Addis Ababa University School of Information Science and School of Public Health M.Sc in Health Informatics Programme

Project Title:

Design of a Patient Record System For Shashemene Referral Hospital

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June 2014
Addis Ababa, Ethiopia

Addis Ababa University

School of Information Science

And

School of Public Health

M.Sc in Health Informatics Programme

DESIGN OF A PATIENT RECORD SYSTEM FOR SHASHEMANE REFERRAL HOSPITAL

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Dedication

This project work was dedicated for my beloved wife **Glegele Hailu** and my sons **Fraol** and **Hundaol**.

Acknowledgements

First and foremost, Glory to God. Without God's support and guidance in my life, nothing would have been possible. I am also very grateful to my advisors, Dr. Derje Teferi and Dr. Demeke Assefa. They are not only my advisors but they are also my mentors. Thank you for giving me meticulous comments and correction without your comments and correction I may be out of track. Of all the qualities of my advisors, there kindness touched me most. Thanks Dr. Derje and Dr. Demeke you have a place in my future career.

Many thanks go to all staffs of Shashemane Rreferral Hospital` specially Dr. Wahib medical director of the hospital for he has shown me a great respect and hospitality during my project work .In addition, S/r kelamua and S/r Etenesh working in the ward and Ato Jemal who were working in the HMIS office for assisting me in requirement gathering and for giving me your time in responding to my questions.

I know I tend to be a nuisance when things are not going in my way and putting up with this is very difficult. Fortunately, I am blessed with a wonderful wife w/r Gelgale Hailu who has a limitless tolerance to all my agitations. I really appreciate this with lots of love and respect as I always do.

I would also love to thank Abiy Kassa who let me use his office and give me development tools he also deserve equivalent respect with others. Thank you Obama (Abiy)!

Furthermore, many thanks go to my Dad Ami Morke, Mom Alemitu Uka and Youngest sister Bontu Ami for financial support. I really appreciate this with lots of love and respect. I thank God for having you as family.

Finally, my deepest gratitude goes to the all time friend of mine, Pastor Bushura Teshita. I just can't thank you enough. May God bless you!

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Acronyms

AAU	Addis Ababa University
AHR	Automated Health Record
ART	Anti Retroviral Therapy
BR	Business Rule
CDC	Center for Disease Control
CDSS	Clinical Decision Support System
CEO	Chief Executive Officer
CPR	Computer-Based Patient Record
DFD	Data Flow Diagram
EMR	Electronic Medical Record
ER	Entity Relationship
ETB	Ethiopian Birr
FMOH	Federal Ministry of Health
GB	Giga Byte
GC	Gregorian calendar
GHz	Giga Hertz
GP	General Practitioners
HDD	Hard Disk
HI	Health Informatics
HIS	Health Information System
HMIS	Health Management Information System
HO	Health Officer
HSDP	Health Sector Development Program
HTML	Hyper Text Markup Language
ICT	Information Communication Technology
IPD	Inpatient Department
ISO	International Standard Organization
KMS	Kilometers
LIS	Laboratory Information System
MB	Mega Byte
MRN	Medical Record Number
MWN	Mid-Wife Nurses
OBY/GYN	Obstetrics and Gynecology
OO	Object Oriented
OOA/D	Object Oriented and Analysis/Design
OPD	Outpatient Department
OS	Operating System
PHP	Hypertext Preprocessor

RHB	Regional Health Bureau
SDLC	System Design Life Cycle
SQL	Structured Query Language
SRH	Shashemane Referral Hospital
TB/ LEP.	Tuberculosis/Leprosy
TUTAPE	Tulane University's Technical Assistance Program for Ethiopia
UC	Use Case
UI	User Interface
UML	Unified Modeling Language
VB	Visual Basic
ZHB	Zonal Health Bureau

Abstract

Background: To provide quality of health care, medical practitioners require complete, accurate, and timely data. Practitioners need to know their patients' medical history to avoid prescribing treatments that may have adverse effects. Though, most medical records are kept in voluminous paper files, typically located in doctors' offices or other health service provider sites. These files are often not available when most needed in addition report generation from these files is also difficult and not timely. To overcome this catastrophic problems designing of a patient record system is mandatory.

Objective: The proposed project attempted to Design a Patient Record System for Shashemene Referral Hospital which enables the user of the system to use patient data effectively and to pass good decision on patient treatment.

Methodology: The proposed project used Structured System Analysis and Design system development approach and it used different data collection tools i.e. (interview, observation and relevant document review techniques) to collect sufficient data needed for the system to be developed. Analysis and design of the proposed system was performed by using analysis and design technique i.e. Data Flow Diagrams (DFD) for process modeling, Activity Diagram and Entity Relationship Diagrams (ER) for data modeling, for programming language Hypertext Preprocessor (PHP) and Hyper Text Markup Language (HTML) were proposed for implementation phase. Structured Query Language (SQL) server 2008 and Microsoft Access 2007 were the tools used for data base table construction and their relationship. For data flow diagram the tool used was Microsoft Visio 2007.

Result: The developed design of a patient record system for Shashemane Referral Hospital incorporates Register new /update repeat patient detailed information, Search patient detail, assign patients to different case team, mange ; patient treated at Out Patient Department (OPD) , admitted patient, bed schedule, nursing care plan , discharge summary, user account and generate report. To capture all of these data relational data base system was designed. Finally, system architecture also designed to give a high level view of the new system.

Conclusion: Patient health history recording is mandatory it helps the health professionals to easily accesses health history and prevents them from prescribing drugs that has adverse effects which threatens patient's life. The developed design of a patient record system contains patient registration, management of patient history at Out Patient Department and Inpatient Department and also report generation for stake holders.

Recommendations: To achieve the aim of this project work Shashemane Referral Hospital, Addis Ababa University and other stake holders should react on the implementation phase of this design.

CHAPTER ONE

Introduction

Patient record is "a warehouse of information about an individual's lifetime health status and health care, stored electronically or manually" [1]. There are two types of patient record systems which are used to manage patient information, namely paper-based record system and the computer-based record system. The basic advantage of developing computer-based record system is to increases the accessibility and use of the patient record or data. And this is also one of the aims of one country's Health Information System (HIS) in order to improve the Health System Development (HSD), and the health status of the population [2].

To provide quality health care, medical practitioners require complete, accurate, and timely data. Practitioners need to know their patients' medical histories to avoid prescribing treatments that may have adverse effects. They need quick access to the results of laboratory tests and other diagnostic procedures to determine the best treatments. In emergency situations, critical information can mean the difference between life and death. Yet most medical records are kept in voluminous paper files, typically located in doctors' offices or other provider sites. These files are often not available when most needed. Even hospitals and medical facilities now using automated systems cannot easily access patient data maintained by other providers [3].

Electronic sharing of medical data offers great potential for improving health care delivery by providing doctors with full knowledge of patients' medical histories, permitting many practitioners to share a patient's data simultaneously, and reducing the need for costly duplicate diagnostic tests. Similarly, insurers will be able to increase their efficiency and productivity through electronic claims submission and payment [3].

To improve the routine HIS there is a growing recognition that Information Communication Technology (ICT) can replace traditional routine paper-based HIS with flexible electronic means and could bring significant cost reduction and effectiveness in terms of timely delivery of health care services in developing countries [4].

"Electronic systems also maintain quality and accurate data, and make reporting potentially more flexible and efficient. On the contrary, in paper-based systems the data is collected and compiled manually at each site where the data is collected, a process that hinders managers and decision makers at higher levels of the hierarchy from viewing the disaggregated data coming from lower levels of the system [5]". Besides this, accessibility of data in the paper-based system is time consuming, potentially unreliable and inefficient when the number of records becomes very large [6, 7].

As a solution to such challenges medical databases have been implemented to the health system since 1960s [8]. During their first invention they were used to provide a patient's

billing service. Later on, as Linberg (1979) mentioned, these databases were started to use for the purpose of collecting and storing patient's medical history. Nowadays medical database has different comprehensive functions including Clinical Decision Support System (CDSS), Order entry, electronic information exchange etc [9].

Following the change of government in 1991, the new Government of Ethiopia put in place many political and socio-economic transformation measures. Among these, it developed a first national health policy, which was followed by the formulation of four consecutive phases of comprehensive Health Sector Development Plans (HSDPs), starting from 1996/97. At the core of the health policy are democratization and decentralization of the health care system; developing preventive, promotive and curative components of health care; assurance of accessibility of health care for all parts of the population; and encouraging private and NGO participation in the health sector. HSDP-IV is a policy level strategic document that will guide the development of sub-national plans and set the rules of engagement in the health sector [10].

One of the strategies of health policy of Ethiopia is organizing Health Management Information System (HMIS) by: Managing the system appropriate and relevant for decision making, planning, implementation, monitoring and evolution, maximizing the utilization of information of all levels and developing central and regional information documentation center [11].

1.1. Background

Shashemene Referral Hospital is found in Kuyera town about 238 km south of the capital city Addis Ababa. It is one of the most experienced hospitals of the region with more than 50 yrs of service for the population of the area which is currently estimated to be 2.1 million people. It was built by missionaries in 1942 and in 1968 upgraded to governmental general hospital. In 1999 the hospital upgraded to referral hospital. Now a days the hospital encompasses 12.2 hectares of land with a total of 242 employees (Technical=123, Supportive=119 employees) with the bed number of 167 .The hospital on average serves 254 patient per day [12].

The hospital is situated in the West Arsi Zone, Shashamane woreda. This Hospital has been experienced huge growth. Due to the growing number of patients, daily operations have increased to the point that it has become quite difficult for Hospital personnel to manage all paperwork related to Hospital operations. The purpose of this document is to present, in a detailed manner, the requirements needed by Shashemene Referral Hospital (SRH) [12].

The hospital is giving different types of services which include:
Out Patient Department (OPD) Service Includes: (Ophthalmology, Dental clinic, Obstetrics and Gynecology, Emergency and ART clinic).
Inpatient Services Includes: (Pediatrics ward, Medical ward, surgical ward, Oby/Gyn Ward and TB/Lep ward.)
Pharmacy Services Given for: (Inpatient, OPD and ART patients)
Investigation departments

- ***Laboratory Service Given for*** :(Inpatient, OPD and TB/Lep patients)
- ***Radiology(x***-ray, Ultrasound)

Human Resource Description of Shahemane Referral Hospital

Table 1: Human Resource Distribution of Shasshemane Referral Hospital, 2014.

S.no	Types of professional	Number Professionals	Remark
1	Specialists	8	
2	GP's	7	
3	HO's	3	
4	Nurses	82	All types(MWN, Bsc. nurses)
5	Lab. Technologist/Technician	12	
6	Pharmacist/Pharmacy Technician	7	All type
7	x-ray Technician	4	
Total		**123**	

1.2 Statement of the problem

Paper-based patient record management faces many challenges. It decreases quality of information management in health care, and also reduces the productivity and quality of care provided. It does not allow sharing information between different places at the same time. Paper records may be lost, not easily accessible and might not contain full information for decision making or for action. Printing cost for format is also high. It is also not convenient as physicians and other health care providers have limited time to dig through volumes of paper to retrieve information for decision-making and/or share it with patients. It also leads to medical errors in prescriptions, as writing them on paper might not clear and is too difficult to read it [13].

The assessment result done by Angaw S. BraaJ showed that SmartCare also shows it was adopted with immature requirement analysis and recommends for better situational analysis [14].

Through the interview made with Dr. Jemal expert of Public Health Specialist at Tulane University showed that: The current smart care soft ware does not incorporate the updated indicators which necessitate the development of new smart one and TB /Lep treatment outcomes are not fully built-in in the software which shows requirement collection process was not participatory which in turn causes problem in data entry and report generation.

Preliminary study was done at Shashemene Referral Hospital in search of problems in the current system and to identify the felt need of the hospital for new system. According to the response received from Ato Jemal who was working in Medical Record Unit of Shashemene Referral Hospital showed that the large number of patients visiting the hospital has created cumbersome task to the workers in Medical Record Unit. This enormous task has greatly increased volume of data to be collected, large space to store them and difficulty to retrieve useful information from stored data. In addition, the other observed problem that was mentioned by the respondent was in the current system (i.e. the paper based system) the data entry is prone to error and redundancy of patient medical record frequently occurred.

During assessment of smart care implementation at Ras Desta Hospital by Health Informatics (HI) students of 2013 batch they documented the response of responsible individuals Nurayna and Engdawork: The formats on the smart care software which helps to register treatment outcomes of TB cases were not fully included. For instance, some of the formats uses for TB diagnosis and investigation were missed as well as some formats in the smart care were complex when compared to the HMIS form and the forms are different from the manually registered one this in turn cause difficulty for the users of the soft ware. The other problem detected was TB report format in the software was not put like the manual Unit TB Register which missed the treatment out come. So, they used to report manually.

The other problems found in Smart Care were security issues. The password and user name is the same for one department. Everybody working in that particular department use the same user name and password this leads to difficulty in identifying the person who sent investigation report this situation becomes worse when the reported investigation is found wrong or incomplete and it doesn't incorporate nursing care plan that is given for admitted patient. Hence, this project is designed to investigate and give solution for the existing system problems which are described above.

1.3 Objective

1.3.1 General objective

To design an Electronic Patient Record System to be used by Shashemane Referral Hospital.

1.3.2 Specific Objectives

To achieve the general objective, the following specific objectives were stated.

- To elicit system requirement and identify the system's requirements
- To analyze system requirements
- To design a Patient record system

1.4 Significance of the Study

For students: The proposed System Analysis and Design document serves as the basement for future implementation of software by interested students.

For the Hospital and the Health Centre or other health facility*:* The new proposed document i.e. analysis and design of a patient record system will help for all health facilities to include the felt need and process of their departments. And also help them to outsource the implementation phase of the proposed project for external entity and meanwhile, to follow the implementation of their need.

For Physicians and other Health professionals**:** The proposed Patient Record System was used participatory System Analysis and Design approach. This approach helps all health professionals to include all their need so that the future software that will be user friendly.

For Medical research, Statistics and Teaching**:** The proposed analysis and design document is also valuable to design software that will help in the collection of statistics data on health care /services and the incidence of diseases. Furthermore, the proposed document will help for teaching health informatics students.

For Non Governmental Organization: A System Analysis and design document of a Patient Record System will help NGO's who are working in the area of health sector

software development as a base document to identify the best programming language to use and to design new software.

1.5 Scope and Limitation of the project

The proposed project focused on design of a patient record system for Shashamane Referral Hospital which is found in west Arsi Zone, Shashemene woreda ,Kuyera town. In addition, the proposed project also focused on developing system requirement and analysis, design document of the system, which can maintain information about health condition of the patient who was registered at Medical Record Unit and then treated at OPD's and Inpatient departments of the hospital and to recommend a web based communication between them. A web based communication also help for easy accessibility of the data when ever needed by FMOH, RHB, patients and health professionals. The above mentioned scope of the project was done by the use of structured system analysis and design methodology between February- June, 2014Gc.

Due to limitation time, the proposed project doesn't analyzed and designed specific services of the hospital like LIS and Pharmacy Information System, which can be networked to Doctors who are working at OPD's and IPD's.

CHAPTER TWO

Literature review

2.1 General literature

Information System

According to the definition of O'brien (2007) information system encompasses people, hardware, software and communication network that helps to control, transform and distribute information between organizations [15].

According to World Health Organization (WHO 2004) : Health information System is a system that integrates data collection, processing, reporting and use of information necessary for improving health service effectiveness and efficiency through better management at all levels of health service[15].

Records Management

Records Management is the practice of identifying, classifying, archiving, preserving, and sometimes destroying records according (International Standard Organization, 2001). Defines records as "information created, received, and maintained as evidence and information by an organization or person, in pursuance of legal obligations or in the transaction of business [15]

Push for Medical Computerization

According to (Meghan, 2006) report Electronic Medical Record could save 140 billion dollars a year in health care expenses. While saving tens of thousands of lives each year. The technology dramatically reduces the time between a patient's initial consultation with a physician and his receiving treatments. Electronic Health Record also dramatically cuts errors in prescribing drugs that can cause severe problem in patient's life and reduce redundant drug prescriptions [15].

Creation, expansion and linkage of health record system is the aim of health system development. The importance of health record system also includes reduction of medical errors which may leads to improvement of patient safety, helps health professionals to communicate relevant patient health information's. In addition good health record system reduces cost of the organization, increase efficiency of health organization and reduce duplication of medical records [16].

Heath Information

Health information is recorded information regarding physical or mental condition of an individual, health care provision, or health care payment collected routinely from the health service or periodically from the population [17].

Use of health Information System

The essence of health reform and decentralization of health system describes that health systems should be managed at the level of service delivery. This in turn leads to the shift of functions between the central and peripheral levels which generates new information needs and calls for the restructuring of information systems to collect and use information for decision making at local, district, provincial and national levels [17].

A study done by the WHO clearly put that "the function of HIS is to bring together health data from different sub-systems (sources) to share and disseminate them to the different audiences for health information (owners, providers and users) and to ensure that health information is used rationally, effectively and efficiently to improve health action. Therefore, strengthening the HIS is a core process in using patient data [18].

Through HMIS the routine HIS reporting of information is upward in health system. One of the problems of upward reporting of health information data is poor quality. However it is proved that this poor quality of reported health information can be improved at the local level before sending up as a report. One of the mechanisms to control the quality of data is to make facility members to be local consumers of data. The facility managers monitors its accuracy, completeness (how well it represents the population served), and timeliness (whether the data is fresh enough that decisions taken on its implications are likely to affect the situation) before sending it upwards. When information is utilized and controlled by people who collected it then it will be more accurate. The improved quality following extensive use of data leads to further assurance to use data at all levels of the health system [19, 20].

Qualities of a Good Information System

According to Comptroller (1995) an information system includes the following [21].

Efficiency: a good information system should allow for input and output by providing an objective for recording and aggregation information. It should be able to quickly collect and edit data, summarize results, and adjust as well as correct errors promptly.

Effectiveness: a good information system should be able to attain its goals or the goals of the organization. To simplify prompt decision making, an organization's information system should be capable of providing current information to appropriate users**.**

Performance: A good information system should be able to enhance communication among employees, deliver complex material throughout an organization.

Time lines: Information system should be designed to expedite capturing, storing and reporting information in a real time scale when needed.

Consistency: A good information system should be reliable. Data should be processed and compiled with consistency and uniformity. Variations in how data is collected and reported can distort information and trend analysis.

A Note on Terminology

The Oxford Textbook of Primary Medical Care describes medical records as "the information that exists about a patient in a medical service". Record keeping assists doctors by retaining and communicating patient medical history in a portable, convenient format. Relevant information must be quickly available to allow rapid, effective decisions and reduce unnecessary repeat procedures. The natural medium with which to record medical history is paper, since it is simple to use, low in cost, and reasonably durable. Information may be quickly added and readily shared amongst health professionals caring for a patient. However, problems arise due to the decentralized nature of the healthcare system; patients frequently visit different offices for dental work, cardiology, and primary care, impeding the necessary flow of medical information. Fragmented, incomplete patient records pose an obstacle to patient care. An electronic medical records system has the potential to solve the problems of traditional paper records [22].

Generally there is confusion in the definition of Electronic Medical Record and Electronic Health Record. Most people use these words interchangeably this is due to lack of clarity in health sectors, health professionals, policy makers and consultants about these terms; the fact that there is no standardized or accurate or accepted definition. To avoid these confusions the following listed definitions are selected. The selection of these definitions based on their clarity and comprehensiveness. Electronic Medical Record is automated for clinician's work flow and ensuring that all clinical information is communicated. Electronic Medical Record support physicians in decision support because it incorporate evidence-based decision support system tools. The other main difference between Electronic Medical Record and Electronic Health Record is in case of Electronic Medical Record it contains data that are useful for billing, quality management, outcome reporting and public health surveillance. Moreover, Electronic Medical Record has additional features such as clinical decision support, a provider order entry system, a controlled medical vocabulary or result reporting system, in general terms Electronic Medical Record is a system which helps physicians to enhance their patient management[23].

Electronic Health Record is the system that helps to capture health in formations of the patients including vital sign, immunization, diagnosis, medications, present and past histories, progress notes, laboratory data and radiology report [23].

A third type of record is Personal Health Record which is controlled and managed by patients it is universally accessible, layperson comprehensible, lifelong tool for management of chronic disease [23].

System Analysis and Design Approach

It is a common approach of software development it passes through SDLC phases. At the completion of each activity or phase, a document is produced that must be approved by the stakeholders before moving to the next activity or phase. The developer will not go back to the former phase even if problem occurs for this reason it has got the name waterfall system [24].

Structured System Analysis and design (SSA/D)

This methodology was dominated in late 1980's. It's incorporate SDLC passes in which the development process to go through. In addition this methodology introduces the use of formal modeling and diagram technique. This methodology gives emphases for process modeling and data modeling. For process modeling it will use data flow diagram and for data modeling this approach will use a relational database system [25].

The Object-Oriented/Design Approach

The other system development approach is OOA/D system development approach. Its underlying concept is that one should model software systems as collection of objects, treating individual objects as instances of class within a hierarchy of classes. Object oriented methodologies attempt to balance focus between processes and data, also utilizes UML to describe the system concepts as a collection of objects incorporating both data and processes [25].

Rapid Application Development Methodology

In weakness of structured System Analysis and Design the Rapid Application Development appeared around 1990's. This methodology focuses on rapidly developing a system and it adjusts the SDLC phases to get some part of the system developed quickly and hand over the working software to the users immediately [25].

Agile Development Methodology

The agile methodology is programmatic centric and it focuses more on building a working software just in time it doesn't focus on documentation process. In this methodology changing of requirements even at the end of development is tolerable [25].

Overview of Smart Care

SmartCare is a US Center for Disease Control (CDC-Zambia) initiated nationally scalable Electronic Health Record System designed specifically for low resource, disconnected settings. SmartCare has the objective of improving the quality of health care (and health) by providing support o deliver "Continuity of Care" where existing paper systems are failing to preserve a longitudinal data view, and where clinics may often have no telecommunications.

Partners

Partners working collaboratively with the Zambian Ministry of Health are the Center for Disease Control, the Elizabeth Glaiser Pediatric AIDS Foundation Center for Infectious Disease Research in Zambia (CIDRZ), Tulane University Technical Assistance Project Ethiopia (TUTAPE), and other groups

From Zambia to Ethiopia

Tulane University Technical Assistance Project Ethiopia (TUTAPE), with support from Dimagi, is currently implementing SmartCare in Ethiopia. Dimagi has supported TUTAPE through remote developer support, in-country training and development, and training Ethiopian developers in there Boston office. The Ethiopian version of SmartCare was deployed in 2008.

SmartCare system development in Ethiopia happened in collaboration with the SmartCare team in Zambia and the United States. SmartCare is developed using .Net frame work, .Net Language C#, and Microsoft SQL database. SmartCare has the ability to personalize patient's medical record using SmartCards, to function as either as a distributed (standalone) or as centralized (client/server) mode. The standalone mode is used in the absence of online communication infrastructure here SmartCards are used to transport patient data between different points of services. Further in this mode, SmartCare provides database merges by using any electronic data storage and exchange (e.g. flash disks, CDs) methods across all points of service.

Components of the system include:

- One click HMIS report generation
- Secure Smart Card portable health records
- Pharmacy Drug Dispensation module
- HIV adult and Pediatric HIV modules
- Dashboard patient view
- Role based security

Even though the system has the above mentioned features and benefits, there were some limitations noticed. Since the software is closed application and it's owned by Tulane University's technical Assistance Program for Ethiopia (TUTAPE), ministry of health doesn't have direct access to make modifications, and modules or improve the system. The entire system's modification is taken care by TUTAPE's designers' team [25, 26].

Other problem of the system was that it was deployed by adapting from the Zambian and changing few things to Ethiopic context which shows they used immature system's analysis. [25, 26].

The study done by Kamil (2013) on practices and barriers on deployment of Smart Care in Addis Ababa City Administration Hospitals showed that :the reason behind the low utilization of Smart Care among the hospitals were functionality problem of the system, unable to generate daily, weekly and monthly report of some departments like TB/Leprosy, role based security system which causes difficulty to detect responsible person for everything he/she has done , lack of adequate space to write full information of post operative histories of patients, no alternate power supply , not having special or additional confidentiality design for AIDS and Sexually Transmitted Disease patients. Regarding utilization of smart care 84.5% of the respondents who were working in Addis Ababa City Administration Hospitals claim's that the smartCare did not met the desired expectations [27].

The study done on privacy and confidentiality issues of an EMR(SmartCare)application in Ras Desta Damtew and Zewditu Hospitals by Mamaush Tadesse(2013) showed that among areas which are mentioned patient privacy is at greater risk were registration room, OPD, and IPD, Laboratory rooms and Family Planning department. Related to this point 120 (41.8%) of participants don't trust the software not to reveal sensitive health data because they have concerns that sensitive information will be shared because of poor security and data leaks. Nearly all participants 273 (95.1%) said that health consumer involvement is important before adopting new technologies and greater than 20% of respondents were not comfortable in using EMR which is implemented in Ras Desta Damtew and Zewditu Hospitals rather they prefer paper based one. this shows privacy and security concerns are major obstacles that can hinder the progress to electronic health. If these problems not properly addressed, health care seekers will not feel comfortable in participating in health care procedure and health care professionals will also face huge liability risks. Finally the researcher recommended that all stake holders including patients and users of the system should be given participation and chance in analysis and designing phases before adopting the new technology [28].

2.2 Related Works

The EMR called care ware was adapted from US and deployed in Uganda in 2003 to support HIV treatment. Other developing country implementing the Electronic recording system was Malawi. In this country a touch screen patient management information system used since 2001.Then the extensive use of this system was directly by health care workers in a poor country with limited IT skills is a convincing demonstration of the potential of EMRs with user friendly data entry mechanism [29].

A project report on hospital management system was done by (Mansi chitakara et.al, 2009) the project was done in India. The result of the project report can be used in any hospital, clinic, and dispensary, or pathology, laboratory. The Software includes: Maintaining Patient details, Providing Prescription, Precautions and Diet advice, Providing and maintaining all kinds of tests for a patient and Billing and Report generation. This project used desktop application to be developed in VB 6.0 having Ms Access as backend, Database Design (Ms Access), Form Design (VB 6.0), Coding (VB 6.0), Testing (VB 6.0) and Reporting Tool (Data Report) [30].

In Ethiopia, the implementation of Electronic Medical Record is through software called Smart Care. Tulane University's Technical Assistance Program for Ethiopia (TUTAPE) is developing the Smart Care software in partnership with Tulane University, CDC and the Federal Ministry of Health Ethiopia (FMOH). Smart Care was first developed, tested and deployed in Zambia by CDC for HIV/AIDS care and treatment. Besides the rich and advanced functionality and features, Smart Care has also been proven to work in limited resources environment of developing countries particularly in Africa [31].

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CHAPTER THREE

Methodology

The proposed project used structured system analysis and design methodology with the iterative waterfall model with participatory approach and includes requirement gathering, analysis and design of the proposed system.

3.1 Study Setting

This organizational project was conducted in West Arsi zone, Shashemane woreda, Kuyera town about 238 km south of the capital city Addis Ababa. It is one of the most experienced hospitals of the region with more than 50 yrs of service for the population of the area which is currently estimated to be 2.1 million people. The study was done in Shashemane Referral Hospital from February to June 2014.

3.2 Source and Study Population

The source populations were all health workers in Shashemane Referral Hospital. The study population was all physicians at OPD and IPD, Nurses, Data clerk, HMIS officer and system administer who participate in patient registration, patient data recording, treatment, report generation and dissemination.

3.3 Data Collection Techniques

The required data for the development of the proposed system were collected by the use of the following data collection tools: -

3.3.1 Interviewing

Interviews were conducted with the medical Doctors working at OPD's, HMIS officer and Data clerk and ward nurses to find out what difficulties they encountered with the existing system. The tools that were used to gather interview information's were closed and open ended questionnaire.

3.3.2 Observation

This technique was used to gather accurate information about how the system actually operates, particularly about processes. The workers at hospital watched when they perform and recorded the behaviors and characteristics of operations and processes in the hospital. Prior to the observed job at the hospital observation check list were prepared as a tool to observe the day to day to day activities in the OPD's, HMIS office, Medical Record Unit and Ward's

3.3.3 Document Analysis

Document and formats were reviewed including patient charts, registers, tally sheets, periodic reports that are available at OPD's, Medical Record Unit and HMIS office were reviewed to look upon the usual data recording, completion, processing and reporting process.

3.4 Requirement Analysis

The result of the Interview, Observation and Document review were analyzed immediately after requirement gathering. Finally, the result was presented by DFD and activity diagram.

3.5 Systems Design and development methodology

The proposed project used the Structured System Analysis methodology because of the following reasons:

- It structures a project into small, well defined activities and specifies the sequence and interaction of these activities.
- It uses diagrammatic and other modeling techniques to give a more precise (structured) definition that is understandable by both users and developer.

3.5.1 Analysis and Design Technique and tools

- The technique that were used for analyzing and designing system were:
  - Data Flow Diagram
  - Use case diagram
  - ER diagram
  - System Architecture
  - Relational Database Design
- Tools that used were Visio 2007 for Use case diagram, Data Flow Diagram, System Architecture and ER diagram and Access 2007 for Relational Database Design were used.

3.5.2 Development environment tools

- Software that was proposed for implementation phase:-
  - WAMPSERVER
    - PHP
    - My SQL
    - Apache
  - For the database the selected software was: SQL server 2008
  - For this project the suggested programming language was:-
    - PHP
    - HTML

Front end: HTML enable the construction of easy and intuitive user interface for accessing the database and any browser can display and html document [18].

Middle end: PHP enables links of the text entered in the created graphic user interface to be sent to the database [18].

Back end: SQL server it's easy to use, inexpensive database language it can run on a variety of operating system such as window, Linux, Unix's/2 and others , its secured with technical support widely available on the internet but most of all it support large database[18].

3.6 Dissemination of results

The result of the project will be disseminated by using formal report to Shashemene Referral Hospital and Addis Ababa University school of Information science and school of public health for partial fulfillment of Msc. degree in health informatics.

3.7 Ethical consideration

Ethical clearance was sought from Addis Ababa University Institution Review Board of collage of Health Science through School of Public Health and permission from Shashemane Referral Hospital was obtained before the proposed project was commenced. Before requirement gathering the respondents were asked for their permission to be part of this project and they were told that as they have right not to respond or participate in the project.

3.8 Operational definition

Case team: are the groups of professionals assigned by the hospital to give particular care (e.g. emergency case team)

Data clerk:-a person in charge in hospital to register new patients and update repeat patients.

Data flow diagram: Is a graphical representation of the "flow" of data through an information system, modeling its process aspects.

Electronic Medical Record: Is defined as a patients' medical record which holds information electronically and accessible by computers on a network for the primary purpose of providing health care and health-related services.

Entity relationship diagram: An entity-relationship diagram (ERD) is a data modeling Technique that graphically illustrates an information system's entities and the relationships between those entities.

Health facilities: - health institutions like health centers, clinics, hospitals etc.

Nurse:-a health professional who work in health institution to give care for patients.

Patient/ client:-people who get service from health facilities.

Physician:-a health professional that assess, diagnoses, treat, admit and refer patient.

Ward: - is a place found in the hospital where patient get bed and treated.

CHAPTER FOUR

DISCUSSION OF RESULTS

The rationale of this chapter is to illustrate the requirements needed to design a patient record system for Shashemane Referral Hospital.

4.1. Current System Description

Currently, in Shashemane Referral Hospital they are using manual system (i.e. using pen and paper) to collect patient information.

Since the hospital has been using paper based system different problems were occurred according to respondents problems mentioned were; data pertaining to patients are not complete, some patient records are lost, they are disorganized and in general they have problems with data quality and completeness of the patient records and illegibility of hand writing were a huge problem.

According to the response of health professionals, HMIS officer and Data clerk they expect that the proposed system would have a great importance and will solve the problem of manual system. They also anticipate that the new system will reduce errors and helps proper documentation of diagnosis and treatment data of patients.

Business Process

Registration department business process:

- The patient presents in the registration department.
- If the patient is new the data clerk asks the patients full information from the patient.
- The data clerk registers full patient information
- The data clerk gives identification number.
- The patient makes payment.
- The data clerk sends the patient to the triage officer.
- The triage officer screens the patient.
- After screening, the patient will be sent to the selected case team.

If the patient is repeat or comes with an appointment,

- The patient goes to the registration department and gives the service card or appointment card to the data clerk.
- The data clerk receives the update some in formations like date.
- The data clerk will send the patient to the case team.

Business process of the outpatient department:

- The patient arrives at the outpatient department with patient card.
- The physician takes the identification information which includes the socio demographic, visit and ID of the patient.
- The physician takes history and performs physical assessment.
- The physician registers the history of present illness and past illness.
- After the patient has been examined the physician writes diagnosis and prescribes investigation.
- If the patient doesn't need and investigation the physician prescribes medication or/and give appointment or give referral or order admission. Finally medical record of patient returned to medical record unit and kept there.

Business process of the Inpatient Department:

- The patient brings admission card from OPD
- The ward nurse confirms admission order
- The ward Nurse confirms availability of bed
- The ward physician takes history and performs physical assessment.
- The physician registers the history of present illness and past illness in the progress note.
- After the patient has been examined the ward physician writes diagnosis and prescribes investigation.
- If the patient doesn't need and investigation the ward physician prescribes medication or/and give appointment or give referral.
- Finally the ward physician writes discharge summary
- The ward Nurse will finalize discharge order
- Finally medical record of patient returned to medical record unit and kept there

4.1.1. Identification of Inputs and Outputs of the System

In an open system there are usually inputs flowing into the system and outputs are produced after the inputs have been processed.

Inputs: are attributes that can be stored on a database. They are the major raw materials to arrive at the output.

Inputs of the current manual system of the hospitals were;

1. Each patient must give full personal information for the Data clerk
2. Each patient must pay the required payment in the record office or bring free treatment paper from woreda administrative office

3. If repeat patient he/she must bring service card
4. In referral cases the patient must bring referral papers
5. The patient must tell about his/her illness to the Physician

Outputs: are processed inputs

Out puts of the current manual system of the hospitals were;

1. The Medical Record Unit gives service card for new patients
2. The doctor give a prescription paper for treated patients, referral and Admission paper

Proposed System

Results of Participatory approach

As interactive systems are increasingly promoted as a possible means of achieving system development goals, designers generally agree that participatory design approaches should be applied. In participatory development practice, there has been an emphasis on the importance and specifics of relationships, the interpersonal and social skills of practitioners. Main functions of participatory approaches are: to include all need of stake holders, accomplishing project goals with low cost and greater chances of sustainability.

During the development process of a new system for Shashemane Referral Hospital participatory approach were used. This approach helps to include all the felt need of the users of the new system. Though, lacks of IT skills of the health professionals have created a problem in communication of IT based information of the proposed system.

4.2 Analysis and Requirement Specification

A requirement is simply a statement of what the system must do or what characteristics it needs to have. During a systems development project, requirements will be created that describe what the business needs (business requirements); what the users need to do (user requirements); what the software should do (functional requirements); characteristics the system should have (nonfunctional requirements); and how the system should be built (system requirements) [32].

4.3 Hardware Requirement and Software Requirement

This section describes the hardware components and software requirements needed for effective and efficient running of the system.

Table 2: Hardware Requirements for Shashemane Referral Hospital, 2014**.**

Hardware	Minimum System requirement
Processor	2.4 GHZ processor speed
Memory	6GB RAM
Disk space	120 GB (including 20 GB for database Management system)
Server	10 GB RAM 3 tera bite HDD

Table 3: Software Requirement for Shashemane Referral Hospital, 2014.

Database Management System	**Microsoft SQL server 2005**
Operating System	Windows2007 or later

4.4 System Requirement specification

Software Requirements Specification is the requirements work product that formally specifies a design of patient record system.

4.4.1 Functional requirements

Functional requirements are associated with specific functions, tasks or behaviors the system must support. These specify particular results of a system. The following requirements are some of the functional requirements that, the proposed system will exhibit.

- Register new /update repeat patient detailed information
- Search patient detail
- Assign patients to different case team
- Mange Out patient
- Manage admitted patient
- Manage bed schedule
- Manage nursing care plan
- Manage discharge summary
- Manage user account
- Generate report, such as, patient detailed report, patient admission report, and patient discharging report.

In addition, this setup leads to the functional requirements described below.

System Login:-

User shall type

- Username :-shall be unique given to specific user
- Password: - length of the maximum character char (30) and minimum character char (6).

Username and password match successful login in to the system direct the users to the home page of the Patient Record System.

Registration Management

Users shall have access to register/Update/Save patient information. .

Case Complete

The users shall close out the monitoring of registering of patients and facilities that have been given to the patient. Once a case is closed the user shall be ready for the next request with the homepage displayed on the form.

Logging Out

The Users shall log out of the system by clicking "Log Out".

4.4.2 Non- functional requirements

Non-functional requirements are requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. This should be contrasted with functional requirements that define specific behavior or functions. They are often called qualities of a system.

Performance:-The system is capable of handling huge amount of data within the database in different tables. This system can handle the information of the patients sufficiently as much as possible in the hospital Medical Record Unit,OPD's and IPD's.

Reliability: - Users can have both hard copies in printed report format and softcopy of that data that related to the information of the patient using separated storage media in order to minimize loss of different confidential information of patient if it is facing faller of proposed system.

Maintainability: - During the fault occurrence there is less chance to lose data within the system because there will be continues data backup from the server. In addition to this it is easy to maintain the system due to hierarchal separation among database, business model and user interface hence, the system can be maintained easily.

Availability: - The system is available 24 hours, because, the referral hospital works 24 hours a day and 7days a week. In order to achieve the system to work full time it needs Uninterruptable Power Supply (UPS).

Security: - Security becomes crucial issue in the proposed system. A user must login to the system with user name and password. The system has two groups of users: the Administrator and Limited user. The Administrator user has full privilege to perform on the system. And the Limited user can only perform limited operations.

4.5 Business Rule

A business rules approach is a different way of thinking about the analysis process. Rather than focusing on system requirements, the analysis process is refocused on business rules. Instead of asking users what they want their system to do, they are asked about how their business or organization works.

BR1. Determine validity to access the system
BR 1.1. The user should have valid user name
BR 1.2. The user should have valid password
BR2. Validate Patient information.
BR2.1. Validate in-patient information
BR2.2 Validate personal information of In-patient
BR2.3. Validate contact person information of In-patient
BR3. To receive nursing care plan the patient should stay more than 24 hr in hospital
BR4. The patient shouldn't pay if he returns less than 30 days of his previous registration
BR5. If the patient can't afford payment he/she should bring treatment free paper from woreda Administrative office.

4.6 System Use Case Model

The functionalities of the proposed system, as mentioned in the previous sections, are explained in terms of system use cases in the following section. The dynamic models of the use cases and the interaction with respect to time are described using activity diagrams.

Table 4: List of Actors for Shasshemane Referral Hospital, 2014.

Name	Description
Data Clerk	The Data clerk will register new and repeat patient Search patient by his/her name or date
Ward Nurse	The ward Nurse will carry out admission, Nursing process and discharge processes.
HMIS Officer	The HMIS Officer will view, generate and print the report from the system
Physician	Physician will give Medical service to the patient. View the patient detail and add a new patient history.
System Administrator	Maintain the system of User Account and take back up.

4.7 List of Use case Identification

Login user account
Register patient
Search patient information
Assign patient to different case team
Mange patient at OPD
Manage bed schedule
Manage admitted patient
Mange nursing care plan
Maintain discharge summary
Generate report
Manage user account

4.8 Use Case Modeling

For better understanding of the requirements of the system, use case modeling is being used. A use case diagram illustrates in a very simple way the main functions of the system and the different kinds of users who will interact with it and also the use case communicates at a high level what the system needs to do. Each use case describes how an external user triggers an event to which the system must respond [32].

The use case diagrams illustrated below are the only samples of the whole s systems.

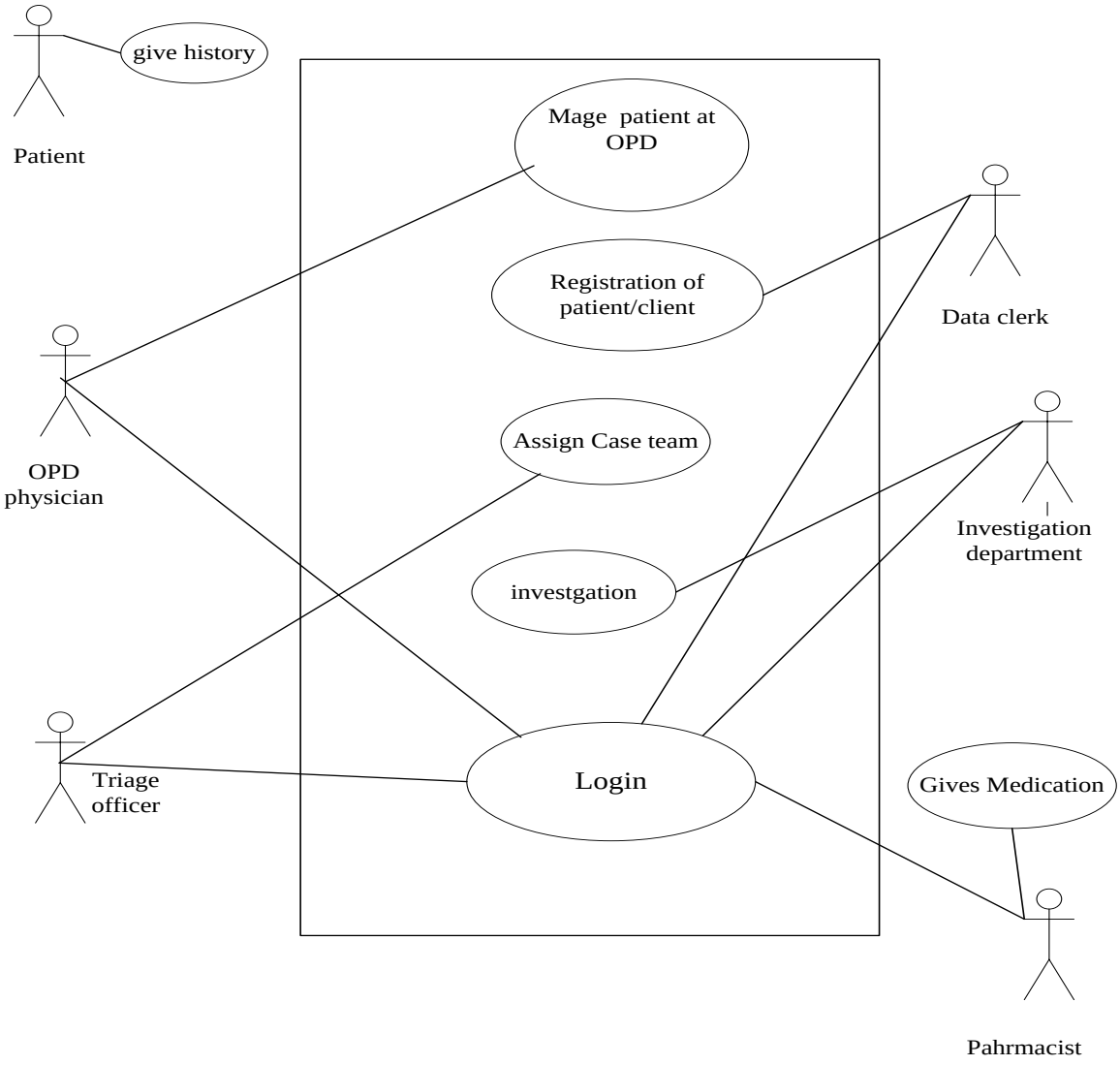

Fig 1: Use case diagram for management of patient at OPD

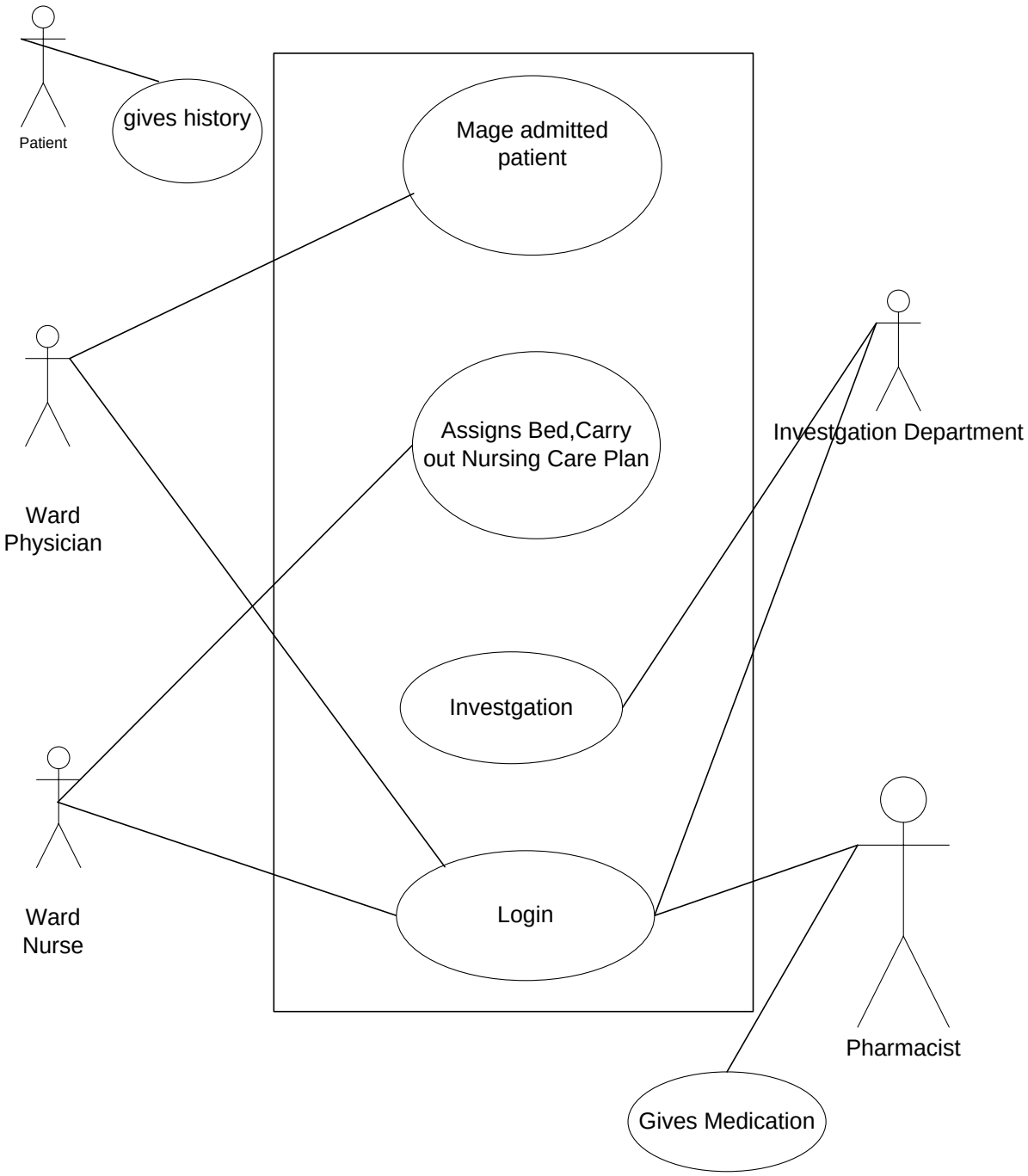

Fig 2: Use Case Diagram for Management of Patient at IPD

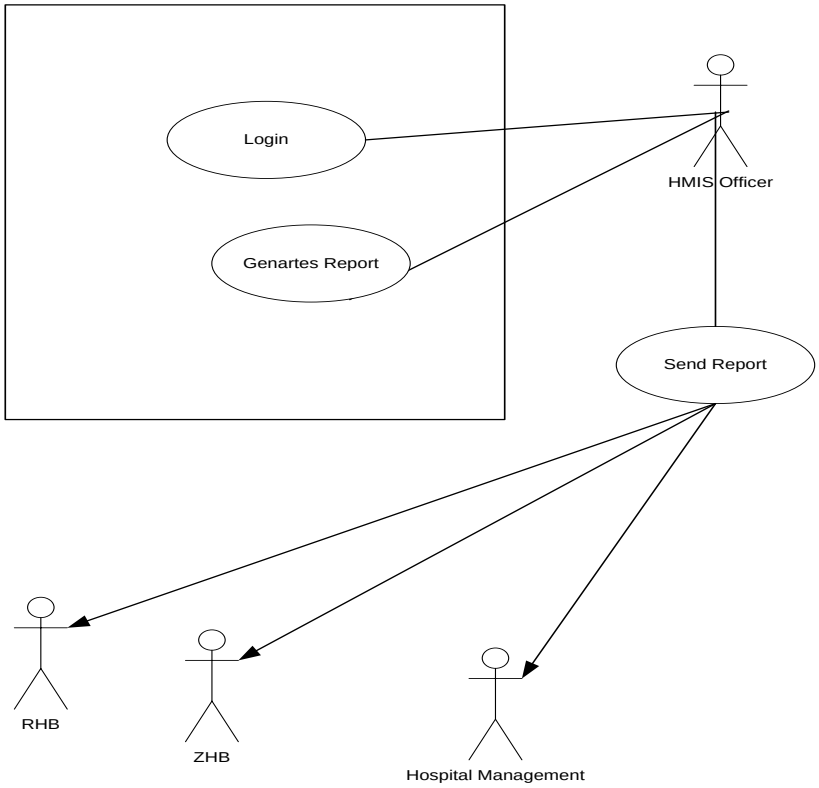

Fig3: Use Case Diagram for Generation of Report by HMIS Officer

Table 5: Use Case 1*:* Login

Use Case ID:	UC-1
Use Case Name:	Authenticate user
Actors	Users
Description:	This use case is used to accept the user ID and password and authenticate User to access data input and data viewing screens.
Normal Flow:	1. The use case starts when a user opens a form which prompts user to enter user ID and password 2. The user enters user ID and Password on the " System Login form UI1" and click[login], 3. The system verifies if the user ID and password is valid, 4. System informs successful login message , The system deactivates/hides buttons that are not to be manipulated by that specific user type, 6. Use case ends when system displays a general user interface with buttons to jump to different windows or forms.
Post condition	user enter in to the system to perform his/her work
Alternative Flows:	3a. Invalid user ID and password 1. The system kindly request the user to enter valid ID and password (allow this 3 times)(BR 1) 2. After the 3rd trial system informs user to contact system administrator for valid user ID and password. **Post condition:** The system prevents user to enter
Frequency of Use:	2

Table 6: Use Case 2: Patient Registration

Use Case ID:	UC-2
Use Case Name:	Register Patient
Actors	Data Clerk
Description:	• This use case helps the data clerk to register the new patent/update repeat patient on the system.
Trigger:	• Patient wants to register • Patient brings referral paper
Preconditions:	• User has been authenticated
Normal Flow:	1. Data Clerk clicks Out-Patient Registration Screen from "UI3 Home Page screen", 2. System Display "UI5 patient registration form " with [add, update, save, cancel, search] buttons, 3. The Data Clerk checks whether the patient is new or repeat, 4. The Data Clerk order the patient pay for service , 5. The Data Clerk Receive receipt number from patient and [record] receipt number and click [save] button, 6. The Data Clerk takes patient information and click [save] button, 7. The system validates the correctness of the entered information via "BR2.2. Validate Out-Patient Information ", 8. The Patient registered as a new patient, 9. The Data Clerk click on [print] button ,The system print Service identification card
Post condition	Transfer patient information to OPD case teams
Alternative Flows:	3.1 If repeat patient the data clerk clicks [update] button **Post condition:** The patient information is updated 4.1 The patient my bring free treatment paper from wareda administration office **Post condition:** The patient will be registered without payment and updated if he/she comes below 30 days (BR 4).

	6.1.The system determines the entered information is incorrect 6.2 The system displays the Data Clerk to re-enter patient information through "UI12 Invalid information screen". **Post condition :** The system start again at step 2
Frequency of Use:	254

Table7: Use Case 3: Search Patient Information

Use Case ID:	UC-3
Use Case Name:	Search Patient information
Actors	Data clerk
Description:	This use case helps to search the patient information if there exist in the patient database
Trigger:	Request from the patient/client
Preconditions:	The patient history should be registered in the patient database before this time
Normal Flow:	1. User enter in to the login form through "UI1 System Log in from", 2. User then click [Search] button to search the patient in the database though user page, 3. The system view search form with list of search options like [Name][MRN]etc,[search],[cancel] buttons, 4. The User fills the search options to search via " Patient search form UI 15" in the patient database and clicks [search] button, 5. The search patient information is displayed on user page.
Post condition	Search is successful or not

Alternative Flows:	5.System determined the patient is not found 5.1 System Inform user the searching result is not found through"UI12 Invalid information Screen" **Post condition:** The system returns to "UI 5 Patient registration screen"
Frequency of Use:	80

Table 8: Use Case 4: Assign Patients to the Case Teams

Use Case ID:	UC-4
Use Case Name:	Assign Patient
Actors	Triage Officer
Description:	The triage officer assign patients to the specific case team after the patient gives short history of his current illness.
Trigger:	Patient data from data clerk
Preconditions:	The patient should be registered to system
Normal Flow:	The system populates a form which describes different case team options with [Select, Save, Send, Search] buttons, Triage Officer clicks [Search] patient from data base, System Display patient information, Triage Officer select the specific case team and clicks [send]button,
Post condition	A patient information sent to specific case team
Alternative Flows:	None
Frequency of Use:	254

Table 9: Use Case 5: Manage Patients at Outpatient Department

Use Case ID:	UC-5
Use Case Name:	Manage patient
Actors	OPD physician
Description:	This use case helps to add diagnosis and treatment detail for the patients by OPD physician.
Trigger:	Patient assigned to OPD physician
Preconditions:	user login to the system User has been authenticated
Normal Flow:	1. OPD physician click on Diagnosis and treatment information screen "UI 11 Diagnosis Information Registration form" from HOME PAGE , 2. The OPD physician confirms the message sent from triage officer, 3. The system displays the Diagnosis and Treatment Information Registration form with [add],[save][cancel] buttons, 4. The physician records symptoms (patient history) and signs (Physical examination) on patient diagnosis and treatment information form and clicks [save], 5. The OPD physician clicks investigation request sub menu which has [different Investigation types], [send],[edit],[save] buttons, 6. The physician at OPD selects on types of investigation he/she wants and send to laboratory department, 7. The physician received message of investigation result, 8. The OPD physician clicks on test result information submenu, 9. The system displays the test result form with [add],[save],buttons, 10. OPD physician add test result information and Diagnosis and click [save] button , 11. OPD physician clicks on list of drug information menu form submenu, 12. The system populates different drug types in the form of menu with [save],[send],[cancel] buttons, 13. OPD physician clicks the drug he wants and clicks [save] and [send] button, 14. Drug prescription order message sent to pharmacy department.
Post condition	Patient History ,Diagnosis captured
Alternative Flows:	5.1 No lab request is selected or ordered

	1. physician records diagnosis 2. and treat patient asymptomatically **Post condition:** The patient is treated without lab. prescription 14.1 The patient may not be give treatment 14.1.1 The physician may give appointment, referral, or admission **Post condition:** The use case ends when the patient got appointment, referral or admission.
Frequency of Use:	254

Table 10: Use Case 6: Manage Bed Schedule

Use Case ID:	UC-6
Use Case Name:	Manage Bed Schedule
Actors	Ward Nurse
Description:	This use case is used to handle the bed scheduling process of the admitted patients**.**
Trigger:	request of new admitted patient
Preconditions:	The patient must bring admission card from OPD User has been authenticated
Normal Flow:	1. the system displays Manage Bed Schedule sub menu with [Assign, Save, Record, Cancel] buttons, 2. The ward nurse checks the availability of the bed from data base and confirms unreserved bed, 3. Patient will pay for Bed service going physically to finance officer and he/she will bring the receipt physically, 4. Ward nurse confirms payment and click[record] receipt number and click [Assign] buttons, 5. The system will show message as bed is reserved for the patient.
Post condition	The patient has got bed service
Alternative Flows:	5a. the patient should bring free clearance paper **Post condition:** The patient exempted from any payment
Frequency of Use:	20

Table11: Use Case7: Manage Admitted Patient

Use Case ID:	UC-7
Use Case Name:	Manage Admitted Patient
Actors	Ward physician
Description:	This use case is used by ward physician to Diagnose, treat, Write the progress note, writes referral, order lab. Investigation and medication to admitted patient
Trigger:	The patient admitted to the ward
Preconditions:	Message received from OPD physician User has been authenticated
Normal Flow:	1. The ward physician clicks on "Manage Admitted Patient" sub men, 2. The system populates progress note form with[Add] , [Cancel],[Save] buttons, 3. The physician records symptoms (patient history) and signs (Physical examination) on Patient progress note form and clicks [save] button, 4. The ward physician clicks nvestigation request sub menu which has [different investigation types], [send],[save] buttons, 5. The physician at ward selects on ivestigations he/she wants and send to investigation department, 6. The physician received message of lab. test result, 7. The ward physician clicks on [test result information] submenu, 8. The system displays the test result form with [add],[save],buttons, ward physician add test result information and Diagnosis and click [save] buttons, 9. ward physician clicks on [list of drug information menu] form , 10. The system populates different drug types with [save],[send],[cancel] buttons, 11. ward physician clicks the drug he wants and clicks [save] and [send] buttons, 12. Drug prescription order message sent to pharmacy department. 13. T he ward physician writes discharge summary and sends discharge order message to the ward

	nurse so that the patient can leave the hospital.
Post condition	The patient managed and discharged or referred from the hospital
Alternative Flows:	5.1. The ward physician directly treat patient with medication or give medical/Surgical Advice or prescribe out the missed lab investigation **Post Condition**: The admitted patient treated without lab investigation 13.1 The patient can be referred or can be discharged against medical advice or death 14.1 The ward physician will write referral paper or the patient will sign and leave the hospital for his being against medical advice **Post condition:** The patient referred or discharged being against medical advice or death.
Frequency of Use:	25

Table12: Use Case 8: Manage Nursing Care Plan

Use Case ID:	UC-8
Use Case Name:	Manage Nursing Care Plan
Actors	Ward Nurse
Description:	This use case describes the process of planning and implementing Nursing care plan by ward nurses for admitted patients
Trigger:	The patient stayed on hospital bed for more than 24 hours
Preconditions:	User has been authenticated
Normal Flow:	**1.** the system displays "ward Nurse Information screen UI 13", **2.** Ward nurse click Mange Nursing Care Plan sub menu, **3.** the system displays Manage Nursing Care Plan form with [Update],[Cancel] and [Save] buttons, **4.** The ward nurse takes and record nursing health history of a patient and gives nursing Diagnosis and fill nursing care plan index list form and click [Save] buttons,
Post condition	The patient received nursing care
Alternative Flows:	4.1 The ward nurse checks if the patient stayed for

	less than 24 hrs in the ward(BR 3) **Post condition:** The patient is not eligible to get nursing care plan
Frequency of Use:	5-10

Table13: Use Case 9: Maintain Discharge Summary

Use Case ID:	UC-9
Use Case Name:	Maintain Discharge Summary
Actors	Ward Physician/Ward Nurse
Description:	This use case helps ward Physician/Nurse to manage discharge summary when the patient leave the hospital.
Trigger:	The discharge order arrive from ward physician
Preconditions:	User has been authenticated
Normal Flow:	1. Ward Physician enter in to " UI1 System Login form", 2. The system displays information that helps to login [user name],[password],[submit],[cancel] buttons, 3. Ward Physician fills name and password and clicks [Login] buttons , 4. System displays Discharge summary form with [save, print], 5. Ward Physician writes discharge summary sends message to ward nurse, 6. The ward nurse clicks on patient management detail, 7. The ward nurse clicks on check payment, 8. The ward nurse receive payment receipt, 9. The ward nurse writes patient finalize discharge summary 10. The ward nurse click [save] and [print] button, 11. The system prints discharge clearance.
Post condition	The patient discharged from the hospital
Alternative Flows:	1.1 If the patient do not pay 1.2 The patient will bring clearance from wareda administration and ward nurse confirms. **Post condition:** The patient exempted from payment
Frequency of Use:	35

Table14: Use Case 10: Generate Report

Use Case ID:	UC-10
Use Case Name:	Generate Report
Actors	HMIS Officer
Description:	This use case is used to process generation of reports from different departments to send message to the stake holders of the hospital.
Trigger:	Report Request
Preconditions:	User has been authenticated
Normal Flow:	1. The HMIS officer clicks Report Generation sub menu from "UI 3 HOME PAGE", 2. The system displays "UI14 Report Generation screen" with [Department list, Save, Send, Cancel ,Generate report ,Print] buttons, 3. The HMIS officer selects Different [department list] from where he wants to generate a report, 4. The HMIS officer clicks [Generate report] button, 5. The system generates the report, 6. The HMIS officer clicks[save], [print] buttons, 7. The HMIS officer send or Attach report to different stake holders from Report Generation screen.
Post condition	8. Report is generated to stake holders and Hospital management
Alternative Flows:	None
Frequency of Use:	4

Table15: Use Case 11: Manage User Account

Use Case ID:	UC-11
Use Case Name:	Manage User Account
Actors	System Administrator
Description:	This use case helps to manage all over the system related to files and user account like change password, create new user.
Trigger:	The arrival of new hire employee
Preconditions:	User has been authenticated
Normal Flow:	1.System Administrator enter in to " UI1 System Login form" 2.The system displays information that helps to login [user name],[password],[submit],[cancel] buttons, 3. System Administrator fills name and password and clicks [Submit] buttons , 4. System displays User account form which holds [create new user], [update user account] "UI16 User Account form", 5.Administrator clicks on [create new user] or [update user account], 6.System validates the information which the System Administrator enters.
Post condition	System Administrator managed user accounts
Alternative Flows:	3.1 The system Determined the Entered information is incorrect 3.1.1System inform system administrator to re-enter "UI16 User Account Form" **Post condition :** System administrator reenter name and password
Frequency of Use:	2

4.9 Activity Diagrams

4.9.1 Activity Diagrams of the proposed system

Activity diagrams are pictorial representation of activities and actions with branched support of choice. Activity diagrams describes: The coordination of activities to give a service and Activities needed to achieve some operations

The following listed activity diagrams were the only sample of the whole system

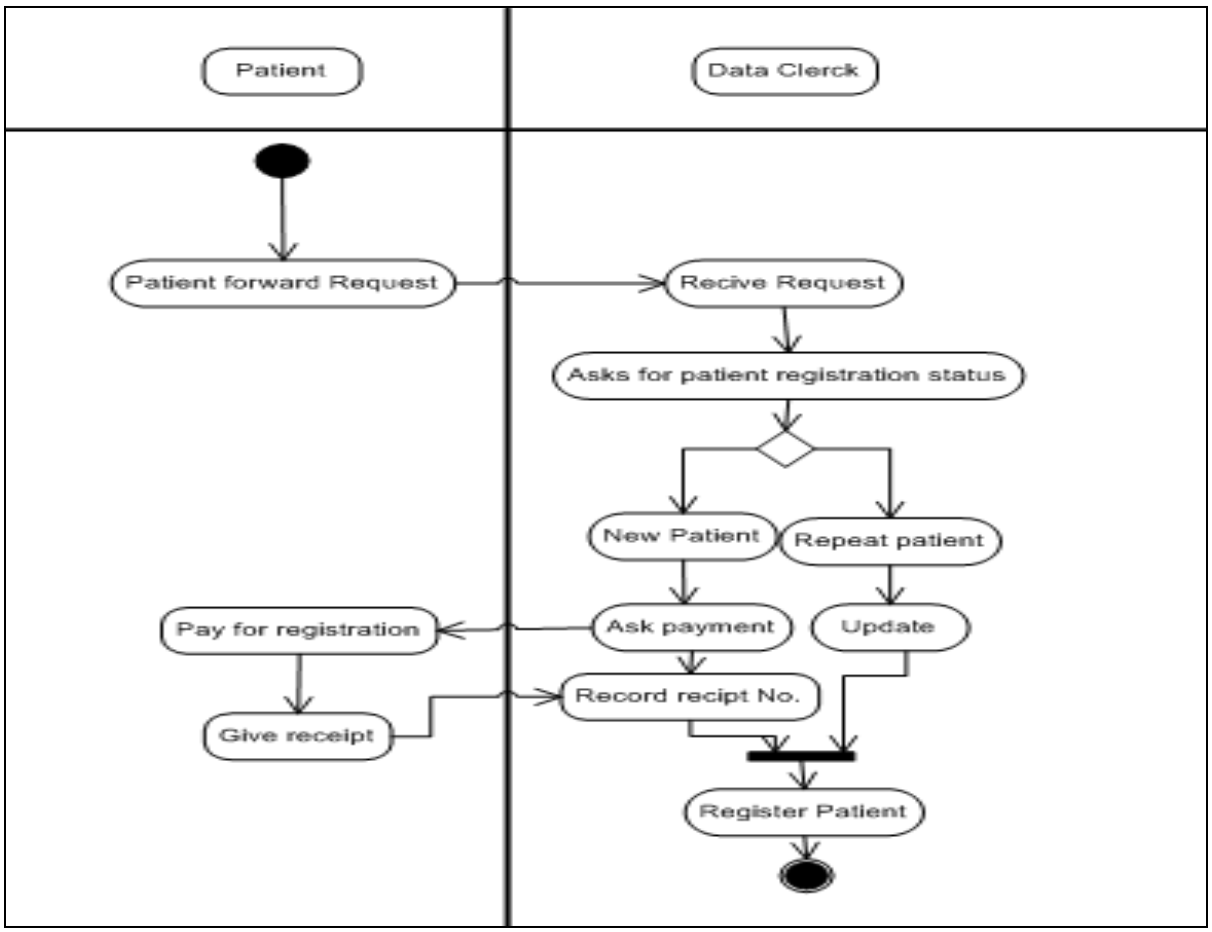

Fig 4: Activity Diagram for Patient Registration

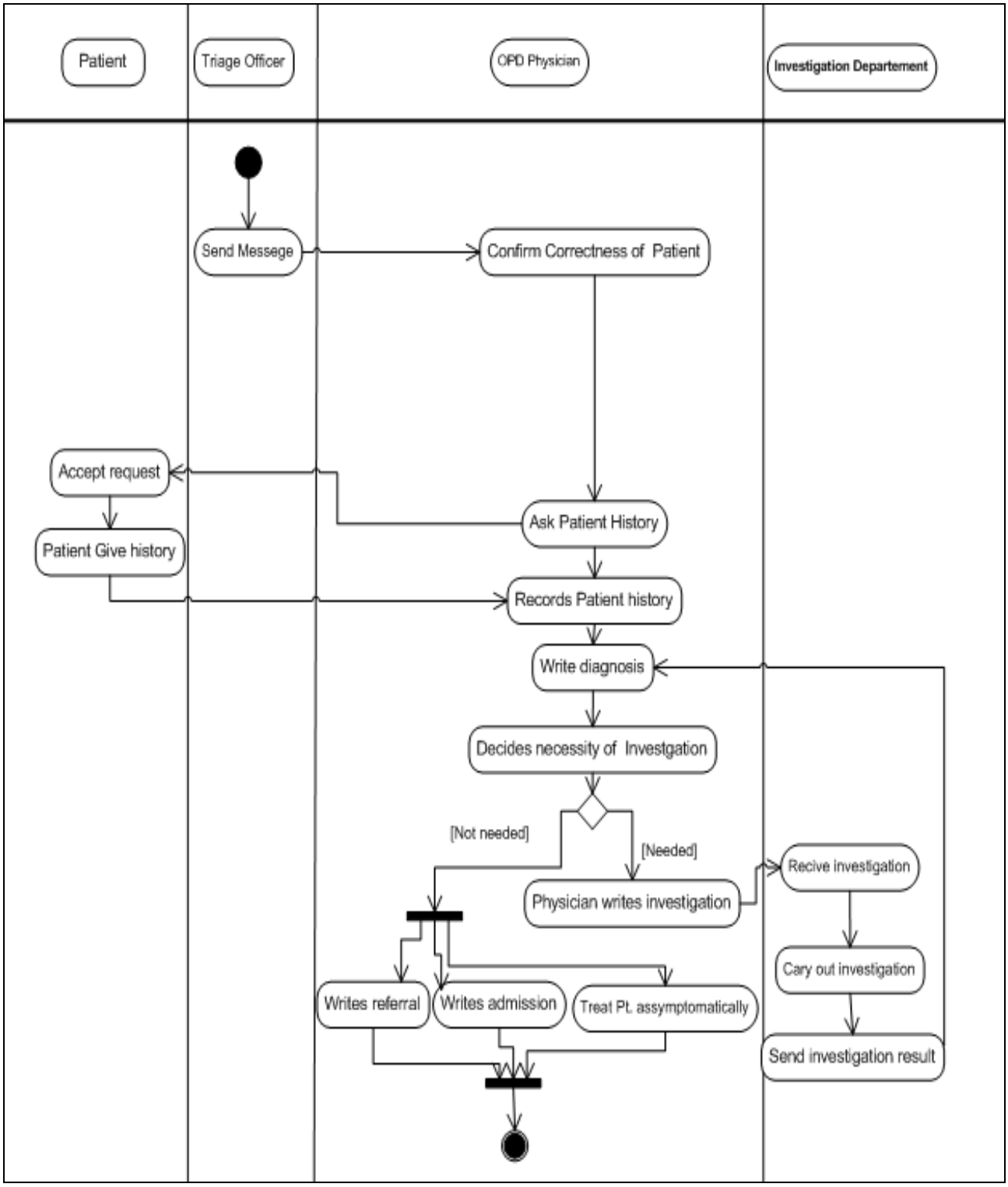

Fig 5: Activity Diagram for Patients Treated at OPD's

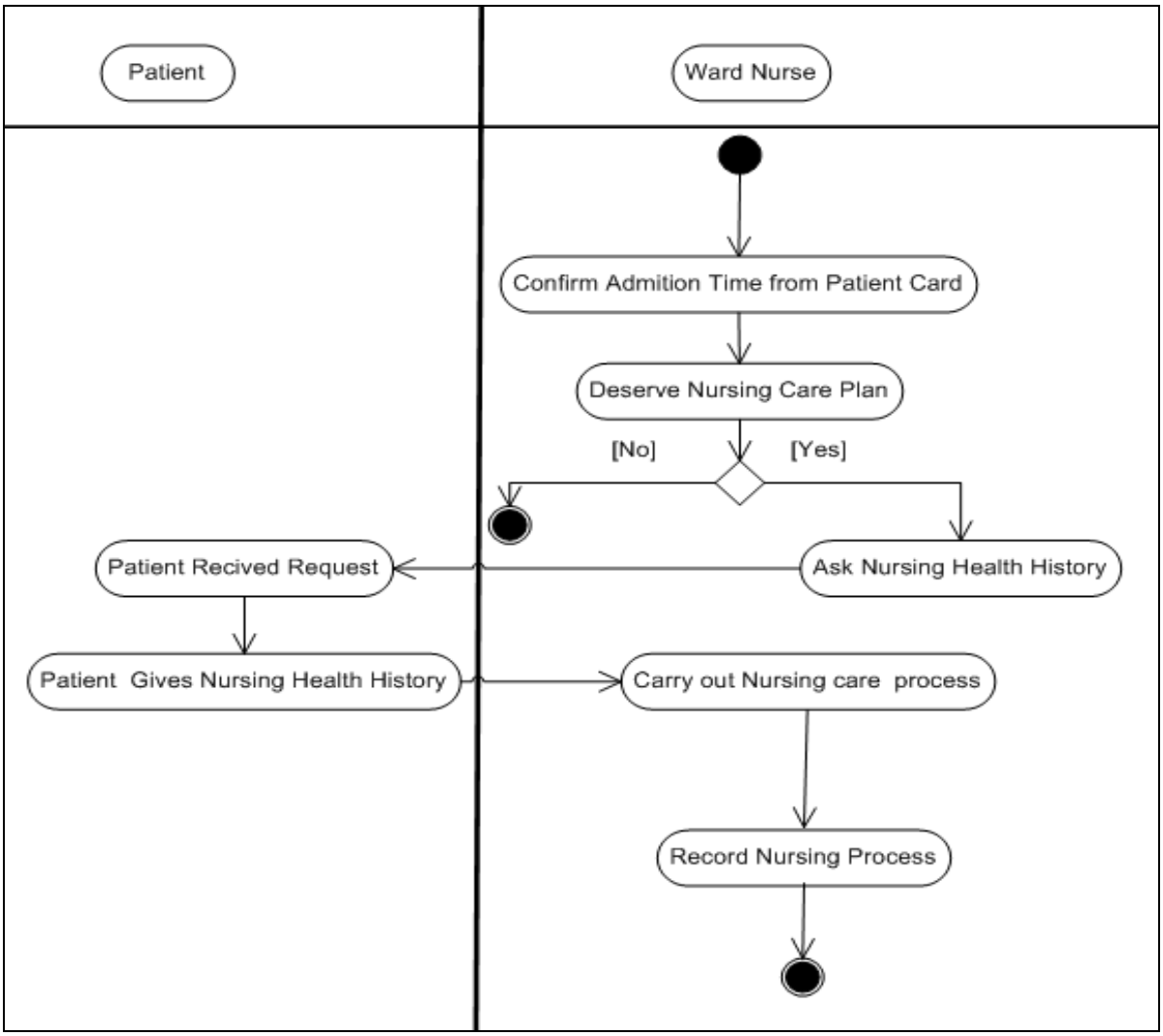

Fig 6: Activity Diagram of Nursing Care Plan for Admitted Patients

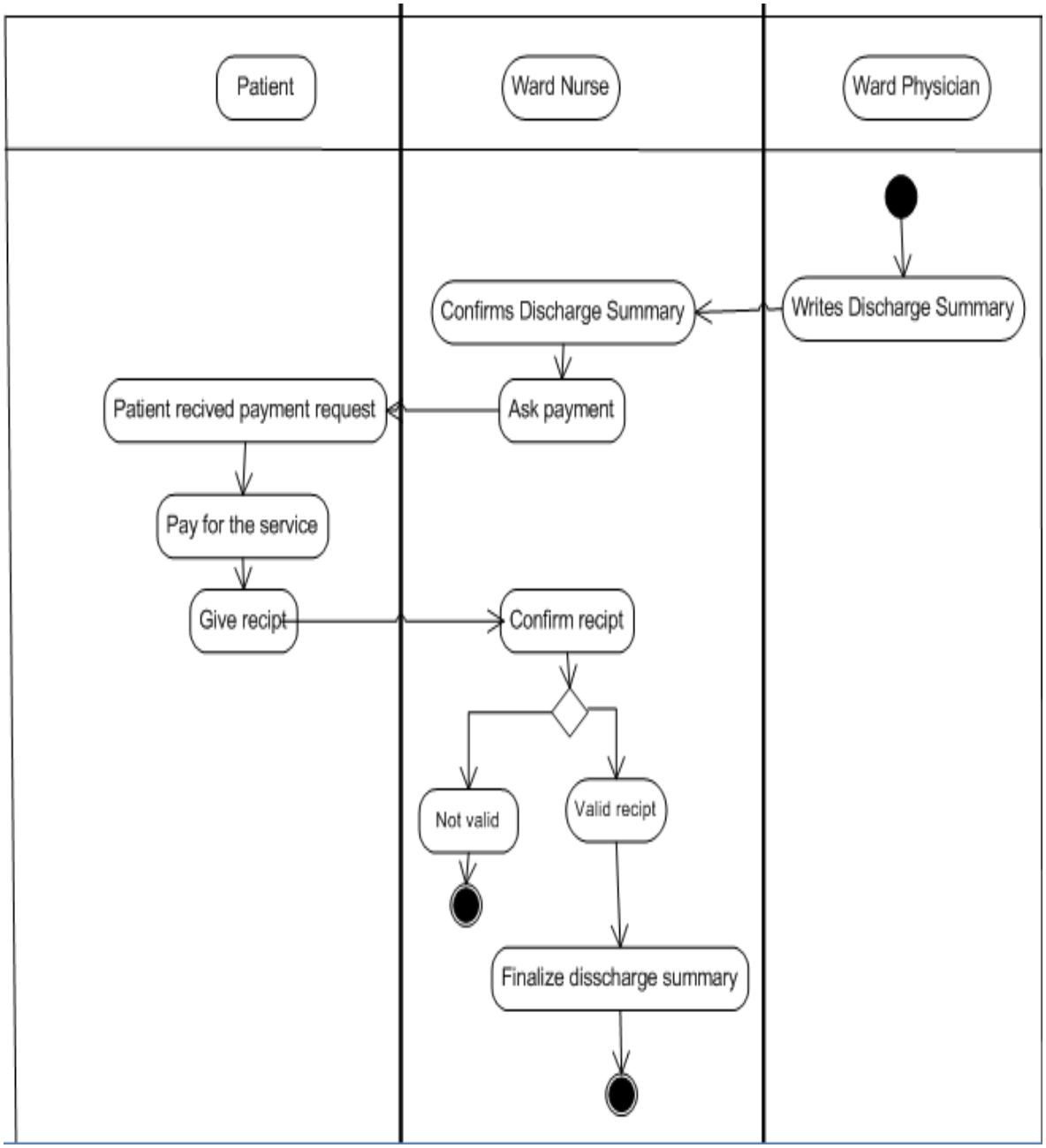

Fig 7: Activity Diagram for Writing of Discharge Summary for Discharged Patients

4.10 Process Modeling

A process model is a graphical way of representing how a business system should operate. It illustrates the processes or activities that are performed and how data move among them. It involves defining the processes of a new system vis-à-vis an existing system. Process modeling allows you to project the process of the new information system from a less to a more detailed level. It explains how a system accesses and manipulates data from external entities using one or more processes or modules contained within the system. It uses DFDs [32].

4.10.1 Context Diagram

The context diagram defines how the business process or computer system interacts with its environment—primarily the external entities [32].

4.10.2 Data Flow Diagram

A data flow is a path for data to move from one part of the information system to another. A data flow in Data Flow Diagram represents one or more data items [32].

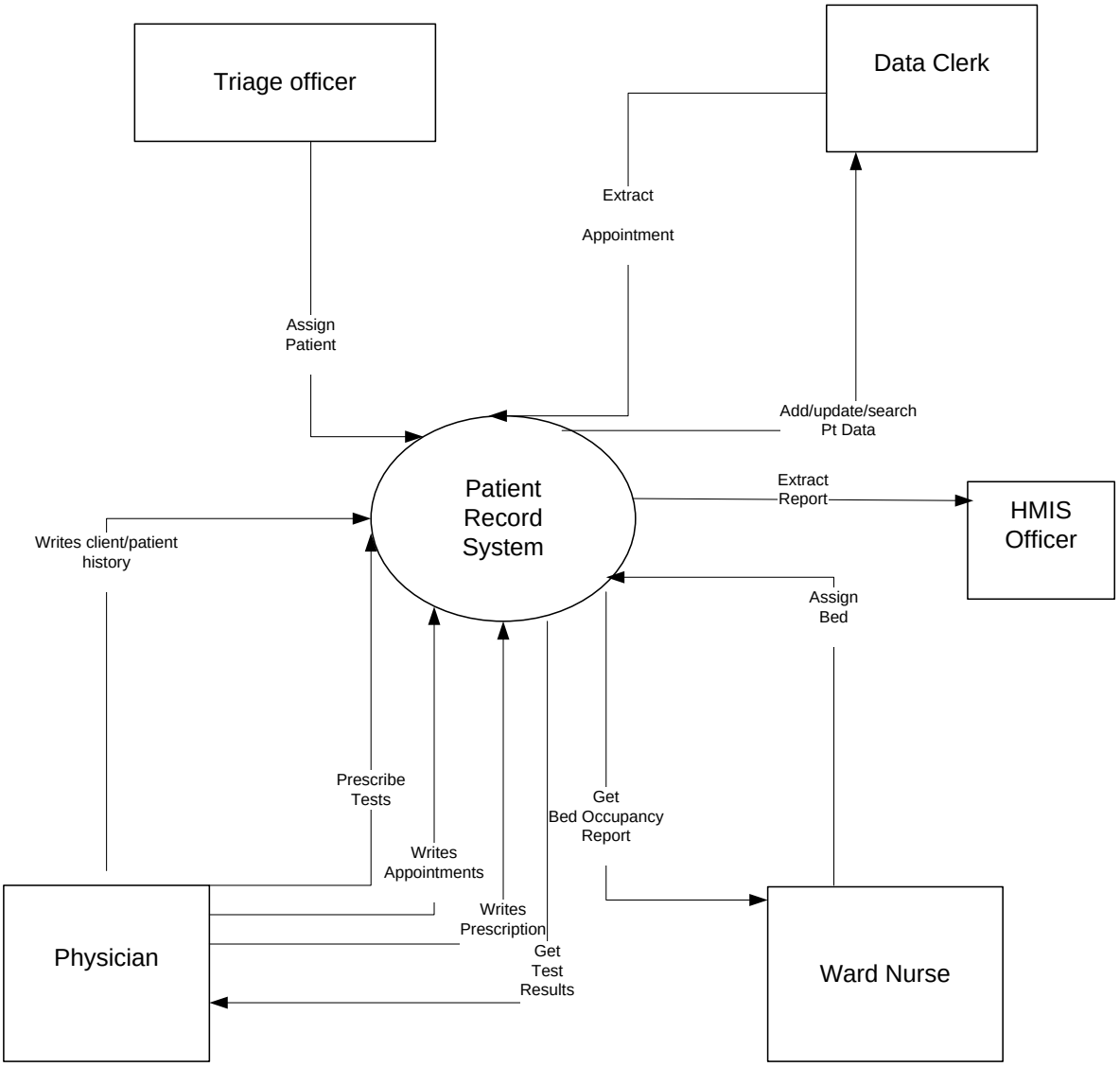

Fig 8: Context Diagram of a Patient Record System

The following analyzed DFD's were the only samples of the whole system

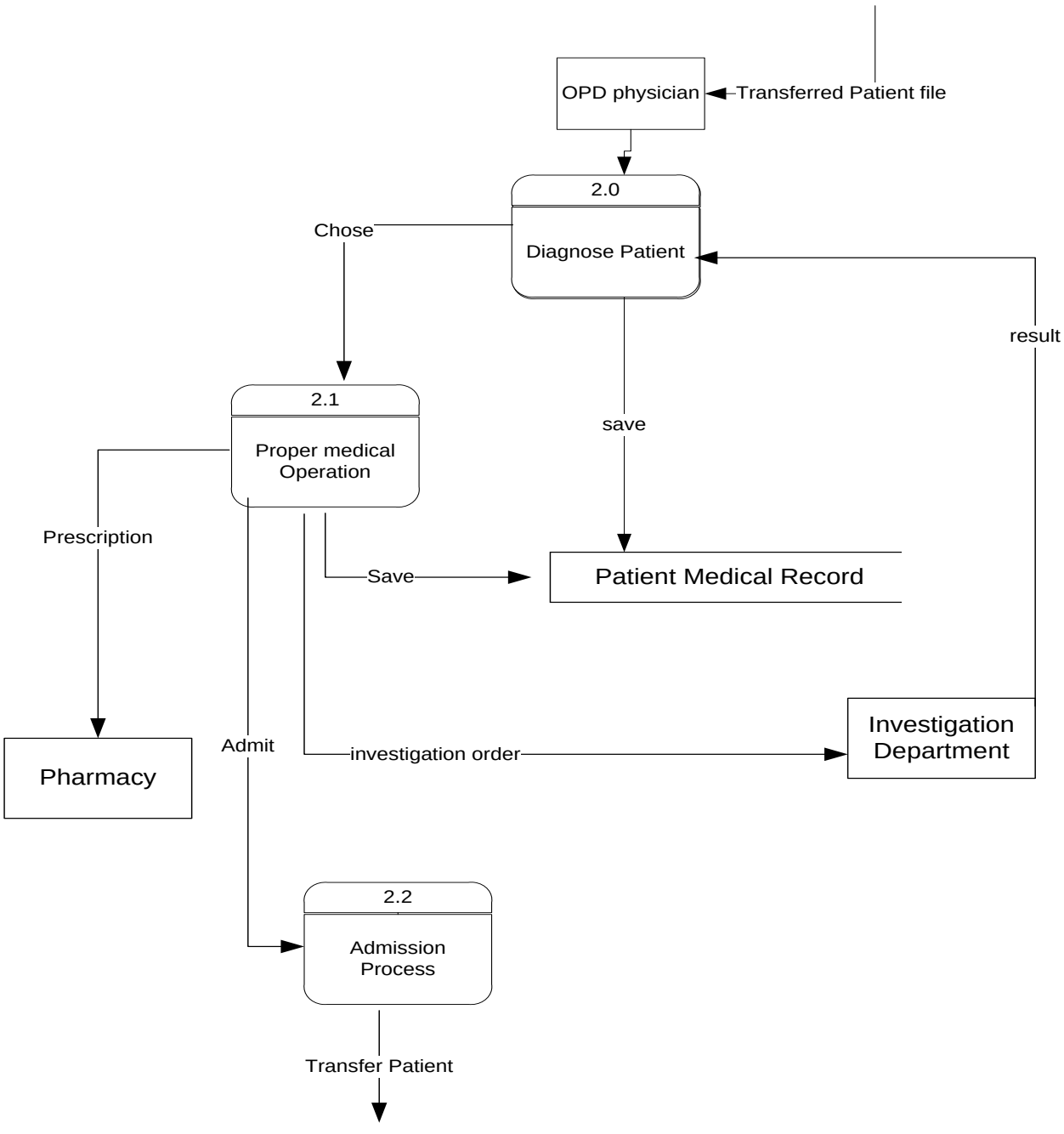

Fig9: Data Flow Diagram of diagnose patient at OPD

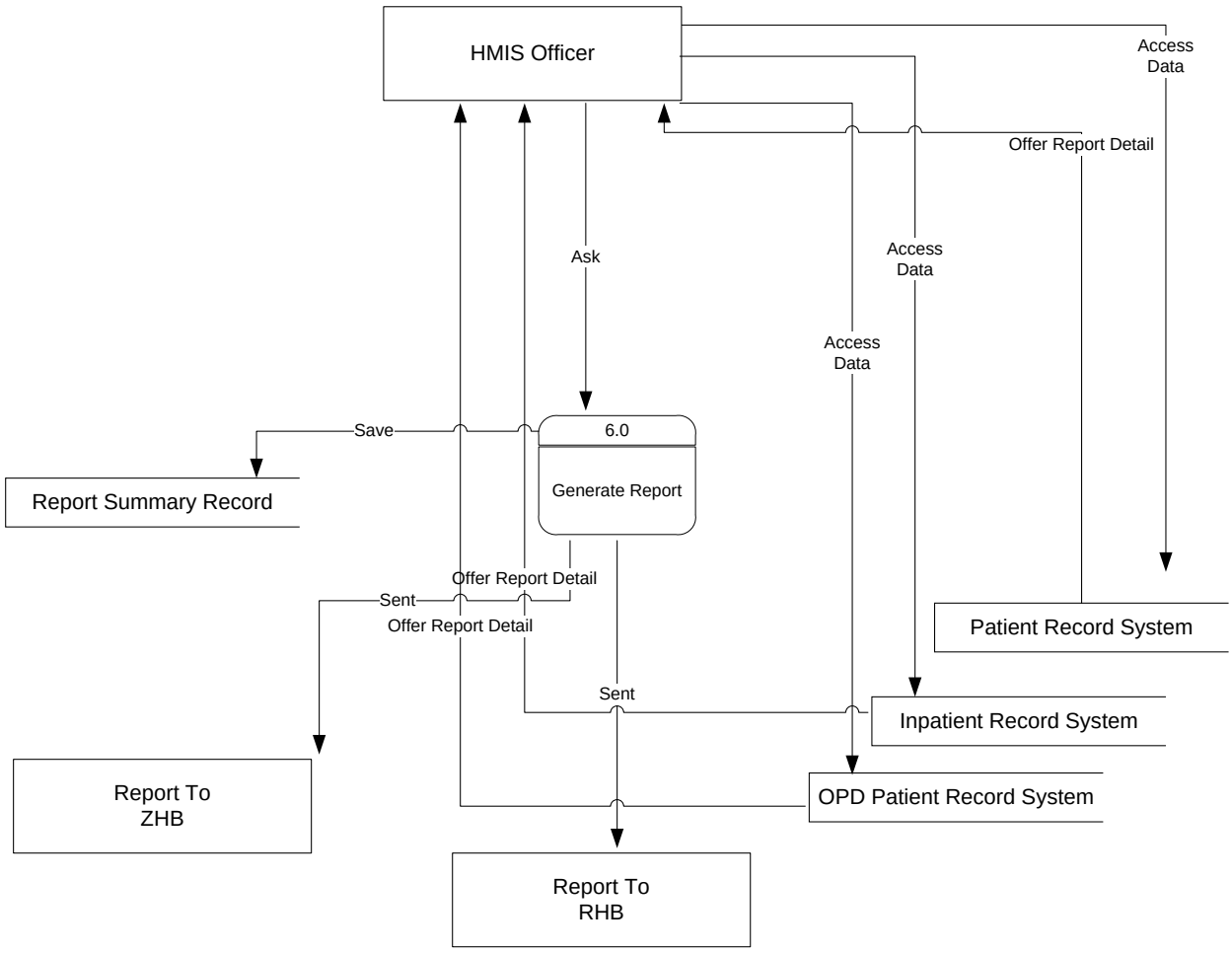

Fig 10: Data Flow Diagram of Generate Report Sub Process

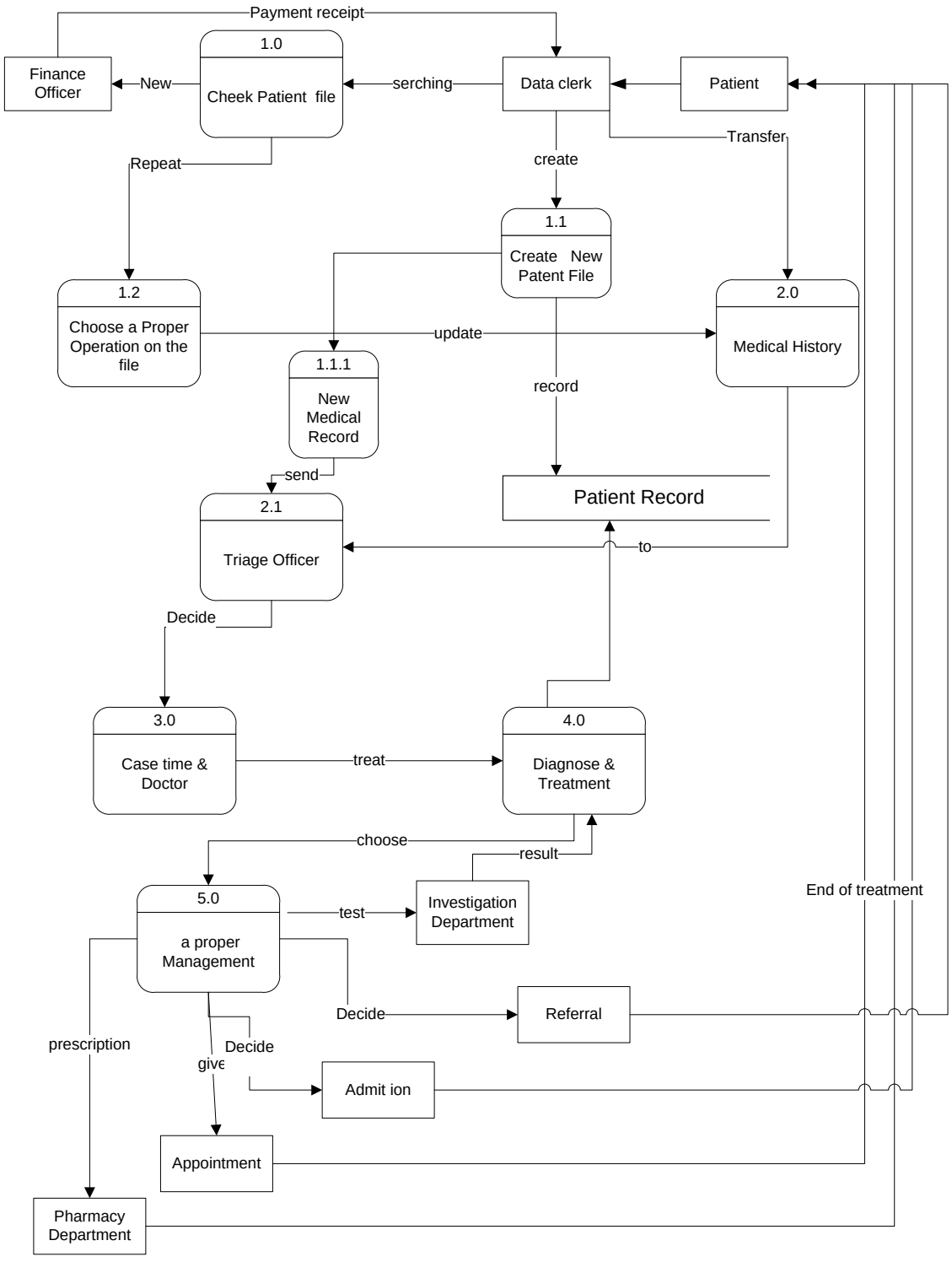

Fig11: Total Data Flow Diagram of Patient Treatment at OPD

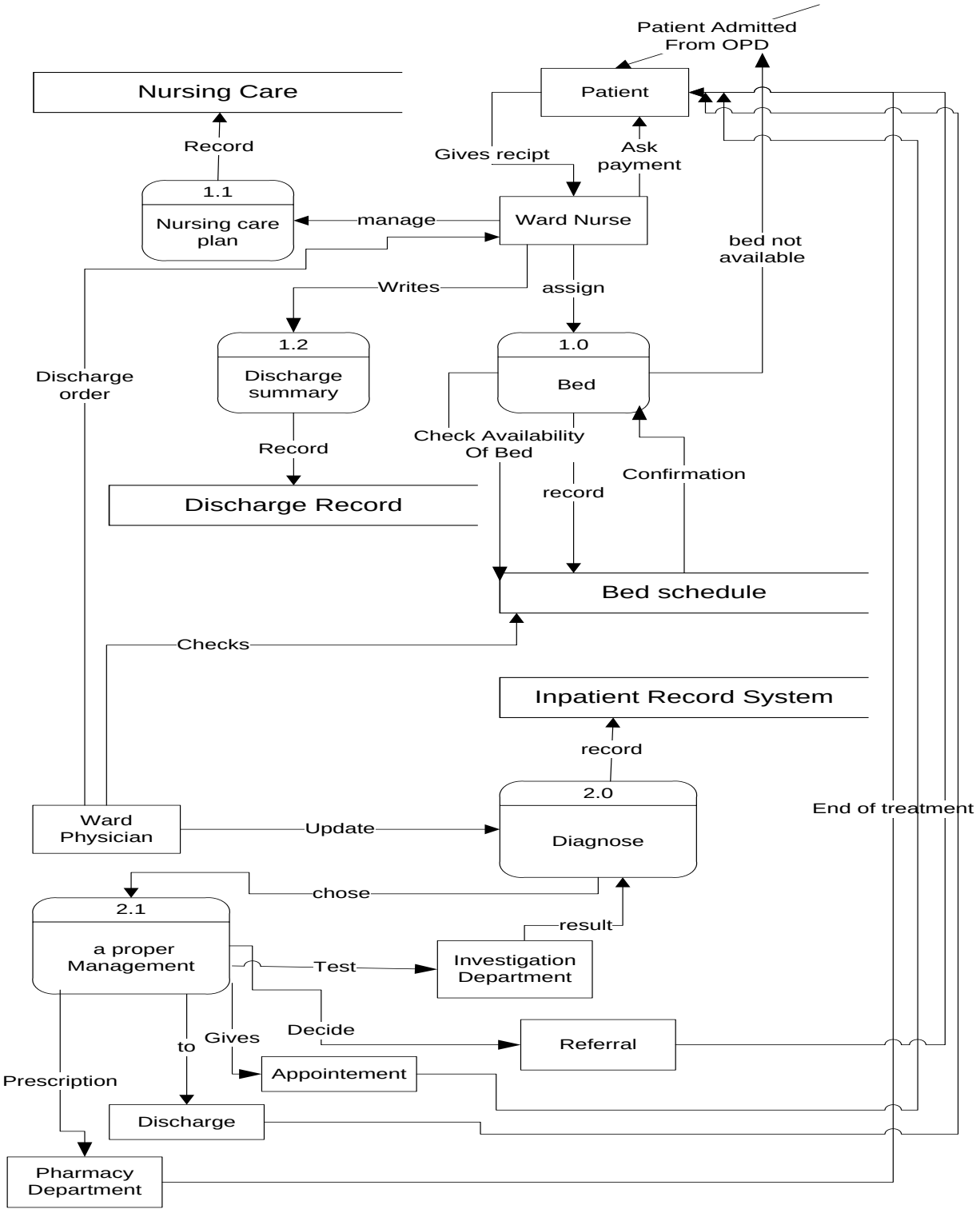

Fig 12: Total Data Flow Diagram of IPD

4.11 System Design

Purpose

The purpose of system design is to give detail information for developing of the proposed system and it guides what to develop and how to develop it. In addition, the design phase decides how the new system will operate.

4.11.1 Data Modeling

Data modeling involves modeling the entire structure of the data to be used in a system. Data modeling basically involves modeling the important data items in the system as well as any relationships between the data items. ER modeling is a data modeling approach that shows the various data entities in a system and the relationships between these entities. Data modeling enables us to present only the structure of the data as required by the new system, without considering the database management system where the data is to be hosted [32].

4.11.2 Database Design

A database is a structured collection of records or data that is stored in a computer system. The structure is achieved by organizing the data according to a database model. The model in most common use today is the relational model [32]. For this particular project also relational database model was used.

4.11.3 Description of entities and their attributes

***An entity*:** A person, partnership, organization, or business that has a legal and separately identifiable existence.

An attribute: is a property of a given entity.

Description of entities and there attribute will help for the developer of the system to identify the relationship between the entities and the associations needed between the entities.

Table16: Description of Entities and there attribute

Entity Name	Business Definition for the Entity	Attributes and their Domain
Patient	A person who is supposed to get medical or surgical service from the hospital	**MRN**, First Name, Father_Name,Grand_FatherName, Sex, Date_of_Birth,Age, Phistory , Date_of_Registration, Region, Religion Woreda,Kebele,House_Number, Phone_No
Physician	A person who is supposed to give service to the patient in the hospital	**Physician_ID**, First_Name, Father_Name,Grand_FatherName, Sex, Salary, Specialty , Case_Team_No ,Username, Password
Pharmacist	A person who is supposed to control drugs and give the prescribed drug to patients	**Pharmacist_ID**, First_Name, Father_Name,Grand_FatherName, Age, Sex, Username, Password
Ward Nurse	A professional who is supposed to give care for patients in the hospital.	**Nurse_ID**, First_Name,Father_Name,Grand_Father Name,Sex, Salary, Username, Password
Ward	Ward is a place in hospital which helps to treat admitted patient.	**Ward_No,**Ward_Name,Nurse_ID
Investigator	A professional who employed to test an investigation.	**Investigator_ID, Department_ID,** Investigator_Name, Father_Name, Grand_FatherName, Age, Sex, Salary, Speciality, UserName, PassWord
Investigation Department	It is a place in hospital which helps to give different investigations	**Department_ID**, Department_Name
Data Clerk	A person who hired by the organization to register patient	**Data_Clerk_ID,** MRN, Triage_Officer_ID, Data_Clerk_Name, UserName, PassWord
Triage Officer	A health professional assigned to assign patients to different case teams	**Trige_Officer_ID,** MRN, Physician_ID, UserName, PassWord

Table17: Description of Relations and there Attribute

Relations	Business Definition for the Relation	Attributes and their Domain
Diagnosis	Is the procedure that helps the physician to identify patient illness	**Diagnosis _ID, MRN**, **Physician_ID, Diagnosis _CODE** Diagnosis_Date, Diagnosis_Time, Physician_ID
Treatment	It is a procedure that is given for patients by physicians.	**MRN, Physician_ID, Nurse_ID** ,Treatment _Detail, Defaulter, Surgery, Treatment complete, Treatment _Date, Treatment _Time
assign	Is a relation which helps to link between patient and triage officer	**Assign_ID , MRN,** Case_Team_No ,Case_Team_Name, Assigned_Date,Assigned_Time
admit	Is a relation which helps to link between patient and ward nurse	**Admition_ID, Physician_ID,MRN,Ward_No** Admition_Date, Admition_Time
Bed	Is an equipment which helps for patient management at hospital and helps to link patient and ward nurse	**Bed_No, MRN ,**Ward_NO,Nurse_ID, Admition_Date, Admition_Time
Care	Is a procedure which helps to give nursing care for admitted patient and helps to link patient and ward nurse	**MRN, Nurse_ID, Bed_No, Ward_No,** Problem Intervention or Action Care_Date, Care_Time
discharge	Is a procedure carried out when patient left hospital for different reasons and helps to link patient and ward nurse	**Discharge_ID, MRN**, Physician_ID, Nurse_ID, Discharge_Detail ,Death, Against Medical Advice, Recovered Referred Discharge _Date, Discharge _Time,
test	Is a procedure which helps detect disease and link physician and laboratory technologist	**Test_ID, Lab_ Technologist _ID,** Result ,Test _Date, Test _Time
prescription	Is a paper which holds list of drugs and link physician and pharmacists	**Prescription_ID,** Pharmacist_ID, Physician_ID, Prescription _Date, Prescription _Time
request	It is the mechanism by which patients ask data clerk for service provision	**Request_ID**, Request_Time, Request_Date, MRN
appointment	It is the schedule time for evaluation of treatment that is give by Physician.	**Appointment_ID,** Appointment_Time, Appointment_Date, MRN, Physician_ID
messsage1	It is the label given for the relation between Data clerk and Triage officer for the message sent between them.	**Message1_NO,** MRN, Data_Clerk_ID, Message1_Time, Message1_Date, Message_Detail

message2	It is the label given for the relation between Laboratory Technologist and Physician for the message sent between them.	**Message2_NO,** MRN, Data_Clerk_ID, Message2_Time, Message1_Date, Message_Detail, MRN, Physician_ID, Lab_Technologist_ID,

4.11.4 Entity Rerlationship diagrams

The entity relationship diagram (ERD) is the most common technique for drawing a data model, a formal way of representing the data that are used and created by a business system. An entity relationship diagram (ERD is a pictorial representation of entities and the relationship between them [32]. The following ER diagrams are created by use of Visio 2007 and Ms Access 2007.

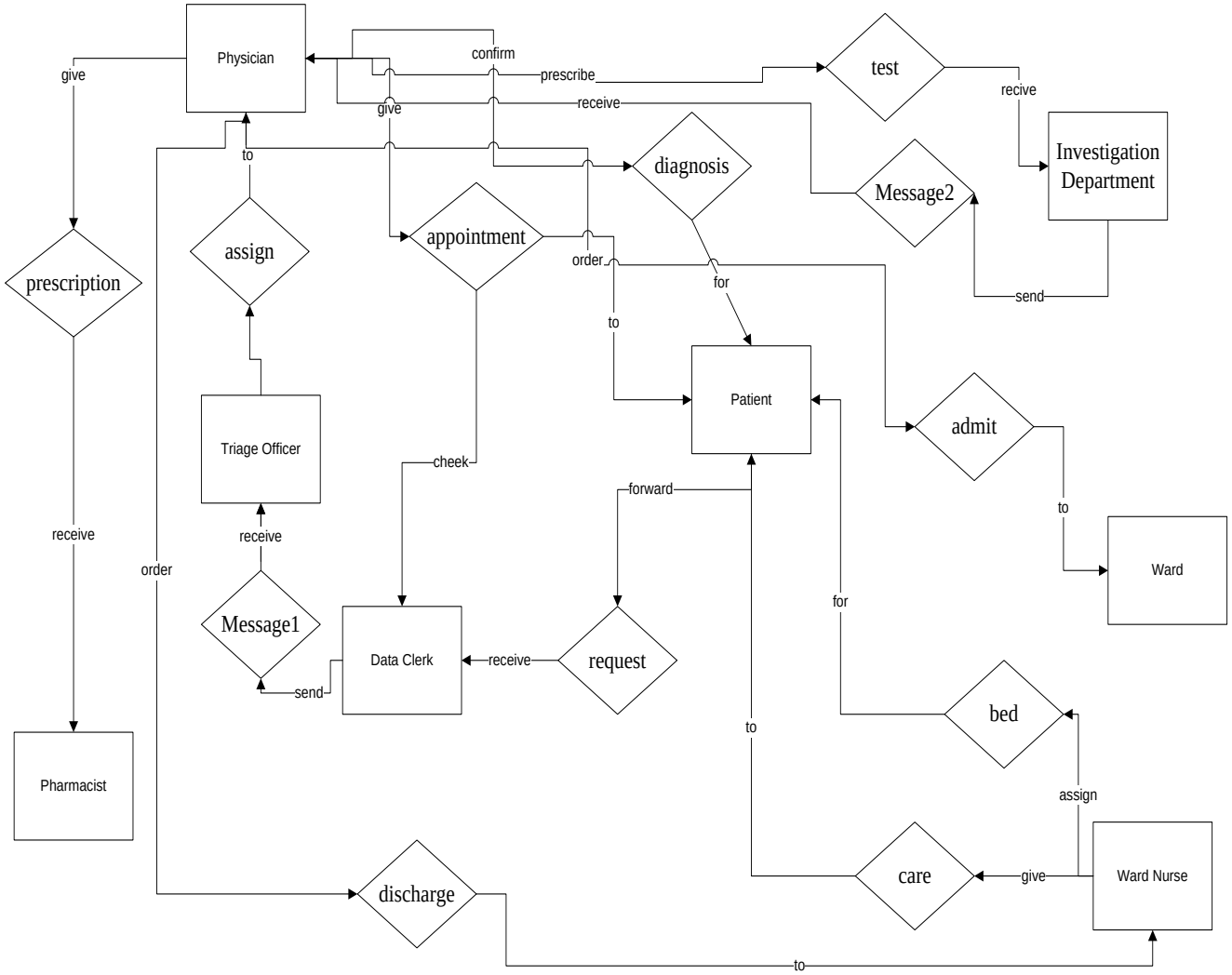

Fig 13: ER Diagram of Patient Record System

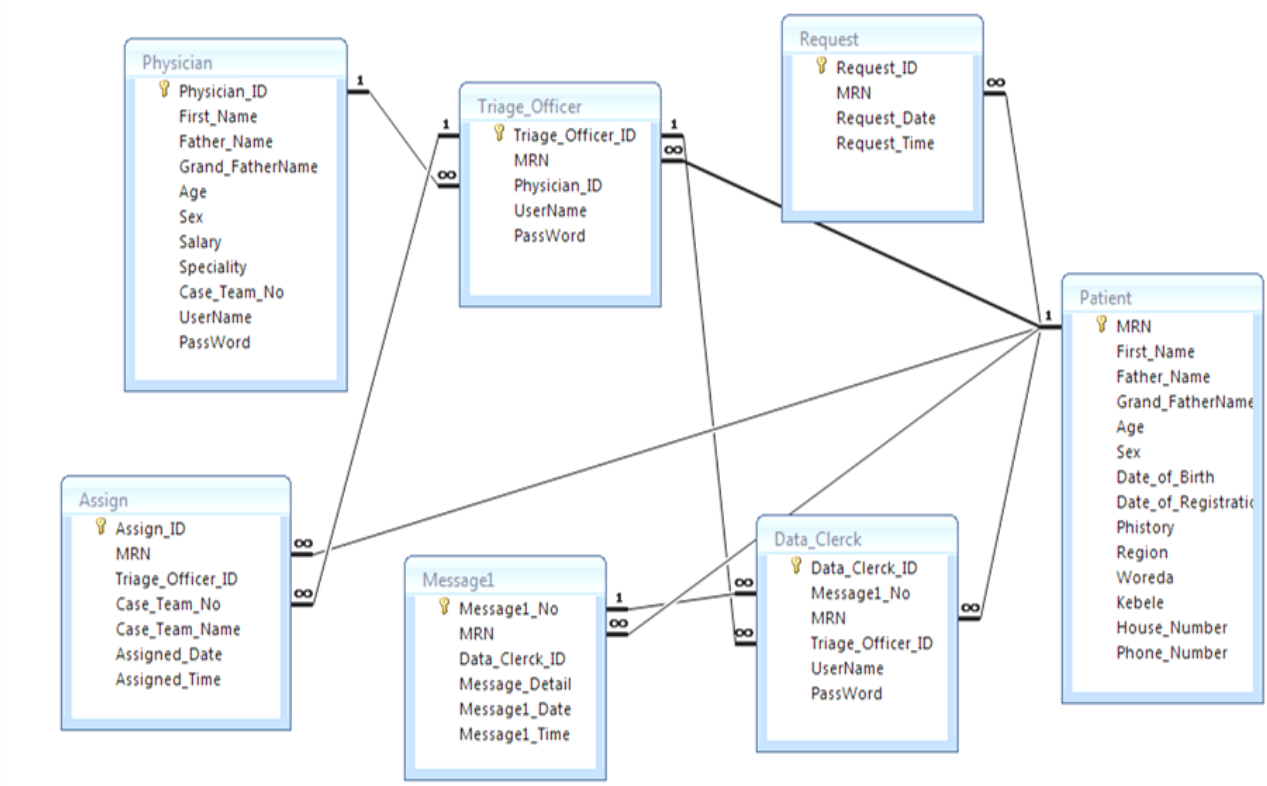

Fig 14: ER Diagram of Patient Registration and Assign to Different Case Team

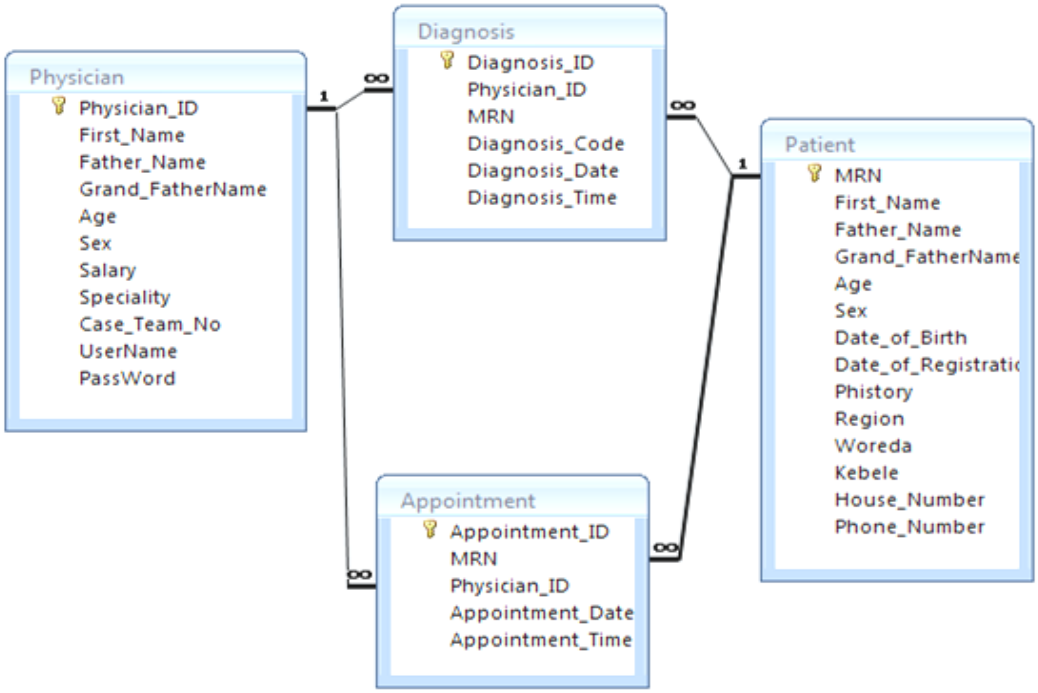

Fig 15: ER Diagram of Patient Diagnosis and Appointment

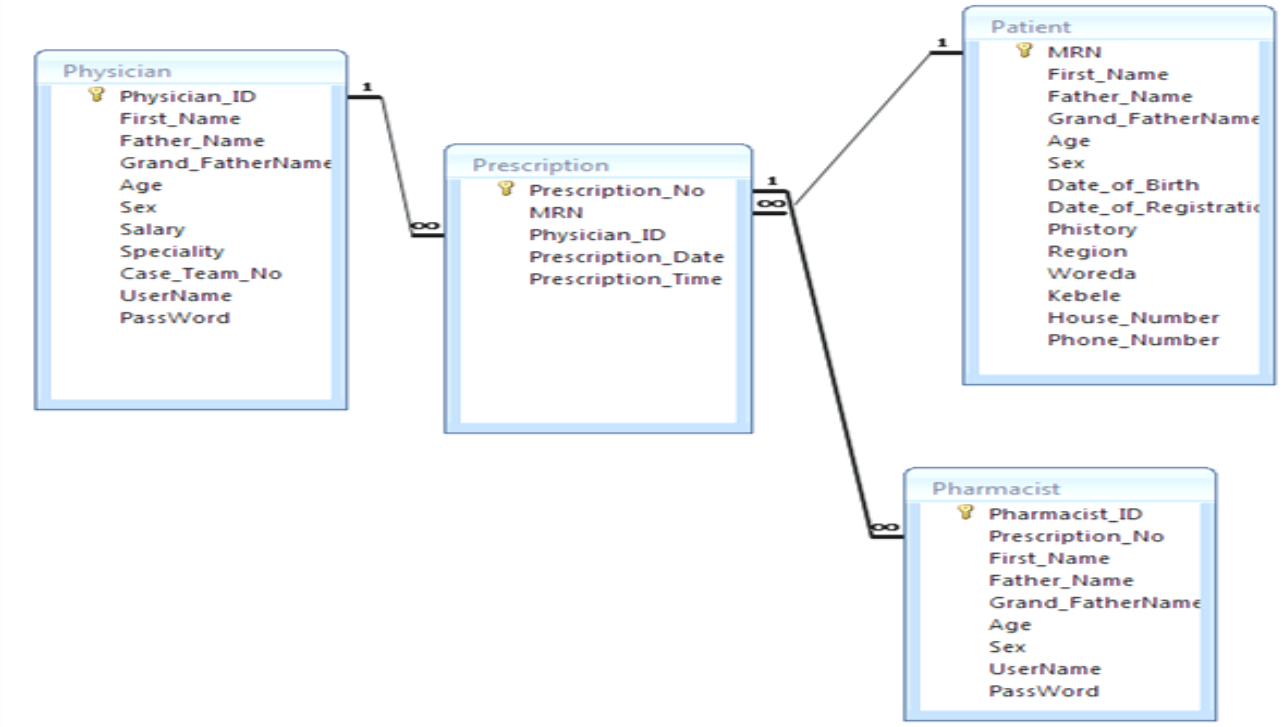

Fig 16: ER Diagram of Physician and Pharmacist

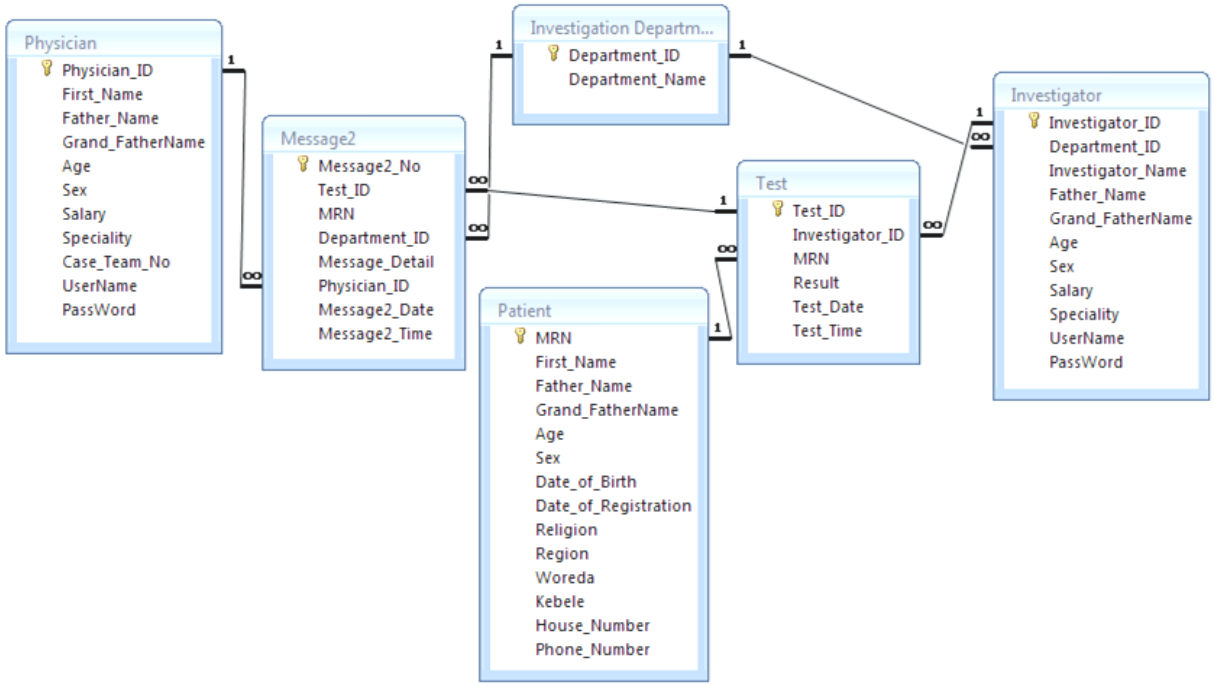

Fig 17: ER Diagram of Physician and Investigation Department

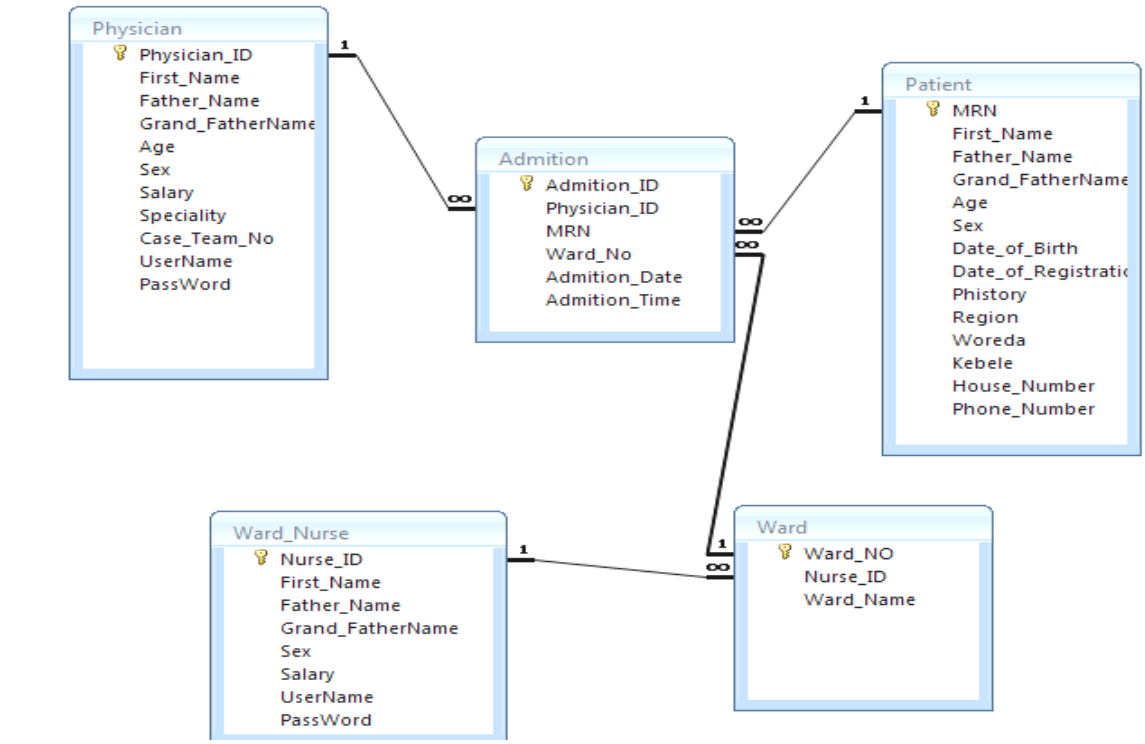

Fig 18: ER Diagram of Physician and Ward

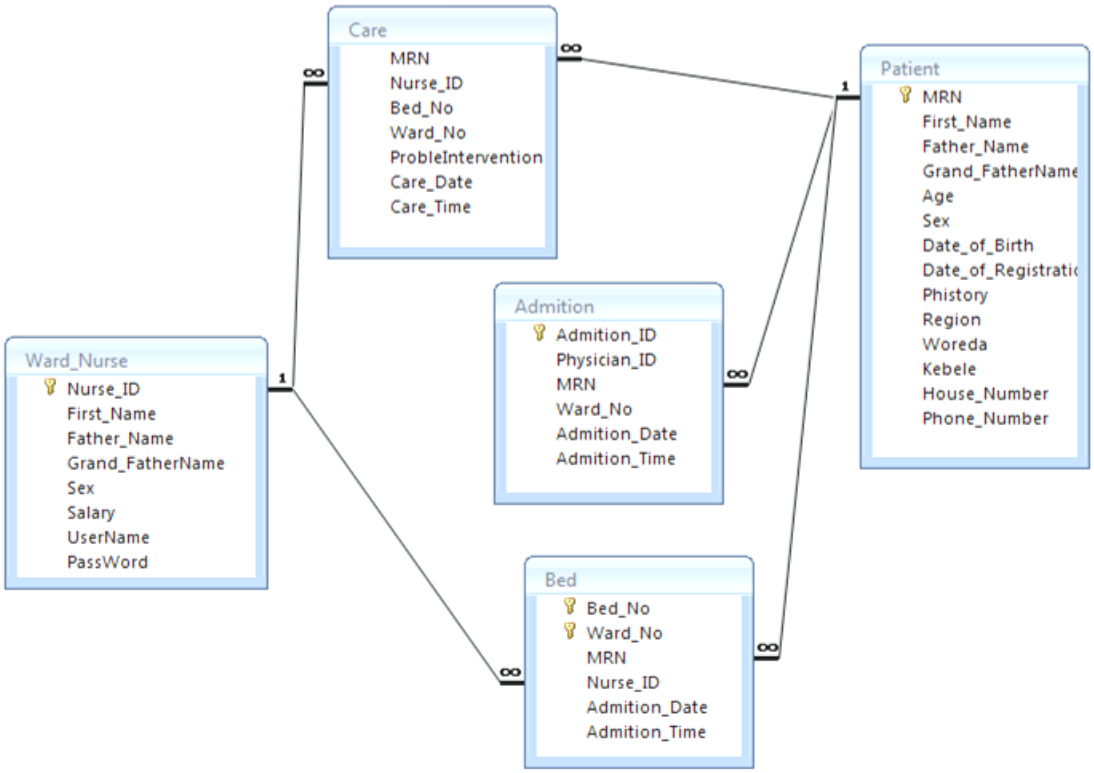

Fig 19: ER Diagram of Patient and Ward Nurse

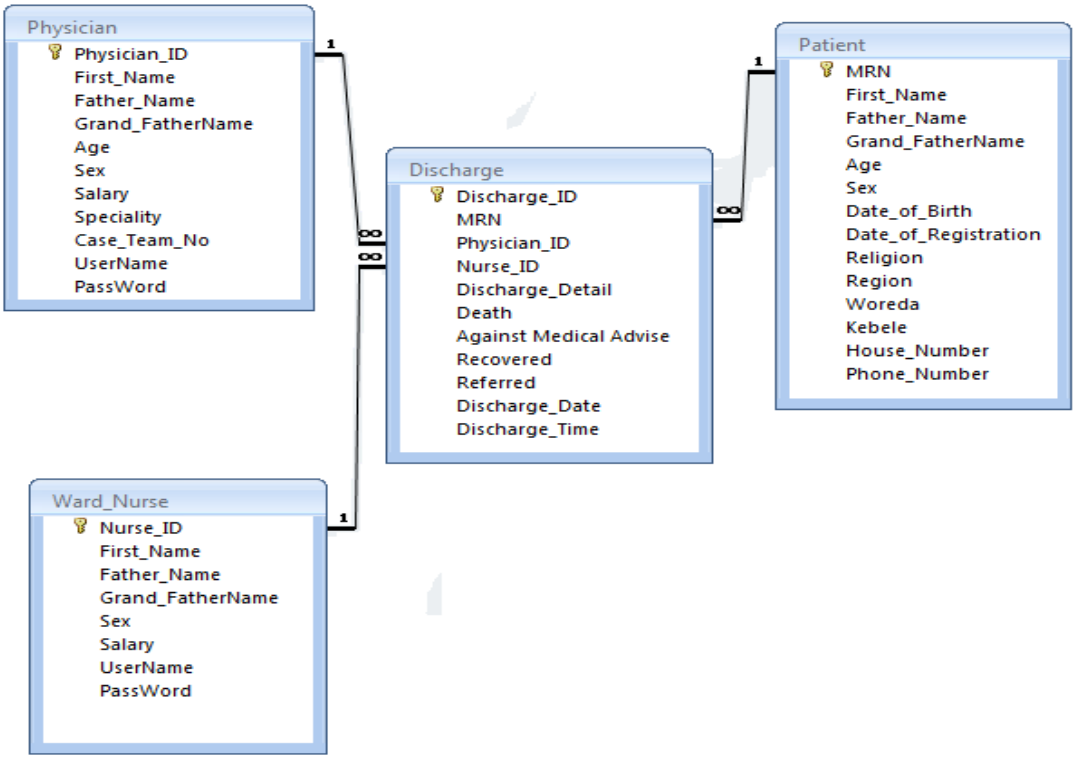

Fig 20: ER diagram of Patient and Ward Nurse

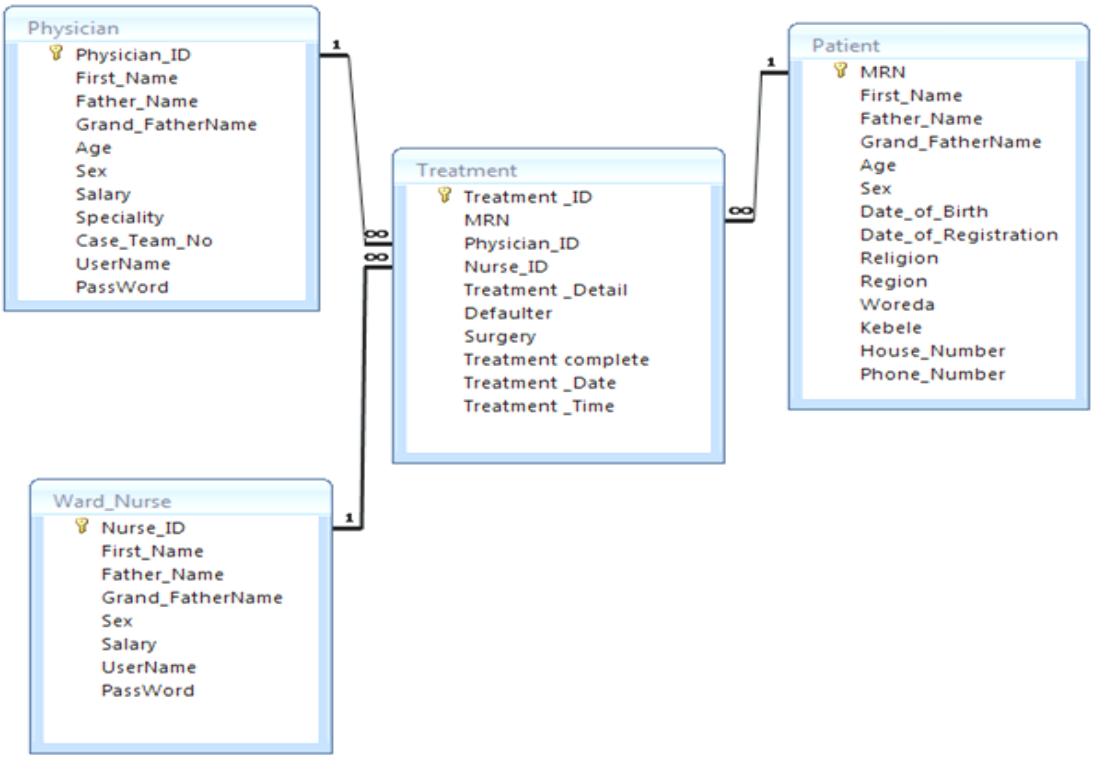

Fig 21: ER Diagram of Patient and Treatment

4.12 List of User Interface

The following user interfaces were identified:
UI1.System Login form
UI2.Invalid Login form
UI3.HOME PAGE
UI5.Patient Registration form
UI6. Department Information registration form
UI7. Employee Information registration form
UI8. Admission form
UI9. Discharging form
UI10. Appointment scheduling form
UI11.Diagnosis Information Registration form
UI12.Invalid Information form
UI13. Ward Information f
UI14.Report Generation form
UI15. Patient Search form
UI16. User Account form.

4.13 System Architecture

An important step of the design phase is the creation of the architecture design, the plan for how the information system components will be distributed across multiple computers and what hardware, operating system software, and application software will be used on each computer (e.g., Windows or Linux operating system software) [32].

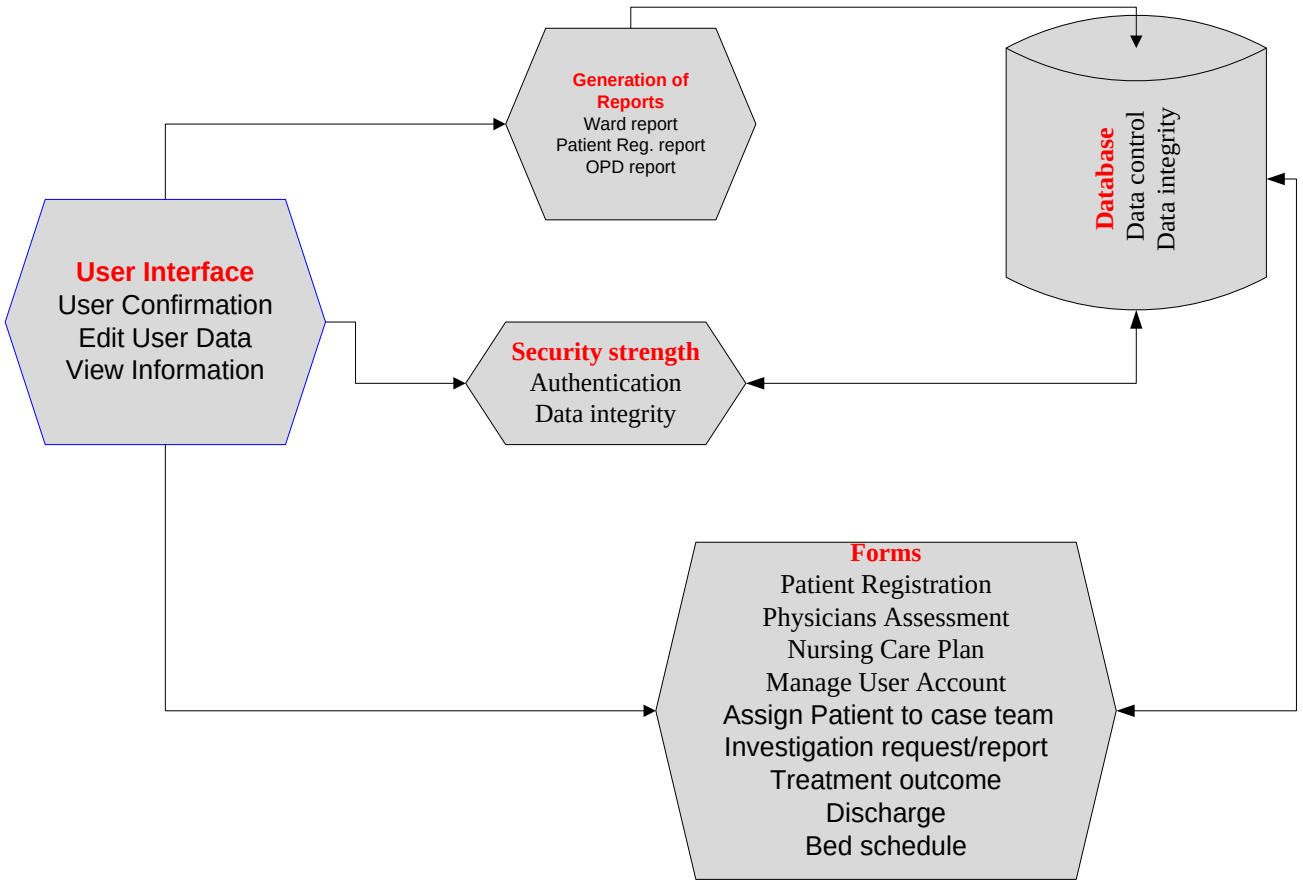

Fig 22: System Architecture of Patient Record System

Project work communication

Making needed information available in a timely manner is very important and helps for effective communication with stake holders.

Table 18: Project Work Communication

Stake holders	Document Name	Document Name	Due
Shahemene Referral Hospital	Finalized document Design of a Patient Record	Hard Copy	June 2014
AAU	Design of a Patient Record finalized document	Hard copy Soft copy	June 2014
Advisors	Project Proposal, System Analysis Document, System Design Document	Hard copy	January 2014 June 2014
Examiners	Finalized document Design of a Patient Record	Hard Copy	June 2014

CHAPTER FIVE

CONCLUSION and RECOMMENDATION

5.1 CONCLUSION

The core aim of this Project was to design a patient record system for SRH for recording of patient health history. Patient health history recording is mandatory it helps the health professionals to easily accesses health history and prevents them from prescribing drugs that has adverse effects which threatens patient's life. Additionally, the design will help the hospital workers to have their contribution on the requirement gathering as the result they will get good patient record system that will help them in their day to day activities. Furthermore, the patient record system was designed by structured system design life cycle which is a good methodology to produce good document. The tools used for collection of requirements were open and closed ended questions for interview and observation check list were used to observe the day to day activities. The result of the study was displayed by use of DFD, activity diagrams, ER diagrams.

5.2 RECOMMENDATION

During the study of this project it was found that the hospitals do not have patient record system. They were using manual systems to keep patient record which has its own problem. An attempt was made to develop a design of a patient record system which gives a permanent solution when it is implemented. The following mentioned recommendations should be carried out by the hospital administration and other stake holders to solve poor patient data handling system of Shashemane Referral Hospital:

- Addis Ababa University and Shashemene Referral Hospital should work on implementation phase of this document.
- Addis Ababa University should make proper arrangements for students to use this document as starting point for further study.
- Federal Ministry of Health and Federal Ministry of Education should incorporate and strengthen IT education in health professionals' curriculum.
- Developers and students may use this document for further improvement and implementation of the system.
- Developers and students may use additional tools and techniques as well as other methods for the improvement and development of the system.

5.2.1 Opportunity and Lesson Learned

This project has helped to understand better what goes in the patient records system. This was effectively done through reading of literature and other related works. The whole process of developing design of a patient record system was an opportunistic challenge.

Annexes

Annexes I

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Annex II

Database tables

Data base tables are designed of rows and columns which help to hold data elements. Database tables help to organize and group data by common characteristics or principles. The following listed tables were created by using of SQL (Structured Query Language) server 2008.

Table1: Patient profile table with its attributes

Column Name	Data Type	Allow Nulls
MRN	int	☐
First_Name	nvarchar(20)	☐
Father_Name	nvarchar(20)	☐
Grand_Father_Name	nvarchar(20)	☐
Sex	nchar(10)	☑
Date_of_Birth	date	☐
Age	int	☐
Phistory	nvarchar(250)	☑
Date_of_Registration	date	☐
Region	varchar(15)	☑
Woreda	varchar(10)	☐
Kebele	nchar(10)	☐
House_Number	nvarchar(10)	☑
Phone_Number	int	☑

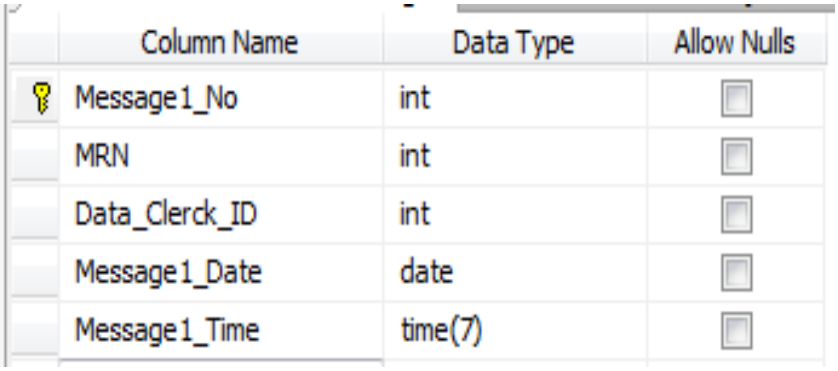
Table2: Data clerk profile table with its attributes

Column Name	Data Type	Allow Nulls
Data_Clerck_ID	int	☐
MRN	int	☐
Triage_Officer_ID	int	☐
UserName	nchar(20)	☐
PassWord	nchar(20)	☐

Table3: Request table with its attributes

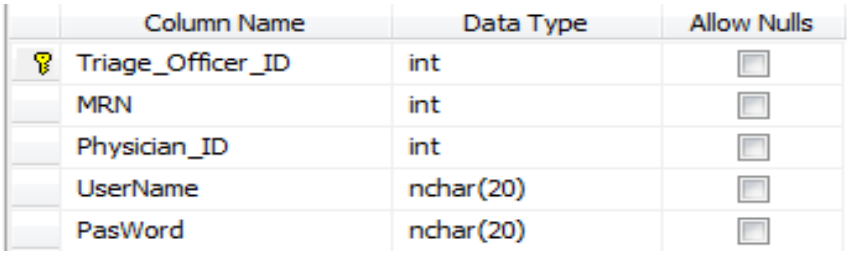
Column Name	Data Type	Allow Nulls
Request_ID	int	☐
MRN	int	☐
Request_Date	date	☐
Request_Time	time(7)	☐

Table4: Message1 table with its attributes



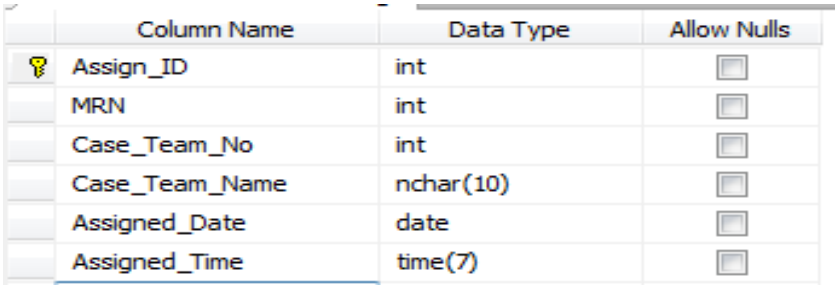
Column Name	Data Type	Allow Nulls
Message1_No	int	
MRN	int	
Data_Clerck_ID	int	
Message1_Date	date	
Message1_Time	time(7)	

Table5: Triage Officer Profile table with its attributes



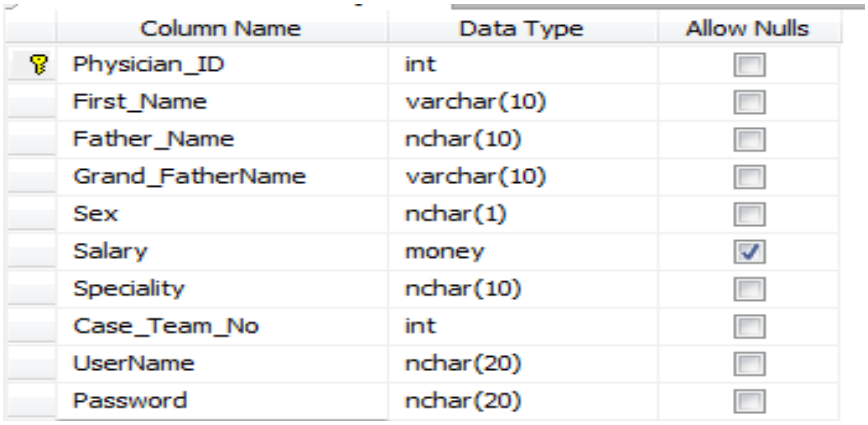
Column Name	Data Type	Allow Nulls
Triage_Officer_ID	int	
MRN	int	
Physician_ID	int	
UserName	nchar(20)	
PasWord	nchar(20)	

Table6: description of attributes for table assign



Column Name	Data Type	Allow Nulls
Assign_ID	int	
MRN	int	
Case_Team_No	int	
Case_Team_Name	nchar(10)	
Assigned_Date	date	
Assigned_Time	time(7)	

Table7: Description of attributes for table Physician



Column Name	Data Type	Allow Nulls
Physician_ID	int	
First_Name	varchar(10)	
Father_Name	nchar(10)	
Grand_FatherName	varchar(10)	
Sex	nchar(1)	
Salary	money	☑
Speciality	nchar(10)	
Case_Team_No	int	
UserName	nchar(20)	
Password	nchar(20)	

Table8: Diagnosis table with description of its attributes

Column Name	Data Type	Allow Nulls
Diagnosis_ID	int	
MRN	int	
Diagnosis_Code	int	
Diagnosis_Date	date	
Diagnosis_Time	time(7)	

Table9: Description of attributes for table Laboratory Technologist

Column Name	Data Type	Allow Nulls
Lab_Thechnologist_ID	int	
First_Name	nchar(10)	
Father_Name	nchar(10)	
Grand_FatherName	nchar(10)	
Age	int	
Sex	nchar(10)	
UserName	nchar(20)	
PassWord	nchar(20)	

Table10: Description of attributes for table Message2

Column Name	Data Type	Allow Nulls
Message2_No	int	
Physician_ID	int	
Lab_Thechnologist_ID	int	
MRN	int	
Message2_Date	date	
Message2_Time	time(7)	

Table11: Description of attributes for table Test

Column Name	Data Type	Allow Nulls
Test_ID	int	
Lab_Technologist_ID	int	
Result	nchar(20)	
Test_Date	date	
Test_Time	time(7)	

Table12: Description of attributes for table Pharmacist

Column Name	Data Type	Allow Nulls
Pharmacist_ID	int	
First_Name	nchar(10)	
Father_Name	nchar(10)	
Grand_FatherName	nchar(10)	
Age	int	
Sex	nchar(1)	
UserName	nchar(20)	
PassWord	nchar(20)	

Table13: Description of attributes for table Prescription

Column Name	Data Type	Allow Nulls
Prescription_ID	int	
Pharmacist_ID	int	
Physician_ID	int	
Prescription_Date	date	
Prescription_Time	time(7)	

Table14: Description of attributes for table Nurse

Column Name	Data Type	Allow Nulls
Nurse_ID	int	
First_Name	nchar(10)	
Father_Name	nchar(10)	
Grand_FatherName	nchar(10)	
Sex	nchar(1)	
Salary	money	✓
UserName	nchar(20)	
Password	nchar(20)	

Table15: Description of attributes for table Ward

Column Name	Data Type	Allow Nulls
Ward_NO	int	
Ward_Name	nchar(10)	
Nurse_ID	int	

Table16: Description of attributes for table Bed

Column Name	Data Type	Allow Nulls
Bed_No	int	☐
MRN	int	☐
Ward_No	int	☐
Nurse_ID	int	☐

Table17: Description of attributes for table Admission

Column Name	Data Type	Allow Nulls
Admition_ID	int	☐
Physician_ID	int	☐
MRN	int	☐
Ward_No	int	☐
Admition_Date	date	☐
Admition_Time	time(7)	☐

Table18: Description of attributes for table Appointment

Column Name	Data Type	Allow Nulls
Appointment_ID	int	☐
MRN	int	☐
Physician_ID	int	☐
Appointment_Date	date	☐
Appointment_Time	time(7)	☐

Annex III

List of Activity Diagrams

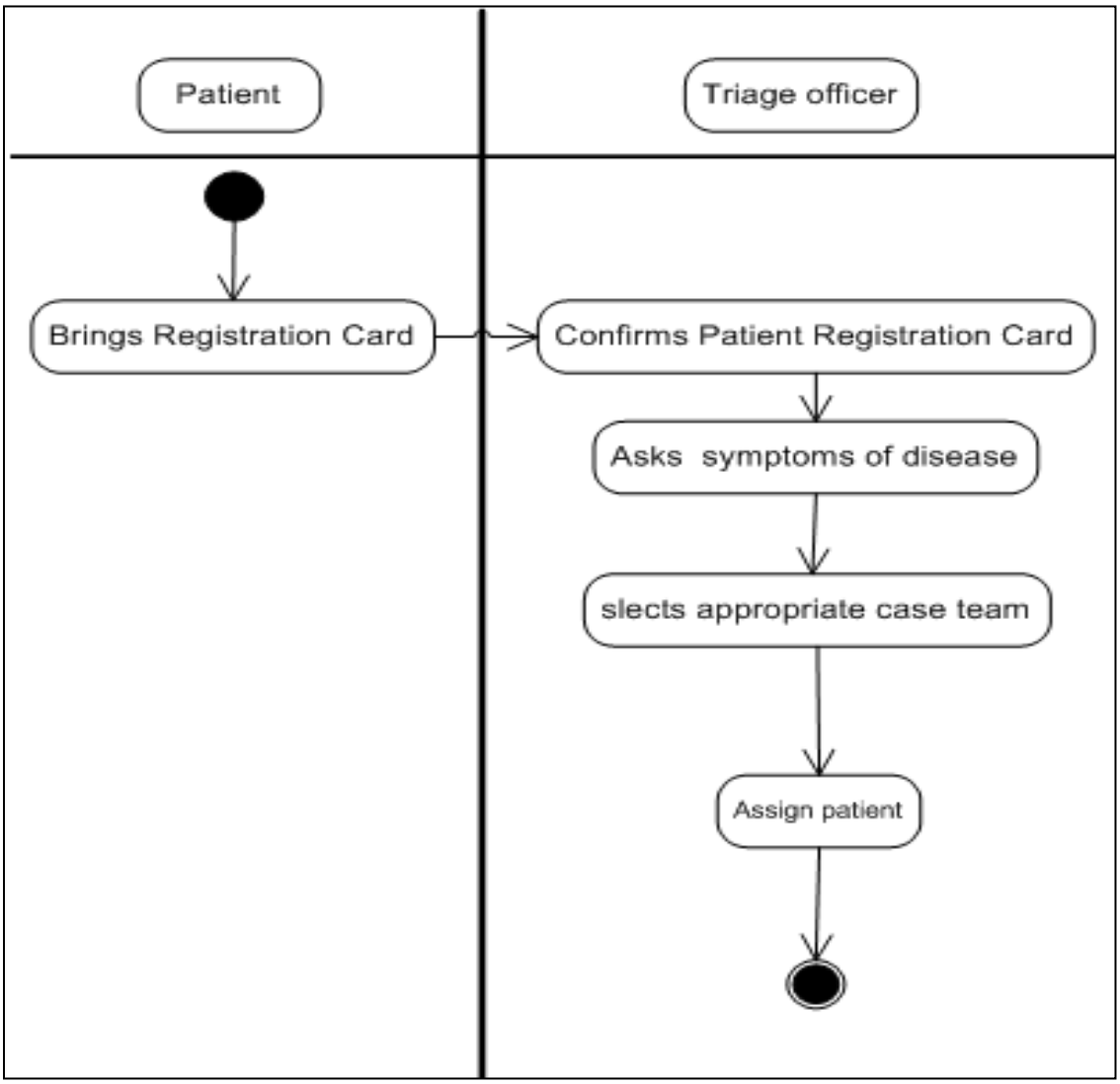


Fig 1: Activity Diagram for assigning of patients to case teams

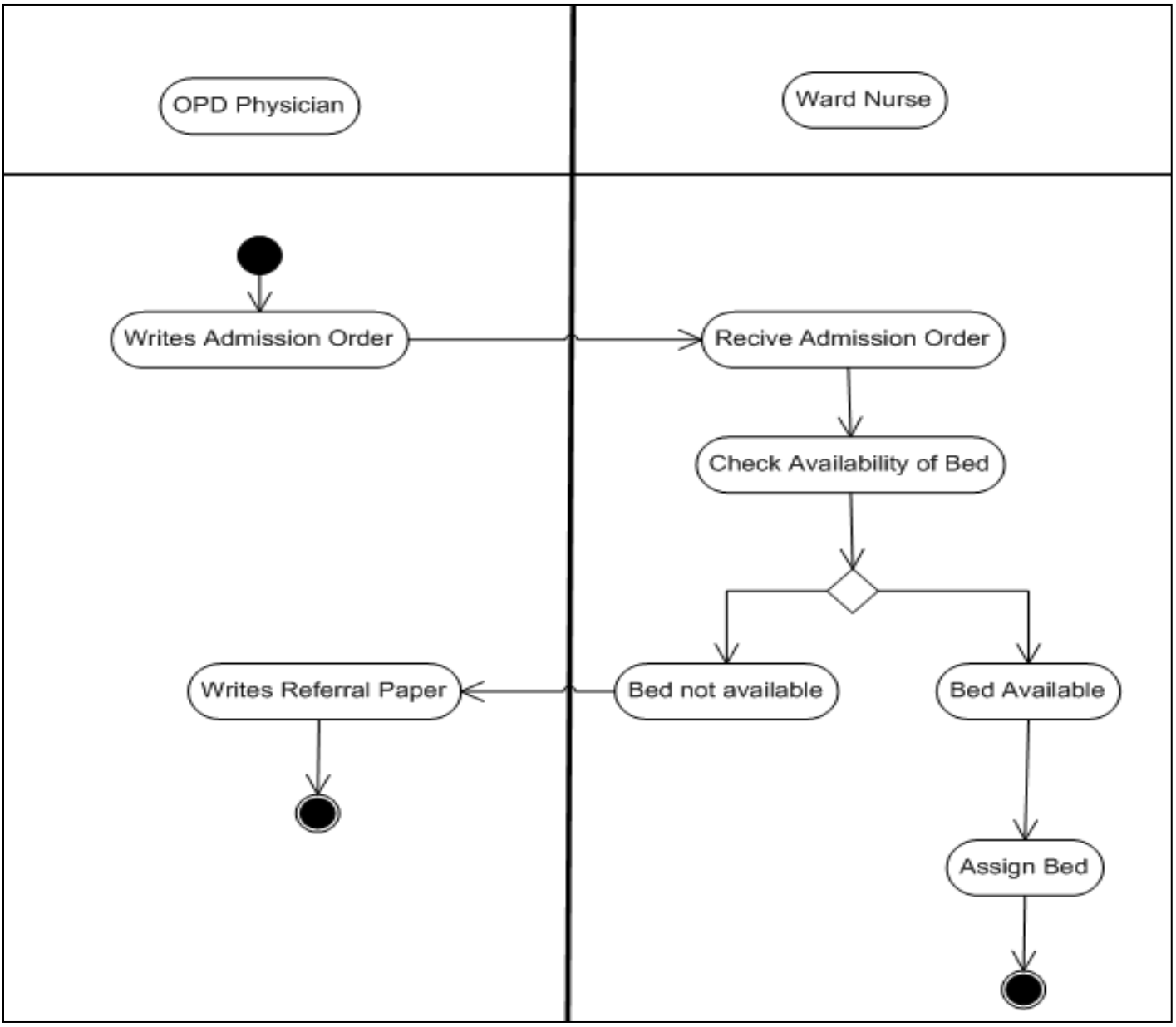


Fig 2: Activity Diagram for assigning of beds for patients

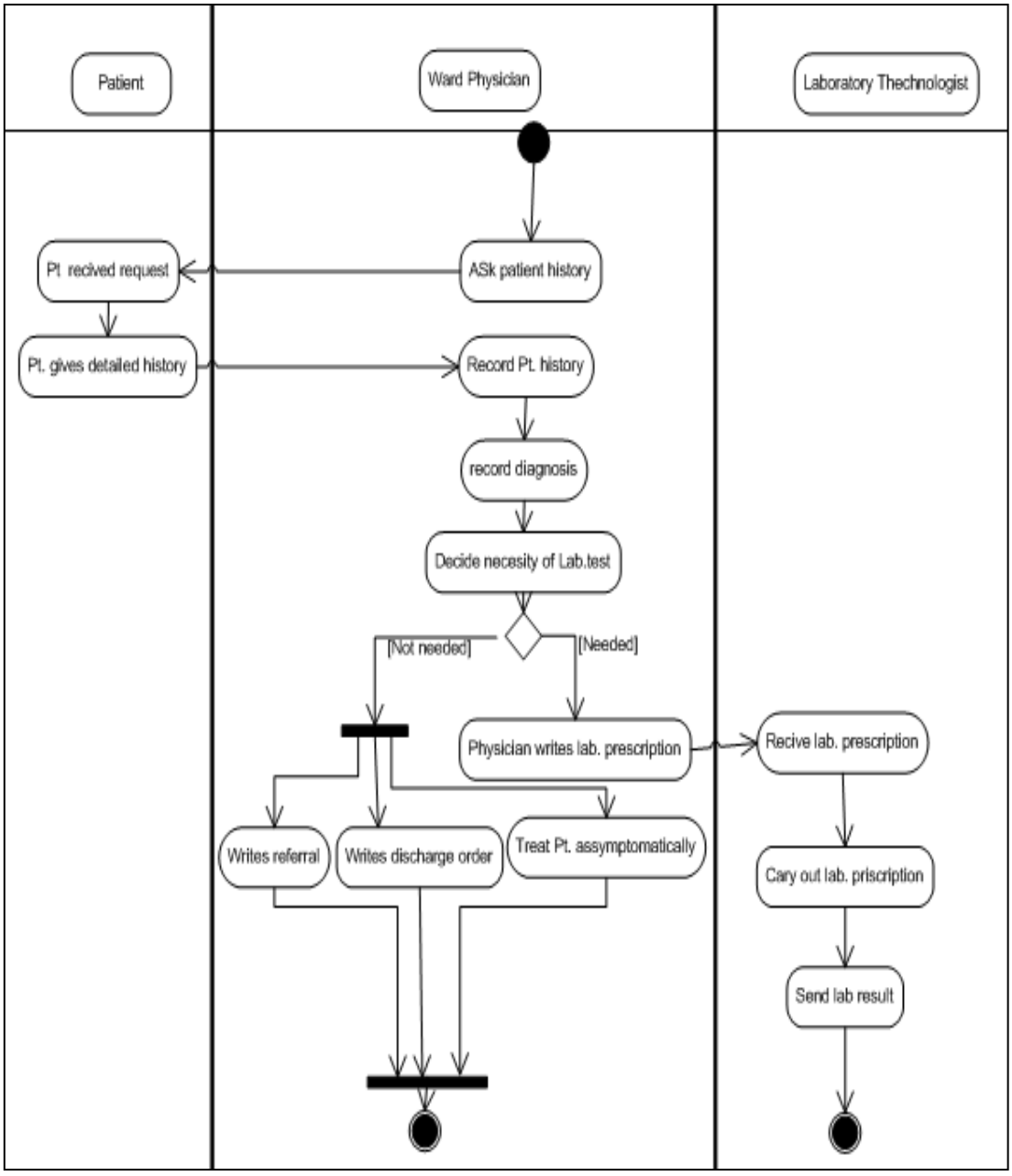


Fig 3: Activity Diagram for patients treated at wards

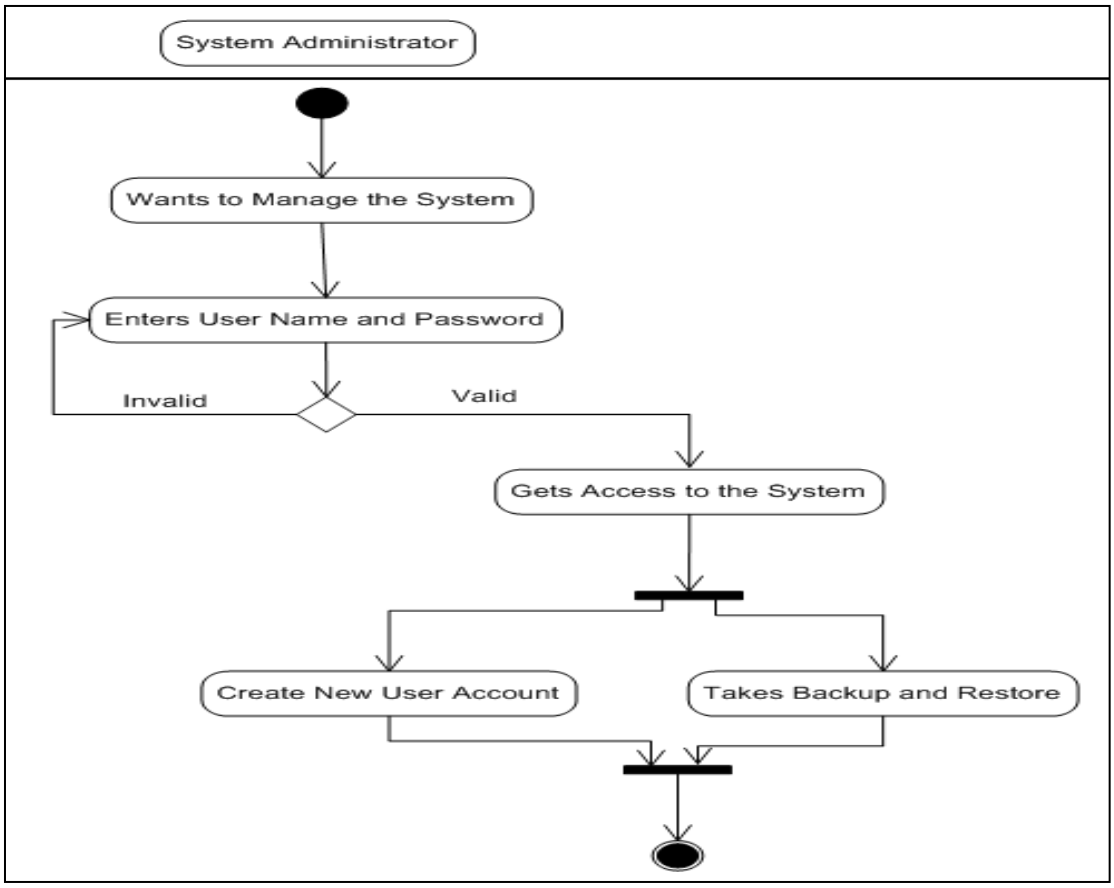


Fig 4: Activity Diagram for managing system by system administrator

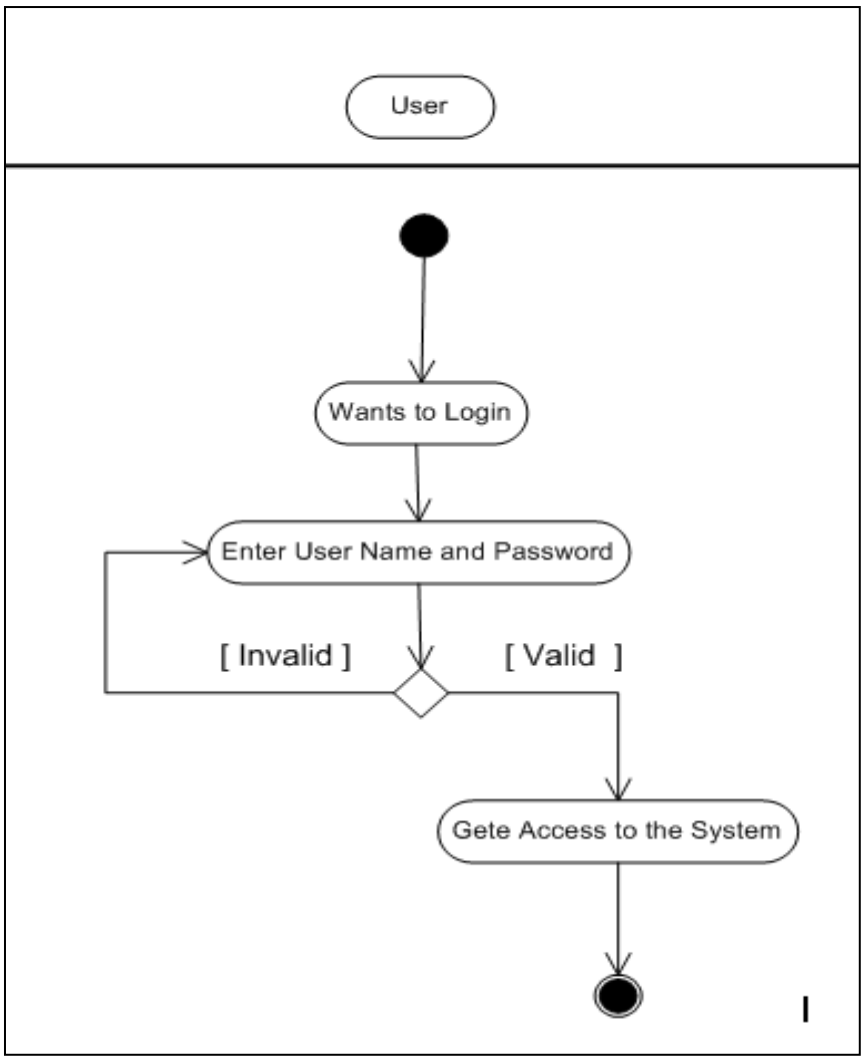


Fig 5: Activity Diagram for login by users

Annex IV

List of Data flow Diagram

Data Flow Diagram helps to design data process

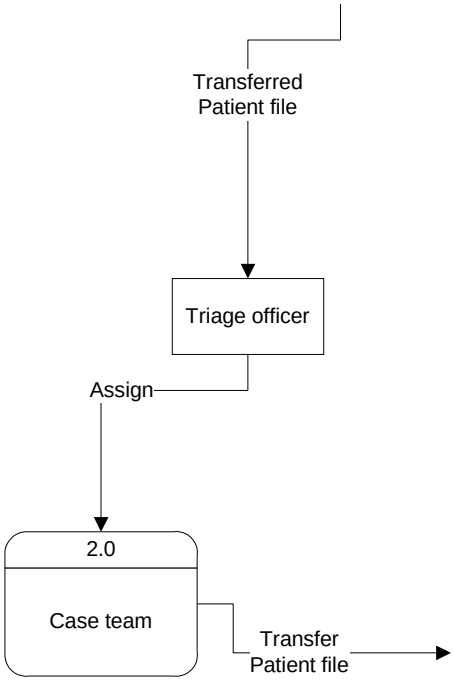


Fig1: Data Flow Diagram of Assign patient process

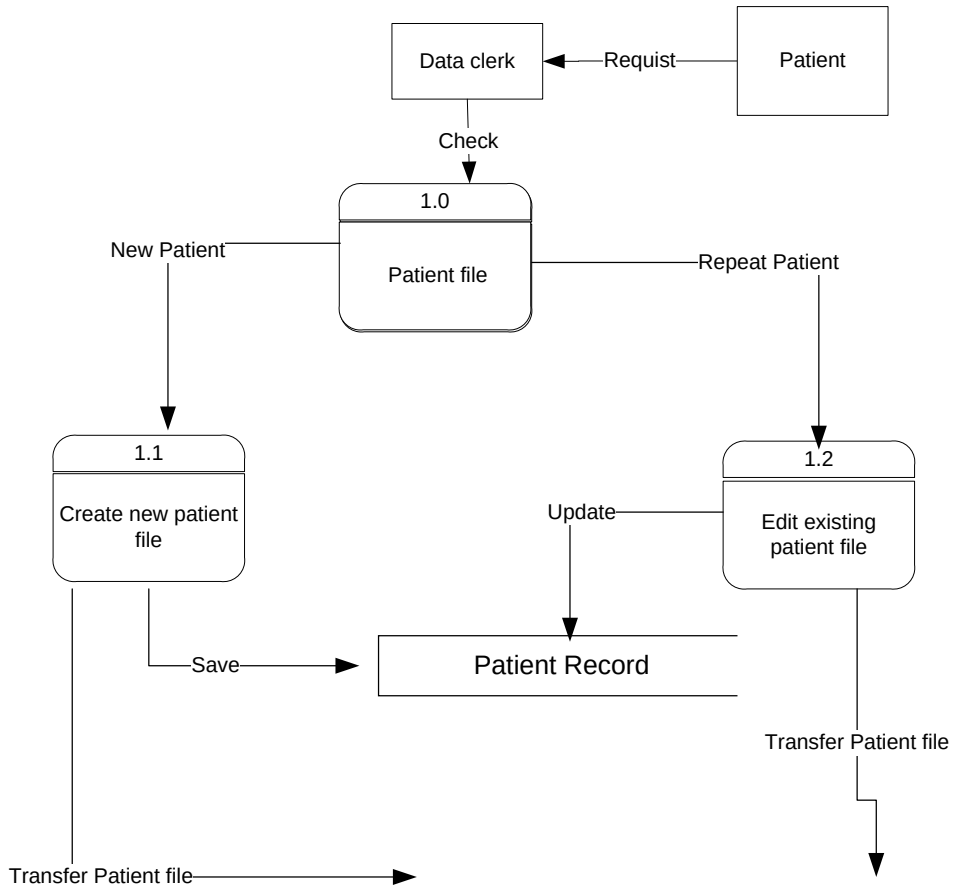


Fig2: Data Flow Diagram of check patient file process

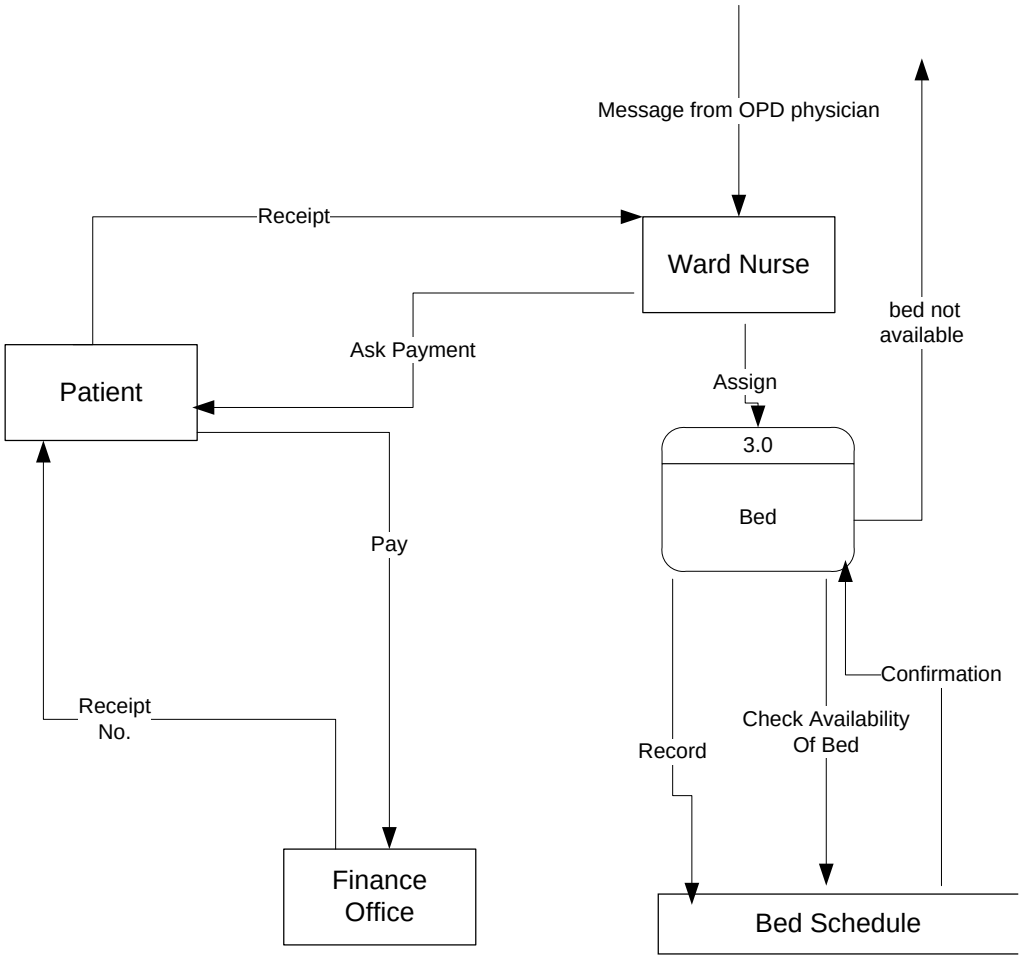


Fig3: Data Flow Diagram of Manage Bed Schedule

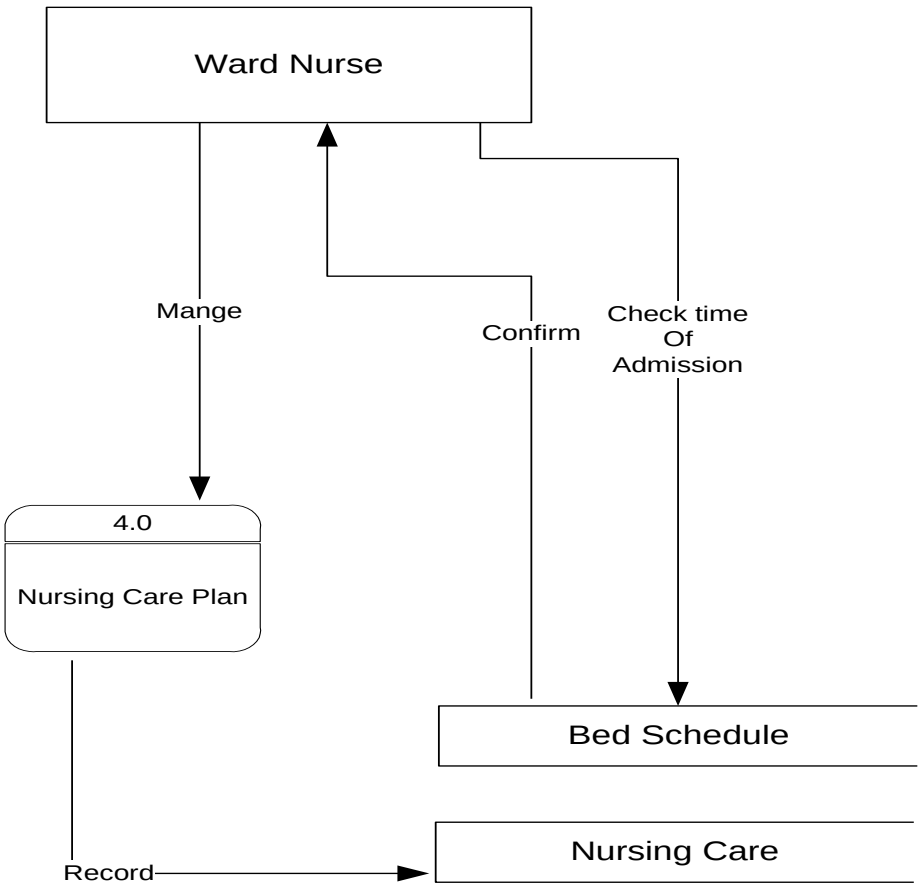


Fig4: Data Flow Diagram of Mange Nursing Care Plan

Annex V

Interview questions and Observation check list

Interview Questions

Purpose: The interview questions will help to assess the current system and to design future patient record system for Shashemane Referral Hospital

General Information:

Interviewee: _____

Responsibility**:** _____

Closed ended question

1. In what way a patient record system was recorded?
2. Who are individuals involved in patient care?
3. What is the method used to collect reports from departments?
4. Who are the stake holders use your reports?
5. Do you think there are problems in the process of patient registration, treatment and report generation?

Open ended questions

1. Please mention the feature you need in the new system?

_____

_____

_____

2. What are your concerns and worries in deployment of the new system

_____

_____

_____

3. Observation check list

Department_____
Date_____

Process to be Observed	Yes	No	Remark
1. Patient registration carried out according to standard			
2. Patient health records are placed in its places			
3. Retrieval of patient record is it time tacking?			
4. Is there any lost/damaged patient health records?			
5. Do they use all formats in OPD/Ward			
6. Do all physicians assess, Diagnose and treat patients according to standards?			
7. Does reporting generation process is time taking?			

Observer Name_____
Signature_____
Date_____