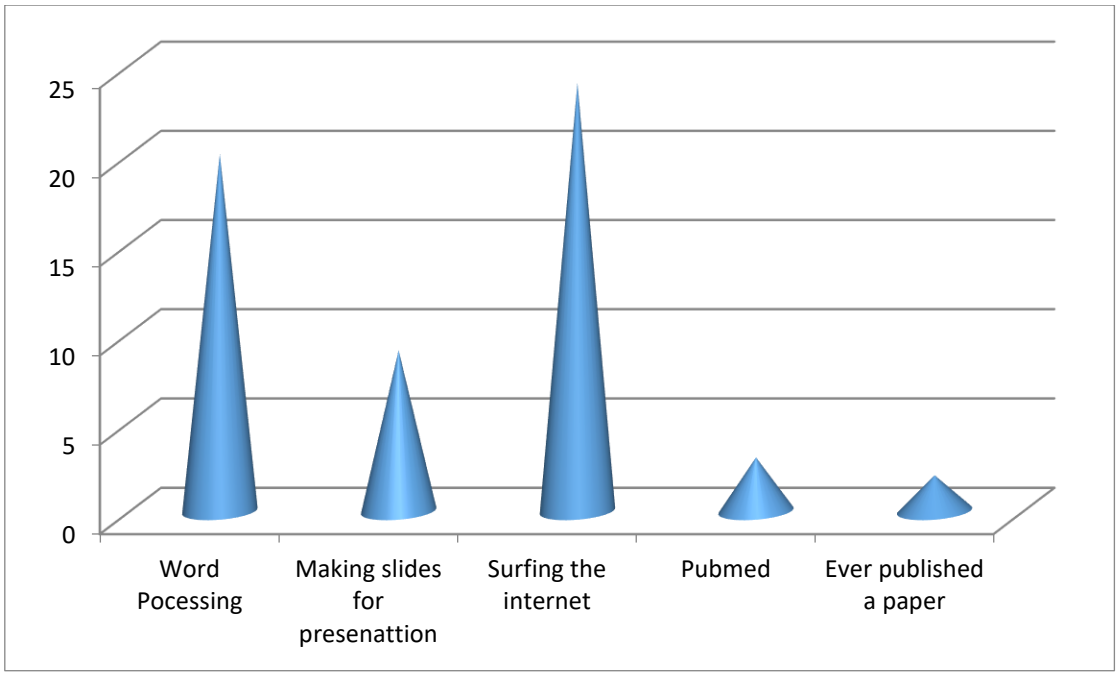
18.5 RESULTS

18.5.1 Demographic Profile

Out of the 30 respondents (doctors), 18 were males while 12 were females.

18.5.2 Personal Skills/Competencies

The personal skills and information-handling competencies of the respondents were asked in the next section. Out of the 30 doctors, 20 doctors could use word processing software. Only 9 of them could make their own slides for presentation. Large number (24) surf the net for various purposes. 3 of them referred PubMed out of which 2 had published a paper as well.

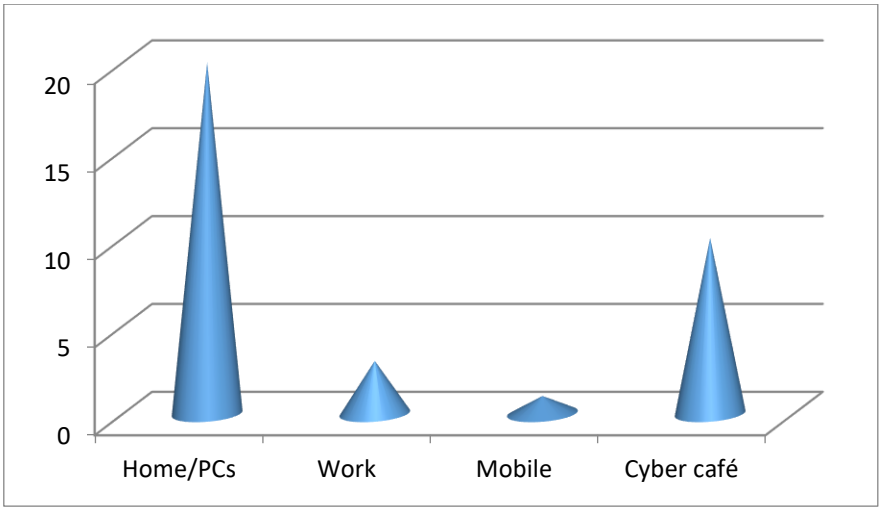


Graph 3. Personal Skills

18.5.3 Access to Personal Computer

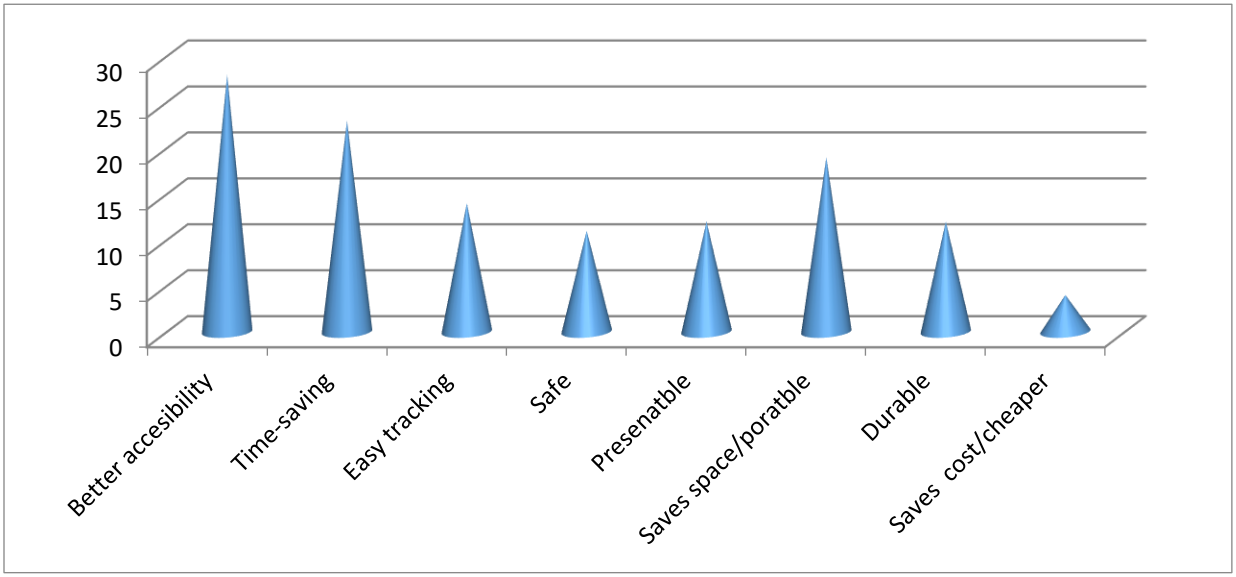
Almost all respondents had access to the internet. 20 of the doctors have a PC at home. They were generally young and middle-aged doctors. It was noted that the younger respondents tended to have multiple access (like work, cybercafé) to the internet than the older respondents.

18 out of the 30 respondents accessed internet used internet <1 hour for checking important mails.



Graph 4. Access to PC

The major reason given by the respondents on why the computer-based system was better was better accessibility of records to doctors. Other popular reasons were that it would be time-saving, saves space/portable. Doctors agreed that easy tracking of the data could be done. The data is more presentable and durable. Some of them also agreed that it would be cheaper on the long run.



Graph 5. Other Reasons

18.5.4 Age & gender

Only 2 out of the 12 female doctors could prepare their presentation slides while 7 out of 12 male doctors could prepare their slides.

18.6 DISCUSSION & RECOMMENDATION

One central factor is, however, the ownership of a personal computer. The ownership of a computer is associated with favorable perception of the computer-based record system. Also, the people who could use Microsoft Word, PowerPoint and excel were more males than females- suggesting a gender-based digital gap.

The older doctors specifically among the age group 45-60 are so used to the traditional paper-work. 4 among this group think computer-based records are of no use, they believe in their recording system. 2 among this group are not sure if at all the system will work or not. Nevertheless, they are aware of the advantages of the computer-based record system. It is mandatory to enable and assist doctors in their acquiring of computer literacy for personal as well as use in the hospital. The training modules should be planned according to the literacy level of the doctor, their willingness to learn and the patient load else computer will become an additional burden. Female doctors of this government hospital are low in computer literacy; they should be encouraged and assisted in their skills. This test was conducted on a very preliminary level. Thus, more research is needed to understand the factors that influence computer and internet use among doctors in Kenya.

19. ANNEXURES

ANNEXURE-1

In order to maintain the ongoing projects in an organization, a certain tool must be used to keep track of things. There are various tools present in the industry to manage projects like Trac, Jumpchart, and Lighthouse. At HISP India, Redmine is the tool which is being used to track the projects.

REDMINE

Redmine is a free and open source, web-based project management and bug-tracking tool. It includes a calendar and Gantt charts to aid visual representation of projects and their deadlines. It handles multiple projects. Redmine provides integrated project management features, issue tracking, and support for various version control systems.

The design of Redmine is significantly influenced by Trac, a software package with some similar features. Redmine is written using the Ruby on Rails framework. It is cross-platform and cross-database. Redmine is open source and released under the terms of the GNU General Public License v2 (GPL).

Features

Some of the main features of Redmine are:

- Multiple projects support
- Flexible role based access control
- Flexible issue tracking system
- Gantt chart and calendar
- News, documents & files management
- Feeds & email notifications
- Per project wiki
- Per project forums
- Time tracking
- Custom fields for issues, time-entries, projects and users
- SCM integration (SVN, CVS, Git, Mercurial, Bazaar and Darcs)

INSTRUCTIONS FOR TESTING MODULES AND VERIFYING ISSUES

HOW TO REPORT ON REDMINE

Definitions

Actors	
Implementer	Person who deeply know the system flow, and configuration details. The implementer interacts with the user for requirement analysis and is in charge of the customization, testing and verification of the application.
Developer	Person who programs computers or designs the system to match the requirements of users.

Processes	
Test	When a new environment is set up (e.g. New instance for a hospital), after configuration and customization of the system is done by implementers, we may need to make sure the system performance is perfect before we declare it a ready to be launched. Testing process will always follow a Test Script document (when available) Testing may result in : **Bug:** when an error on the system flow is found. **Support:** when an existent requirement in the system needs to be adapted for a particular instance.

Verification	When an issue is marked as *Resolved* by a developer, the implementer should make sure the issue has been resolved and is working fine. After verification is done status of the issue will be changed to: **Closed:** in case the issue is resolved. **Feedback:** in case is not working properly. In this case a comment with the error found should be added.

Type of Environment	
Development	Unstable environment in which developers work. They change and modify versions before resolving issues or releasing versions.
Testing	Semi stable environment in which implementers configure the system, and test and verify the different issues.
Production	Stable environment to which users have access. Real instance of the system. (In our case it is usually located on the hospital)

Issue Types	
Bug	When an error or an unexpected behavior on the system flow is found.
Support	When an existing requirement needs to be customized for a particular hospital.
New Feature	When a new requirement is requested by the hospital and accepted by the

	implementers.

Issue Status	
New	A new issue is created by a developer or implementer.
In Progress	A developer is currently working on the issue.
Resolved	A developer has resolved the issue.
Feedback	Implementers or developers need to exchange information.
Closed	The issue is resolved by a developer and verified by an implementer.
Rejected	An issue is rejected by a developer or an implementer.

Priority Levels

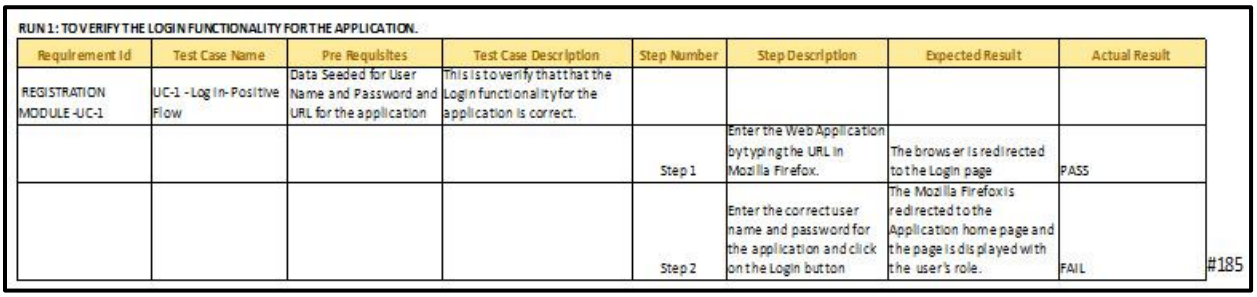
Low	The issue is not critical for the system performance or the user needs. Long term changes.
Normal	The issue is not critical for the system performance or the user needs.
High	The issue is not critical for the system performance, but is urgent for the user
Urgent	The issue is critical for the system performance but basic daily activity of the hospital is not compromised.
Immediate	The issue is critical for the system performance and basic daily activity of the hospital is compromised.

Type of Versions

Snapshot	A snapshot is a temporary version in which new bugs, support or requirement issues will be resolved. Two modules with the same version number, but the snapshot suffix, could be different and have different behaviors. Testing and verifications are performed over snapshot versions. **E.g.–** Billing 1.1.1-Snapshot
Release	When a snapshot version is tested and verified as working fine, then it is released as a stable version with the same version number, without the snapshot suffix. Two modules with the same version number will always be exactly the same module. In production environment we should only deploy released versions. **E.g.-** Billing 1.1.1

Following a Test Script. What to do when a test case success or fail?

When a test case step return the expected result, PASS should be written on its Actual Result column. When a test case step does not return the expected result we should report it as an issue in Redmine (read how to report an issue on Redmine). After that we will write FAIL in the Actual Result column followed by the issue number.



RUN 1: TO VERIFY THE LOGIN FUNCTIONALITY FOR THE APPLICATION.

Requirement Id	Test Case Name	Pre Requisites	Test Case Description	Step Number	Step Description	Expected Result	Actual Result
REGISTRATION MODULE -UC-1	UC-1 - Log In- Positive Flow	Data Seeded for User Name and Password and URL for the application	This is to verify that that the Login functionality for the application is correct.				
				Step 1	Enter the Web Application by typing the URL in Mozilla Firefox.	The browser is redirected to the Login page	PASS
				Step 2	Enter the correct user name and password for the application and click on the Login button	The Mozilla Firefox is redirected to the Application home page and the page is displayed with the user's role.	FAIL #185

WHERE AND HOW TO REPORT AN ISSUE ON REDMINE?

Where?

Every module has its own project on Redmine, under the project Modules. Issues should be reported under the correspondent project depending on the module we are working on.

How To?

To report an issue we will access the project named as the module we are testing and click on New Issue. On the new issue screen we will fill the following fields:

- **Tracker:** Bug / Feature / Support (see Definitions section)
- **Subject:** [Module Name] [Module Version] [Hospital Core Name] Short description of the error.
    - Module Name even if it can be redundant in some cases, is very useful to have the name of the module in the subject of the issue.

- Module Version information can be found on *Administration* → *Manage Modules*

- Hospital Core Name can be found on *Administration* → *Manage Global Properties* as the value of the *hospitalcore.hospitalName* property.

- **Description:** The steps followed until the error is found should be copied on the text box. Followed by the description of the error.
- **Status:** New / In Progress / Resolved / Feedback / Closed / Rejected (see Definitions section)
- **Priority:** Low / Normal / High / Urgent / Intermediate (see Definitions section)
- **Target Version:** We will select the version matching with the Snapshot version we are testing. (see Definitions section) / Not really. The target version is the version in which this bug is expected to be fixed. It is not really related to the version under test. This is for the purpose of generating roadmap for a release.

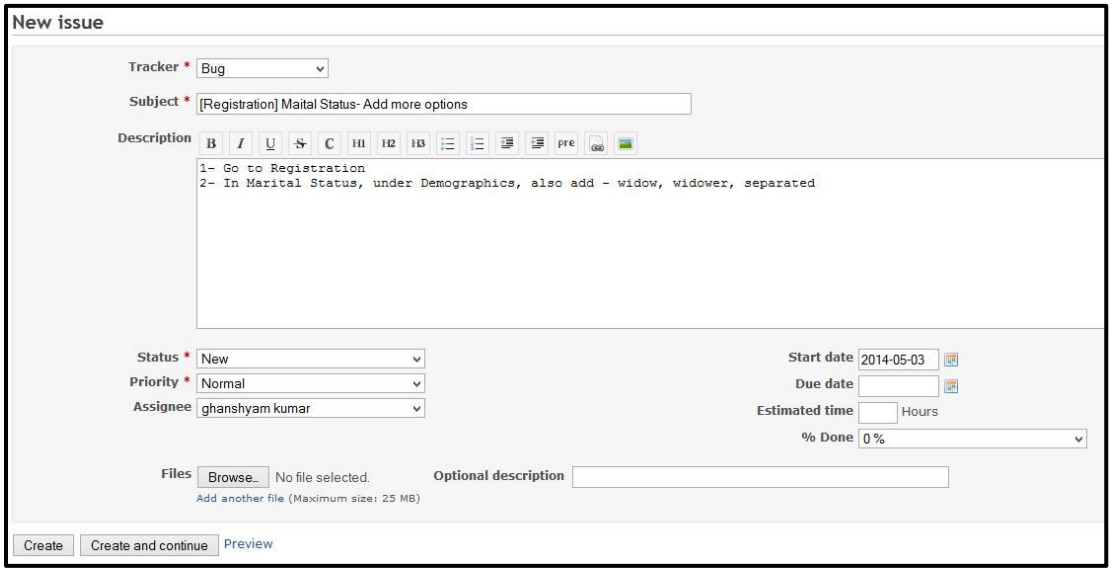


Figure 30. New Issue on Redmine

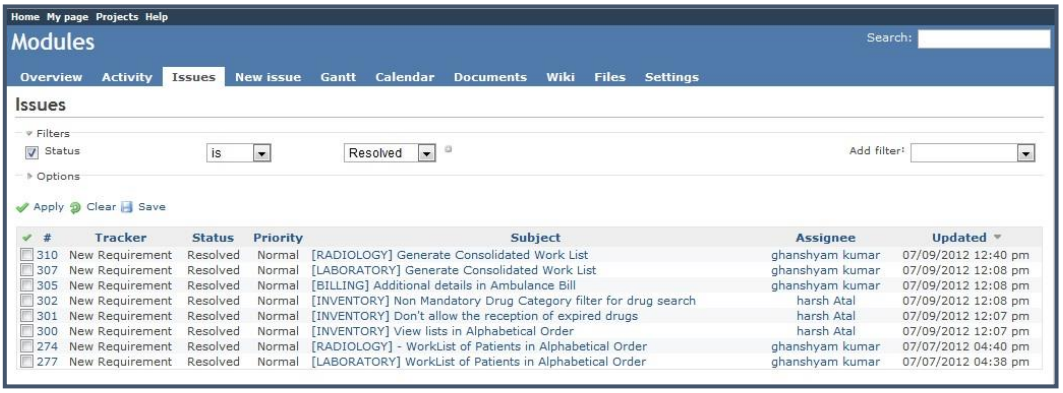
VERIFICATION PROCESS

Developers

- The developers' team will resolve issues during the day, commit the code, and change the resolved in Redmine.
- When creating new issues (bugs or new requirements), the name of the module will be the first word in the name.
- [BILLING] Advanced Search in Find Patient(s)
- If the HospitalCore Module is modified while resolving an issue, an email will be sent to system admin indicating than that module need to be updated as well. The subject of the email should follow the convention:
- New HospitalCore – dd/mm/yyyy

System Administrator

- The System Administrator will check every morning, before 11:00 A.M. the issues marked as resolved the day before.
- The System Administrator will update the modules for which an issue has been resolved the day before in the testing servers.
- The System Admin will send an email to the developers group informing about the modules that have been updated.



Implementers

- Every day, the implementer team can consult the same list of resolved issues knowing that any issue resolved the day before is already updated in the testing servers and ready for verification.
- The periodicity of this task and people in charge should be defined by the implementers' team. From the developers team we would appreciate that the verification is done in a two days' time as maximum, because is the functionality is not working properly… the longer it takes, the more difficult is for us to remember all the details of how we have programmed it.

Annexure -2

CAPACITY BUILDING

TRAINING SESSION/ CAPACITY BUILDING FOR THE END USER

The most important part of implementing HIS is to train the end users in using the modules. The end users in Kenya hospitals basically comprises of Doctors, nurses, laboratory technicians, pharmacist, paramedical staff and other clerical staff. It was essentially taken into consideration to plan training in a proper and feasible manner to ensure satisfactory results. At HISP, the training needs of different end users were assessed and planned accordingly.

TRAINING OBJECTIVE

Training is required in order to prepare the end users to be compatible and comfortable in using the product developed in the most effective way so that it is accessible by the staff in the full-fledged way. Important issues can be discovered to help improve the overall acceptance of the system and usability. It involves delivering learning in regard to product usage and management depending upon the need of different kinds of users.

MOODLE

Moodle (Modular Object-Oriented Dynamic Learning Environment) is a free software e-learning platform, also known as a Learning Management System, or Virtual Learning Environment (VLE). Moodle was developed to help educators create online courses with a focus on interaction and collaborative construction of content, and is in continual evolution. The first version of Moodle was released on 20 August 2002.

The Moodle project comprises several distinct but related elements, namely-

- The software.
- Moodle Pty Ltd (also known as Moodle.com and Moodle Headquarters, based in Perth, Western Australia), an Australian company which performs the majority of the development of the core Moodle platform.
- The Moodle Community, an open network of over one million registered users who interact through the Moodle community website to share ideas, code, information and free support. This community also includes a large number of non-core developers, with Moodle's free source license and modular design allowing any developer to create additional modules and features that has allowed Moodle to become a truly global, collaborative project in scope.
- The Moodle Partner network, which forms the commercial arm of the Moodle environment and provides the bulk of the funding to Moodle Pty Ltd through the payment of royalties.

Features

Moodle has several features considered typical of an e-learning platform, (+) plus some original innovations (like its filtering system). Moodle is a Learning Management System (LMS). Moodle can be used in many types of environments such as in education, training and development, and business settings.

Some typical features of Moodle are:-

- Assignment submission
- Discussion forum
- Files download
- Grading
- Moodle instant messages
- Online calendar
- Online news and announcement (College and course level)
- Online quiz
- Wiki

Developers can extend Moodle's modular construction by creating plugins for specific new functionality. Moodle's infrastructure supports many types of plug-ins:

- Activities (including word and math games)
- Resource types
- Question types (multiple choice, true and false, fill in the blank, etc.)
- Data field types (for the database activity)
- Graphical themes
- Authentication methods (can require username and password accessibility)
- Enrollment methods
- Content filters
- Many freely available third-party Moodle plugins make use of this infrastructure.

Moodle users can use PHP to write and contribute new modules. Moodle's development has been assisted by the work of open source programmers. This has contributed towards its rapid development and rapid bug fixes. By default Moodle includes the TCPDF library that allows the generation of PDF documents from pages.

Moodle is SCORM 1.2 compliant, but does not support SCORM 2004 or Tin Can.

HISP and Moodle

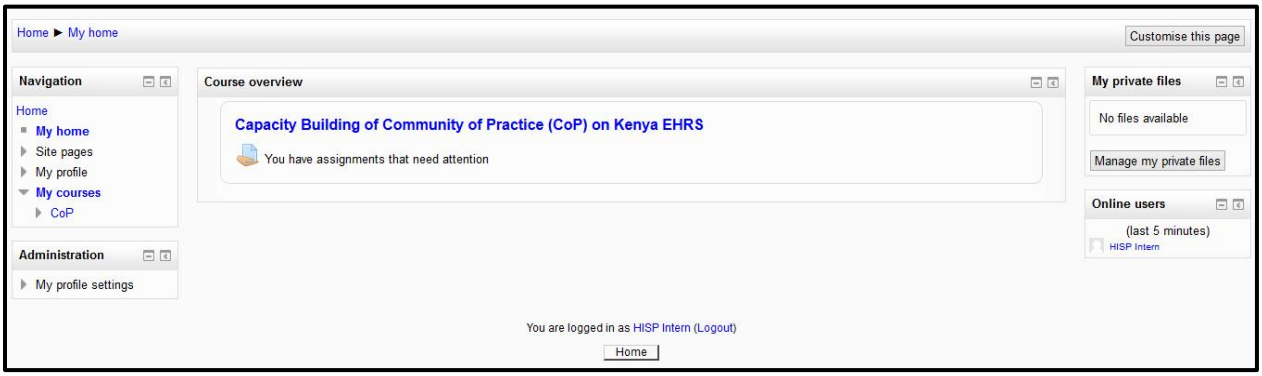
As defined, communities of practice (CoP) are groups of people who share a passion for something that they do, and who interact regularly to learn how to do it better. With respect to Kenya EHRS, which is not being developed by local team, how do we still ensure that dependencies on developing team is reduced and that the system can be managed and customized locally from version 1 onwards – building a strong community of practices is one of the most sustainable ways to do so. Plan for capacity building of the CoP team involves online sessions and exercises on various facets of the system, with brief plan below.

Objectives of capacity building of CoP team:

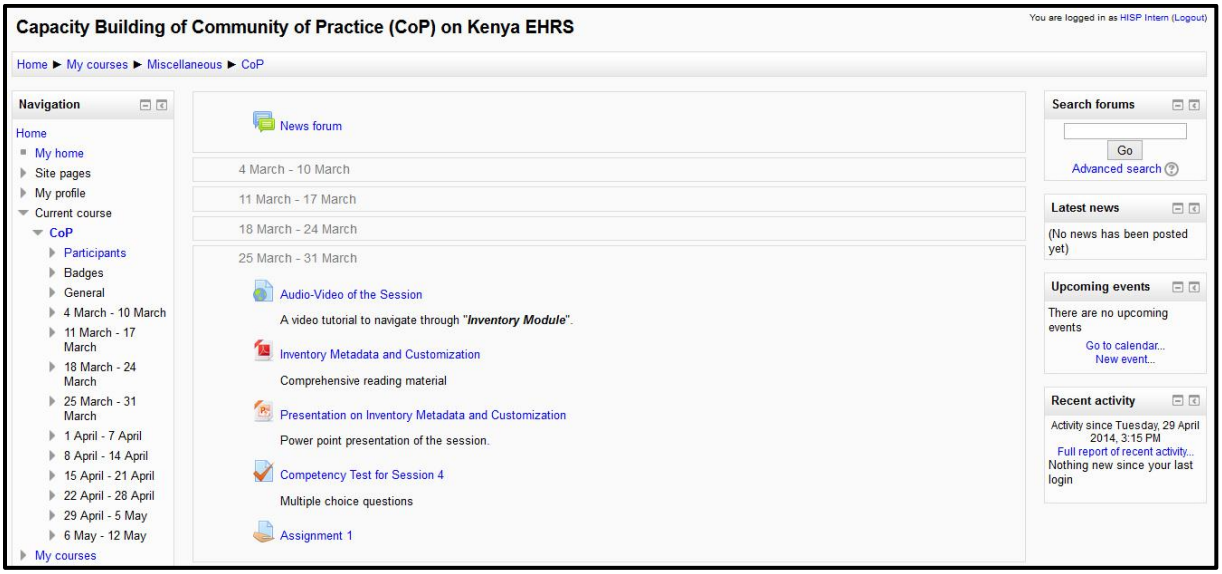
1. Building understanding & clarity on Kenya HER System – working of the system, information flow in the system, patient flow in the system, workflow in the system, reports in the system, integration of system with DHIS
2. Building understanding on customization of the system
3. Building understanding & clarity undertaking further customizations in the system
4. Building understanding & clarity on developing & designing required reports in the system
5. Building understanding on capacity building on the system, with CoP team to be Master Trainers

The homepage of Moodle which is used by HISP is as below. The available course will be listed for the training purpose.

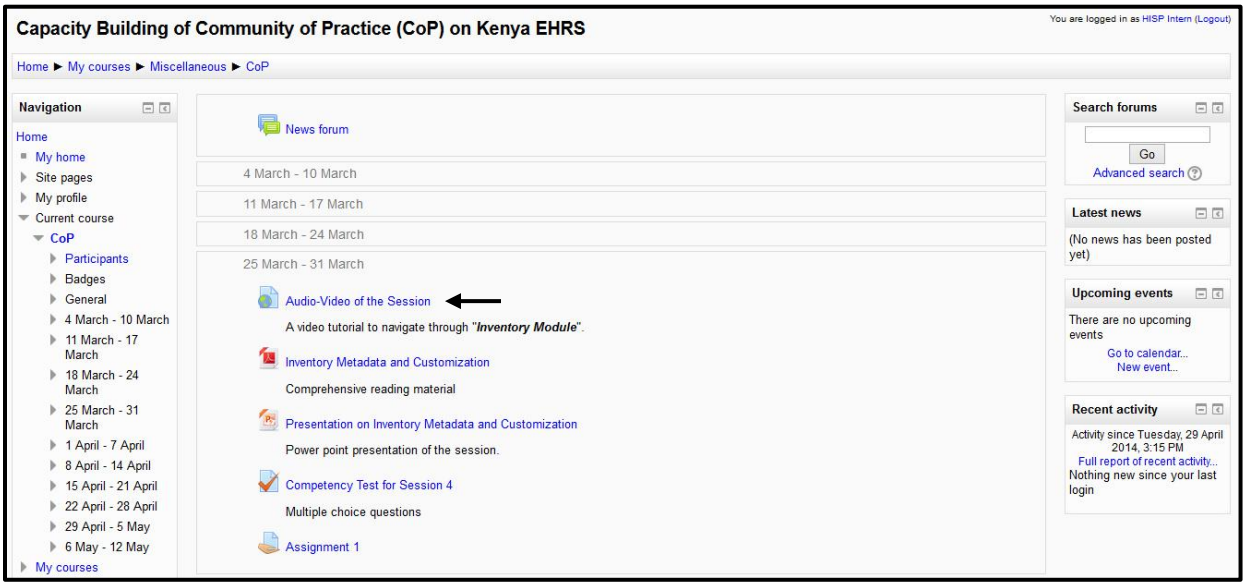
Click on the course and the course overview can be seen which consists of various materials to for reading and evaluation purposes



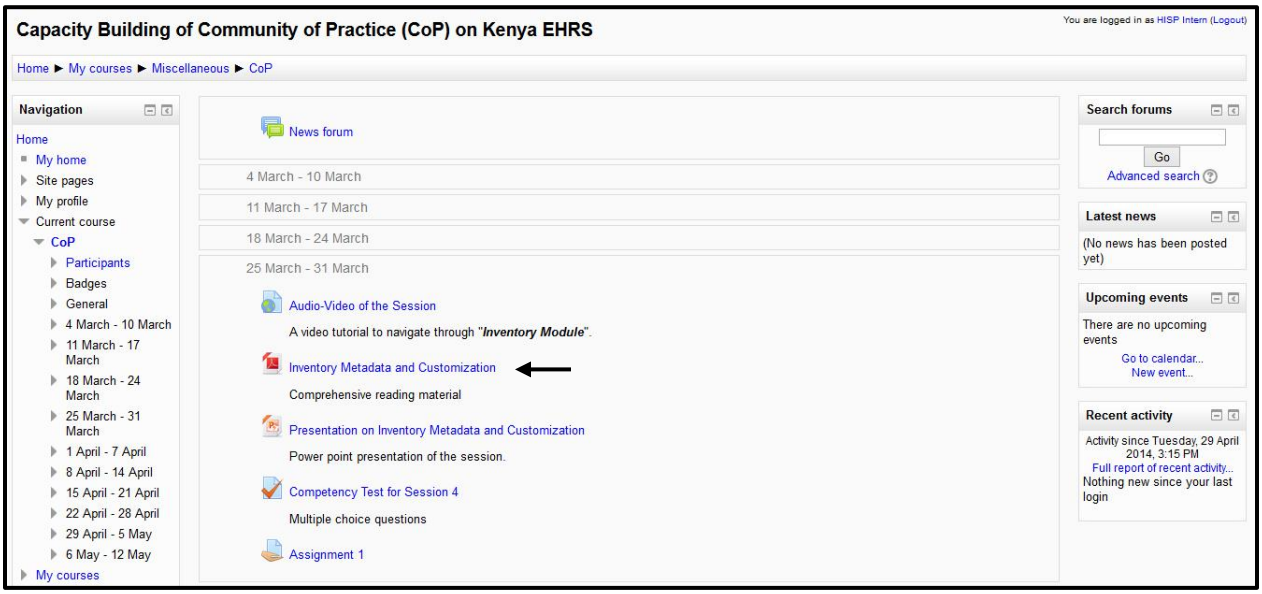
These are the various materials in different form which has been provided for learning aspect.



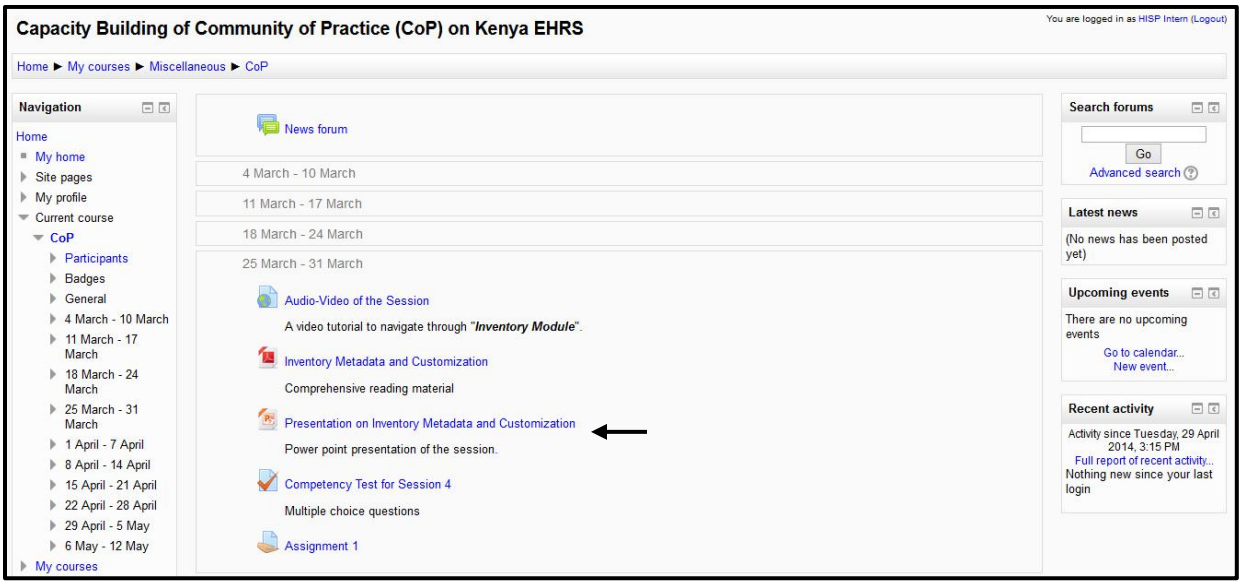
To know about a particular module, there is an Audio-Video material.



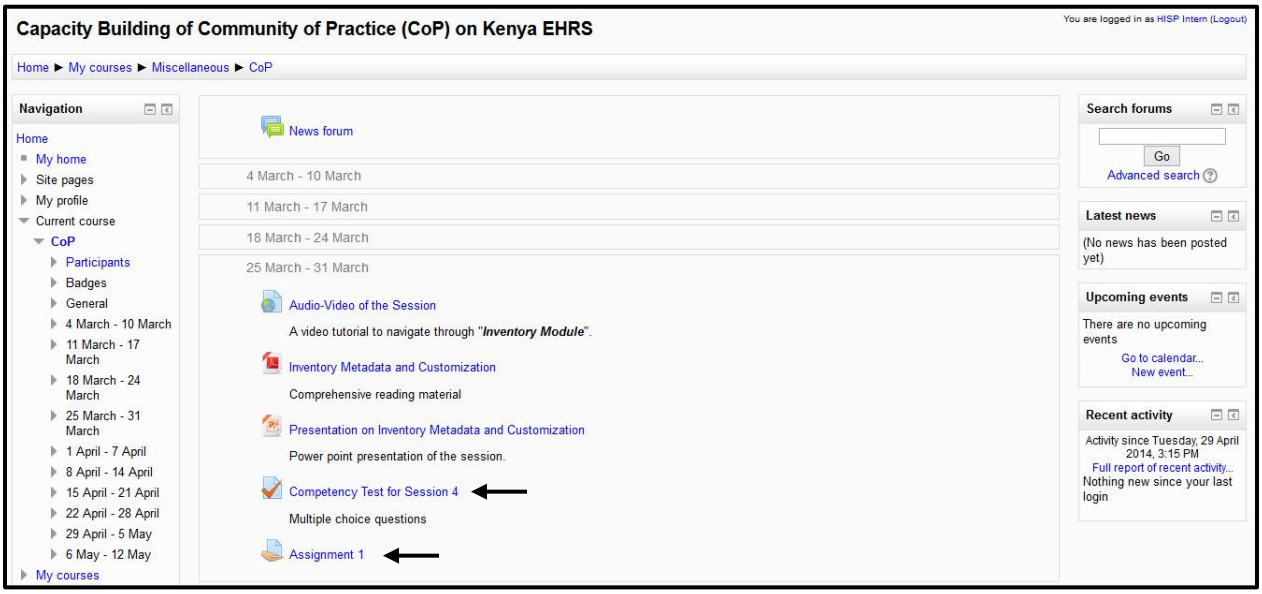
Documents are provided for reading basis of every module.



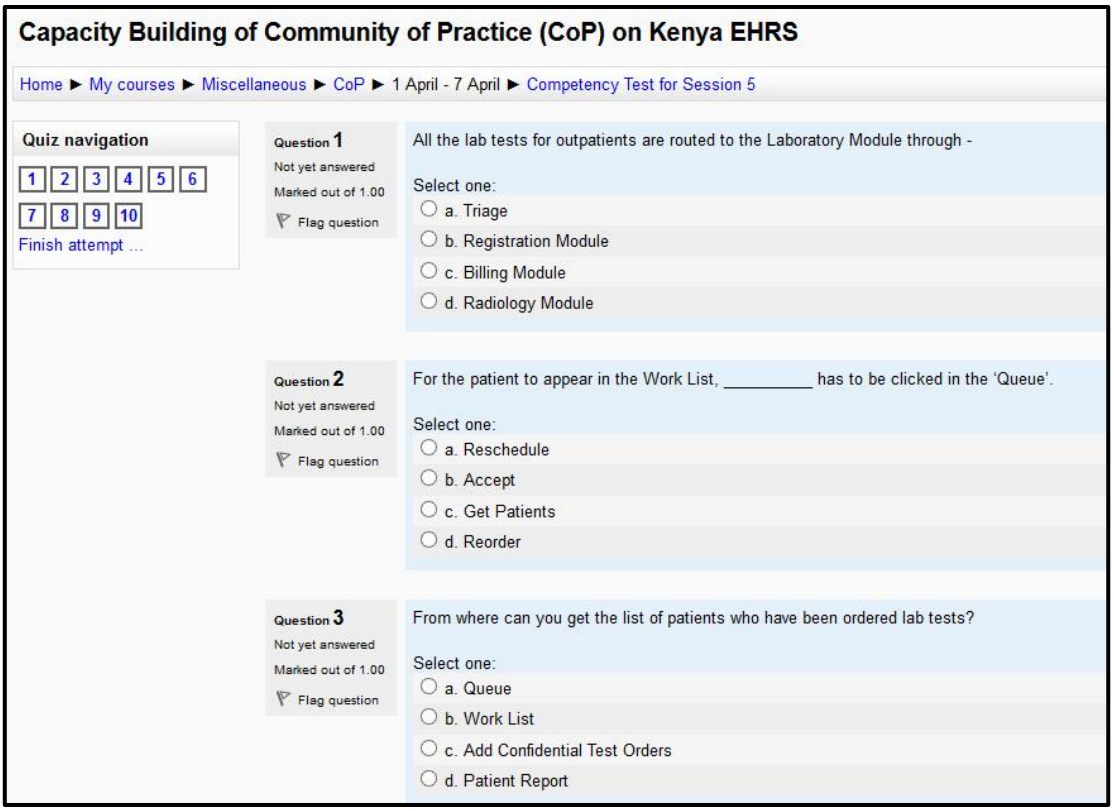
A PowerPoint presentation is also included to give a better understanding of the module.



To evaluate oneself, quiz and assignment are also included to see how much the modules have been understood.



The quiz consists of multiple-choice questions which carry some weightage for evaluation.



Capacity Building of Community of Practice (CoP) on Kenya EHRS

Home ► My courses ► Miscellaneous ► CoP ► 1 April - 7 April ► Competency Test for Session 5

Quiz navigation

1 2 3 4 5 6
7 8 9 10
Finish attempt ...

Question 1
Not yet answered
Marked out of 1.00
Flag question

All the lab tests for outpatients are routed to the Laboratory Module through -

Select one:
- a. Triage
- b. Registration Module
- c. Billing Module
- d. Radiology Module

Question 2
Not yet answered
Marked out of 1.00
Flag question

For the patient to appear in the Work List, _____ has to be clicked in the 'Queue'.

Select one:
- a. Reschedule
- b. Accept
- c. Get Patients
- d. Reorder

Question 3
Not yet answered
Marked out of 1.00
Flag question

From where can you get the list of patients who have been ordered lab tests?

Select one:
- a. Queue
- b. Work List
- c. Add Confidential Test Orders
- d. Patient Report

ANNEXURE- 3

QUESTIONNAIRE (CASE STUDY)

Name:

Designation:

Department:

		Tick the right option here. You may tick multiple option where ever required
Gender	Male	
	Female	
Age	25-35	
	35-45	
	45-60	
Duration of	1-5 year	

practice		
	>5 years	
Personal skills and competencies	Word Processing	
	Making slides for presentation	
	Surfing the internet	
	PubMed	
	Ever published a paper	
Location of access	Home/PCs	
	Work	
	Mobile	
	Cyber café	
Hours of internet	<1	
	1-5	

	>5	
Problems with the medical record	Inaccessible to certain locations	
	Unpredictable	
	Time wasting	
	Lack of durability	
	Costly/expensive	
Will computer-based record be better than paper	Yes	
	No	
	Can’t say	
Reasons for preferring computer-based records	Better accessibility	

	Time-saving	
	Easy tracking	
	Safe	
	Presentable	
	Saves space/portable	
	Durable	
	Saves cost/cheaper	

20. REFERENCES

1. Smithson S., Hirschheim R. (1998). “Analyzing information systems evaluation: another look at an old problem”, *European Journal of Information Systems*, Vol. 7, pp. 158-174.
2. George W. Odhiambo-Otieno, Wilson W.O. Odero, Department of Health Management, Faculty of Health Sciences, School of Public Health, Moi University; March 2005; Evaluation criteria for the district health management information systems: lessons from the Ministry of Health, Kenya
3. National tele health center; University of the Philippines Manila*; the Health Sciences Center*.
4. Https://wiki.openmrs.org/display/docs/Managing+Person+Attribute+Types
5. Udai Singh, Ashutosh Pandey, Amit Kumar ;Testing & Integration Issues in implementation of Advanced Health Information Management System
6. Gap Analysis Document (GAD) version – 10.0.0.1, Post Graduate Institute of Medical Education & Research (PGIMER).
7. H.C. KIMARO* & H.M. TWAAKYONDO, *University of Dar es Salaam, Department of Computer Science, Dar es Salaam, Tanzania:* Analyzing the hindrance to the use of information and technology for improving efficiency of health care delivery system in Tanzania; Tanzania Health Research Bulletin 7, September 2005
8. Angelo S Nyamtema; Bridging the gaps in the Health Management Information System in the context of a changing health sector; Nyamtema BMC Medical Informatics and Decision Making 2010
9. Health Research for Action: Review of the Health Management Information System HMIS/MTUHA. 2000, 136.
10. Ministry of Health of the United Republic of Tanzania: Health Management Information System: Implementation plan 1992-1996. MOH, Dar es Salaam 1993.
11. Smith M, Madon S, Anifalaje A, Malecela M, Michael E: Integrated health infomation systems in Tanzania: experiences and challenges. EJISDC 2008, 33:1-21.
12. Dillon, A., and Morris, M., G., (1996). User acceptance of information technology: Theories and models. Annual Review of Information Science and Technology 31:3-32.