ADDIS ABABA UNIVERSITY

SCHOOL OF INFORMATION SCIENCE

AND

SCHOOL OF PUBLIC HEALTH

M.Sc in Health Informatics Program

Designing a Web based TB patient Follow up Information System: For Wolkite Health Center

By

Adem Shikur

June, 2016

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A project submitted to the school of graduates studies of Addis Ababa University in partial fulfillment of the requirement for the Degree of Master of Science in Health Informatics

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Advisors	Signature	Date
1 Prof. Ahmed Ali	.....	.....
2 Dr. Temtim Assefa	.....	.....

Examiners	Signature	Date
1 Dr.Solomon Tefera	.....	.....
2 Dr.Abera Kumie	.....	.....

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LISTS OF ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ART	Anti-Retroviral Treatment
CCM	Chronic Care Model
DBMS	Database Management Systems
DOT	Directly Observed Treatment
DOTs	Directly Observed Therapy Short Course
DSM	Distributed System Management
EC	Eye Care
Ec	Ethiopia calendar
EHRs	Electronic Health Records
E-Health	Electronic Health
EPI	Expanded Program of Immunization
ER	Entity Relationship
FMoH	Federal Ministry of Health
FP	Family Planning
GUI	Graphical User Interface
HBC	High Burden Country
HBCs	High Burden Countries
HEW	Health Extension Worker
HEWs	Health Extension Workers
HIS	Health Information System
HIT	Health Information Technology
HIV	Human Immune deficiency Virus
HMIS	Health Management Information System

MCH	Maternal and Child Health Care
MDR	Multi-Drug Resistance
MDR-TB	Multi-Drug Resistance Tuberculosis
NHS	National Health Service
OO	Object Oriented
OOA	Object Oriented Analysis
OOD	Object Oriented Design
OOUI	Object Oriented User Interface
OPD	Out Patient Department
PCs	Personal Computers
RHZE	Rifampicin (R) Isoniazid (H) Pyrazinamide (Z) Ethambutol (E)
SMS	Short Message Service
SNNPR	South Nations Nationalities and Peoples Region
TB	Tuberculosis
UML	Unified Modeling Language
UE	Usability Evaluation
UI	User Interface
USA	United State of America
VCT	Voluntary Counseling and Testing
WSHIS	Web Service-based Healthcare Information System
WSIHIS	Web Service-based Integrated Healthcare Information System

ABSTRACT

Background: *Tuberculosis commonly known as TB continues to be a major health problem in the world, particularly in developing countries. Health information system is one of the important tools for the health sector which involves stakeholders situated at national, regional, district, service delivery and community levels. Web-based applications provide the power of desktop and server applications with the flexibility and accessibility of the web. Health-system-related obstacles to follow up treatment for tuberculosis include, dissatisfaction with in health services, need for repeated visits, and delays in receiving the results of sputum smears.*

Objective*: The objective of this project is designing a web based TB Patients follow up information system at wolkite Health Center.*

Methodology: *This Project was conducted using a design science research method. This method is used to develop innovative artifacts that solve societal problems. The investigator used interview, observation and document analysis to elicit user requirements and evaluate the proposed system. Analysis and design of the proposed system was performed using unified modeling language diagrams (use case diagram, activity diagram, sequence diagram, class diagram, and entity relationship diagram). The project was carried out after getting permission from the ethical clearance committee of Addis Ababa University, Medical Faculty through School of Public Health.*

Discussion of Result: *The investigator reviewed the current system of the health facility problems in data process, communication, procedures, people, software and hardware. The system was designed by identifying the entire process and system boundary proposed in the use cases. The system design includes user interface, business logic and backend database design. The user interface has different interfaces such as patient registration, display diagnosis result, prescription, follow up, remind medication and report generate to facilitate user and system interactions. The proposed system was evaluated for its effectiveness and usability to support health service delivery.*

Conclusion: the system did not show the entire product of the system, rather provides *to facilitate health care services for TB patients. It also improves patients' data record and report generation.*

Key words*: Information system, Medication and TB patient follow up*

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Tuberculosis, commonly known as TB, continues to be a major health problem in the world, particularly in developing countries (1). There were almost nine million infections of TB in 2012, and more than one million people die every year from TB. Sub-Sahara African countries take the lion's share with over 260 new cases per 100 000 population. One third of the world‘s population is estimated to be infected with tubercle bacilli and hence at risk of developing active disease (2). Globally, in 2005, the annual incidence of TB, expressed as the number of new TB cases, was about 8.8 million people (7.4 million of these in Asia and sub-Saharan Africa), and the annual number of deaths due to TB was 1.6 million, including 195,000 patients infected with HIV (3). Tuberculosis is a major contributor to the global burden of disease and has received considerable attention in recent years, particularly in low- and middle-income countries where it is closely associated with HIV/AIDS.

Ethiopia is one of the 22 HBCs (High Burden Countries) (4). The national population based TB prevalence survey 2010/11 revealed that the prevalence of smear positive TB among adults and all age group was found to be 108 and 63 per 100,000 populations, respectively. According to Federal Ministry of Health (2011), health and health related indicators are tuberculosis the third leading cause of death in Ethiopia (4).

The DOTs generally requires healthcare workers to remind and observe patients for taking their daily TB medication (5). This process necessitates adequate human labour that is a challenge in developing countries. The technology-assisted DOTs seek to reach more patients at a lower cost through automated reminders via mobile phones. The process needs a few human labour and cost less.

Health Information System is one of the important tools for the health sector which involves stakeholders situated at national level, regional, district, service delivery and community levels (6).Vertical information flow denotes transfer of information at certain intervals (daily,

weekly, monthly, quarterly) between levels of healthcare such as community, health facility, district, regional and national level.

Health Information System as a mechanism with the ability to integrate data collection, processing, reporting, and use of the information necessary to improve healthcare service effectiveness and efficiency through better management at all levels of the healthcare system (7). Health Information System plays an important role in ensuring that reliable and timely health information is available for operational and strategic decision-making, thus providing better healthcare services and enhancing public health. Despite its importance, HIS in many developing countries is weak, fragmented, and often focused exclusively on disease-specific program areas. Notwithstanding the potential of HISs, in practice, the collection, compilation, analysis, and reporting of health data are riddled with major problems. Furthermore, the data received are often not helpful for healthcare management decision-making because they are incomplete, untimely, and unrelated to the priority tasks of healthcare professionals.

Web-based applications provide the power of desktop and server applications with the flexibility and accessibility of the web (8). Using web browsers, users can securely access applications from anywhere within the reach of the organization intranet or extranet .The special issue strives to explore the advanced web-based information systems and database applications in healthcare area (8). A web based system to support TB patients follow up information system in healthcare organizations are undergoing major reorganizations and adjustments to meet the increasing demands of improved healthcare access and quality, as well as lowered costs. The system enabled by searching and identifying patients' schedules for those schedule date is approached, and generate the appropriate Short Message Text reminder message and send to the appropriate patients and Health Extension Workers. Web-enabled information technologies use of Information Technology (IT) to process medical data increases, much of the critical information necessary can provide the means for greater access and more effective integration of healthcare information system from disparate computer applications and other information resources (8).

1.1. Statement of the Problem

Tuberculosis (TB) is a major contributor to the global burden of disease and has received considerable attention in recent years, particularly in low and middle income countries where TB is closely associated with HIV/AIDS (9). Encouraging patients to take their medications

in the hospital and admission during intensive phase help to improve treatment outcome (9). Poor knowledge of standard TB treatment regimen by medical personnel can worsen treatment outcome (10), while side effects of the drugs if not properly addressed can worsen treatment outcome (11).

TB can be cured if patients strictly follow a prescribed medication procedure for a minimum of six months. However, patients often forget to take their medicine as recommended. As a result, the disease takes longer to be cured. It also requires more cost and medication through treatment may no longer be successful (1, 12).

Health-system-related obstacles to follow up treatment for tuberculosis included dissatisfaction with long waiting times in health services, the need for repeated visits, and delays in receiving the results of sputum smears (13).

The consequences of non-adherence to treatment, include increased rates of treatment failure, relapse, acquired drug resistance, and prolonged infectiousness of patients (14, 15). Therefore, effective treatment of tuberculosis requires adherence to a minimum of 6 months treatment with multiple drugs.

Defaulting from treatment remains a challenge for most tuberculosis programs. A study conducted in Hosanna Hospital showed that 20% of patients on Treatment were defaulters (16). On the other hand MDR-TB is a newly emerged challenge in Ethiopia. WHO estimated that about 5000 new MDR-TB infections are documented annually (16).

Poor quality of information does not enable to see whether actions have been taken or if the data have not been suitably entered into the information system (17). Information system includes manual and computerized data technologies. But, the current paper-based record systems inadequate in terms of documentation, disruption, and substantial delay in the health services. Advanced information technologies, on the other hand, provide clinicians with real time information access (18).

Tuberculosis patients monitoring was mainly carried out by means of “notices” generated when patients missed scheduled appointments, the issuing of pre-appointment reminders, registration errors and identification of absentees (19).

Electronic systems maintain quality and accurate data, and make reporting potentially more flexible and efficient (20). To 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 (20).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 (21, 22).

Therefore, Ethiopia has one of the highest TB burden in the world. TB is among the leading causes of morbidity and mortality. For this reason, the aim of this study is designing a web based TB Patients follow up information system to enable sending reminder text messages for medication and reminding scheduled date for patients and HEWs. The system can improve communication and treatment success, generated quality data and aggregated report. The system also enables to reduce waiting time and registration error, and the system facilitates fast service in Health Center.

1.3. Objective of the Study

1.3.1. General Objective

The general objective of this study is to designing a web based TB patient's follow up information system at Wolkite Health Center.

1.3.2. Specific Objectives

To achieve the above general objective of the study, the following specific objectives are formulated.

- To identify system requirements and health services management information system.
- To design system model of the TB patients follow up information system.
- To evaluate the proposed system effectiveness in improving TB follow up system.

1.4. Scope and limitation of the Study

This study delimited to in geographically, conceptually and timely to tackle the research project problem.

Geographically, this project focused on design of web based TB Patients Follow up information system in the Gurage Zone Administration Health Department in SNNPR state, specifically Wolkite Town Administration Health Center and in six health posts. This Health Center serves urban and surrounding rural woreda kebeles. The system will be scaled up and applied in other hospitals. Therefore, the project was tackling the problem by assessing the existing situation of the health workers, patients and health facility information system and identifies user and system requirement.

Conceptually, a web-based system is also necessary in order to improve the accessibility of the patient information, delivery of comprehensive, reliable and timely information needed by health professionals and patients in the health facility. After identification of the user requirement made analyzing and design the system were done using use case model, sequence activity, class diagram, entity relationship diagram and user interface design.

Timely, the project was done the use of design science research method by object oriented system analysis and design technique from January up to June, 2016 GC.

1.5. Significance of Study

This web based TB Patient Follow up information system would help for the TB Patients, the Health Professional, Health Facility, Researcher and Policy Maker

For TB patients

- The system helps remind the patient to medication, treatment and follow up to the nearest health post or health center.
- It also helps to cure the TB patient, restore quality of life and productivity, and prevent death from active TB or its late effects.
- Patients would get guarantee access to effective personal and public health care.

For Health Professionals,

- The system makes their work easier, effective, and efficient.
- It helps them in tracing and controlling the performance of specific TB patients follow up.
- It helps the health professionals in providing quality health care service.

For Health Facility

- It would help to improve fast communication between health center, patients and health extension workers and would prepare organized reports.
- It helps to improve the health service, properly manage TB patients
- It provides patient information at appropriate place and time, updating patient's information and generates report system.

For Researcher

- It provides complete information for TB patient follow up system study and research purpose.
- It can be used as input other related projects.

For Policy Makers

- Policy makers was used a data generated from designed system for their decision and to improve the effectiveness and efficiency of TB patients the health information system in the country.

CHAPTER TWO

2. LITERATURES OVERVIEW

2.1. Web-based Health Care System

A web-based application is one of the technologies which is applicable in health facilities. The Web is becoming the standard interface for accessing remote services of information systems, hosting data centers and application service providers (23). Demands placed on Web based services continue to grow and Web based systems are becoming more utilized than ever.

The World Wide Web (known as "www" or "web") is growing in health facilities. It is a source of information over internet (24). The current Web is largely based on the file system technology, which can deal well with the resources that are primarily static .However, with the unprecedented growth of resources; it is no longer adequate to rely on this conventional file technology for organizing, storing, and accessing large amount of information on the Web. Thus, many large Web sites today are turning to database technology to keep track of the increasing amount of data (24). Database technology has played a critical role in the information management field. Delivering information over the web is cost effective and fast, and gives internet users easy access to databases from any location. For this reason, technology will bring many opportunities for creating advanced information management applications.

2.2. Health Information System in Health Center

Health information systems are frequently refer to the interaction between people, process and technology to support operations, management in delivering essential information in order to improve the quality of health care services (25). Similar to any other industries, the nature of healthcare industry has changed over time from a relatively stable industry to a dynamic one. Health information systems have evolved through several different technologies (25).It describes systems that process data and provides information and knowledge in health care environments as health information systems. Health Center information systems are just instances of health information systems, in which the Health Center is the healthcare environment as well as health care institution (26). The aim of health

information systems is to contribute to a high-quality, efficient patient care. Some of terminologies related to HIS are as follows. Health Informatics is the field that concerns itself with the cognitive, information processing, and communication tasks of medical practice, education, and research, including the information science and technology that supports those tasks (26). Health informatics tools, include computers as well as clinical guidelines, formal medical terminologies, and information and communication systems. In other words, its emphasis is on clinical and biomedical applications with added possibility of the integrating clinical components either among themselves or to more administrative-type health information systems.

Additionally, Health Information Technology is the application of information involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision is making (27).

Healthcare information systems that can record and locate important information quickly have become a standard practice in many healthcare organizations. The milestone of development for HIS were considered as important and summarized as follows (25).

- the shift from paper-based to computer-based processing and storage, as well as the increase of data in health care settings;
- the shift from institution centered departmental and, later, hospital information systems towards regional and global HIS;
- the inclusion of patients and health consumers as HIS users, besides health care professionals and administrators;
- the use of HIS data not only for patient care and administrative purposes, but also for health care planning as well as clinical and epidemiological research;
- the shift from focusing mainly on technical HIS problems to those of change management as well as of strategic information management;
- the shift from mainly alphanumeric data in HIS to images and now also to data on the molecular level;
- the steady increase of new technologies to be included, now starting to include ubiquitous computing environments and sensor-based technologies for health monitoring.

2.3. Health Information Technology

Health information technology (HIT) is “the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, data, and knowledge for communication and decision making” (28). Technology is a broad concept that deals with a species' usage and knowledge of tools and crafts, and how it affects a species' ability to control and adapt to its environment. However, a strict definition is elusive; "technology" can refer to material objects of use to humanity, such as machines, hardware or utensils, but can also encompass broader themes, including systems, methods of organization, and techniques. For HIT, technology represents computers and communications attributes that can be networked to build systems for moving health information. Informatics is yet another integral aspect of HIT.

Informatics refers to the science of Information, the practice of Information processing, and the engineering of Information systems (29). Informatics underlies the academic investigation and practitioner application of computing and communications technology to healthcare, health education, and biomedical research. Health informatics refers to the intersection of information science, computer science, and health care. Health informatics describes the use and sharing of information within the healthcare industry with contributions from computer science, mathematics, and psychology. It deals with the resources, devices, and methods required for optimizing the acquisition, storage, retrieval, and use of information in health and biomedicine. Health informatics tools, include not only computers, but also clinical guidelines, formal medical terminologies, and information and communication systems. Medical informatics, nursing informatics, public health informatics, pharmacy informatics and translational bioinformatics are sub disciplines that inform health informatics from different disciplinary perspectives (29). The processes and people of concern or study are the main variables.

Health information technology (HIT) is health information technology applied to health and health care. It supports health information management across computerized systems and the secure exchange of health information between consumer, providers, payers, and quality monitors (30). Based on an often-cited 2008 report on a small

series of studies conducted at four sites that provide ambulatory care–three U.S.A medical centers and one in the Netherlands the use of Electronic Health Records (EHRs) was viewed as the most promising tool for improving the overall quality, safety and efficiency of the health delivery system. A 2006 report by the Agency for Healthcare Research and broad and consistent utilization of HIT will, (31) Improve health care quality or effectiveness; Increase health care productivity or efficiency; Prevent medical errors and increase health care accuracy and procedural correctness; Reduce health care costs; Increase administrative efficiencies and healthcare work processes; Decrease paperwork and unproductive or idle work time; Extend real-time communications of health informatics among health care professionals; and Expand access to affordable care.

2.4. Theoretical Concepts of Health Management Information System

"HMIS is an organized system of record keeping, reporting, processing, analysis, use and feedback of information which is designed to provide different level of beneficiaries (clients, community, service providers, managers, planners and policymakers) with timely and relevant information necessary to formulate policy, plan, implement, monitor, supervise and evaluate health programmers" (32). Effective and efficient HMIS would provide district health manager with the information required to make effective strategic decision that are the vehicle for district performance and sustainability in those decentralized health systems. Planning and system management HIS resource, include the policy, legislative, regulatory, management and financial environment that must be in place; and the infrastructure and resources required to ensure a fully functional health information system.

The National Health Information System of Ethiopia focuses on the promotion and prevention of disease targeting on primary health care (PHC) services through provision of information for planning and managing the health care system (63). Health promotion and prevention of disease is facilitated with decentralized administration in which Woreda have the mandate to decide on their budget. Thus districts become the most appropriate level for top- down and bottom-up planning and coordinating stakeholder effort through improved health information system (63). Although reliable and timely health information is the foundation of public health action, it is often unavailable due to under-investment in systems for data collection,

analysis, dissemination and use. Consequently, decision-makers cannot identify problems and needs, track progress, evaluate the impact of interventions and make evidence-based decisions on health policy, programme design and resource allocation. The access and use of information by program managers and service providers help resolve bottlenecks and improve program implementation. This eventually leads to improvement in health service delivery and thereby improvement in the health status of the population.

2.5. Tuberculosis Patients Information Systems

TB patients' information system will contribute to reduction of costs, improvement of daily performance ability, operational efficiency, and mostly fundamental prevention of tuberculosis (33). The proposed information-based medical information system will also contribute to solve the problems of current information systems by enabling integration of separated information and by allowing data exchange and sharing through information. The proposed system with application is more efficient than web-based medical information system. This information system itself provides more flexibility and extensibility than previous information systems (33).

2.6. Tuberculosis Care and Control System

Recording and reporting of data is a fundamental component of care of patients with tuberculosis (TB) and control of the disease (34). Data recording and reporting is necessary to monitor trends in the TB epidemic at global, national and sub national levels. To monitor progress in the treatment of individual patients and groups (cohorts) of patients and ensure continuity of care. When patients are referred between health care facilities; and to plan, raise funds for, implement and evaluate programmatic efforts to control TB, including forecasting the numbers of cases and the associated requirements for staffing, medicines and laboratory supplies; and analyzing treatment outcomes. When high-quality data are available, successes can be documented and corrective actions taken to address problems that are identified.

Recording and reporting data about people who have TB symptoms and those who are diagnosed with TB is, nonetheless, a data-intensive process (34). Treatment regimens

span many months (or years in some cases), and patients need to take anti-TB drugs at least a few times a week and often daily. Compliance with treatment must be recorded regularly (daily for drug-resistant treatment and weekly for drug-sensitive treatment). The results of laboratory tests are needed for the microbiological diagnosis of TB; to determine the susceptibility of Mycobacterium tuberculosis isolates to anti-TB drugs; to monitor patient response to medication; and to determine cure or failure of treatment (34).

2.7. Managing and Monitoring Tuberculosis Using Web-Based Tools

Since the invention of the World Wide Web in the early 1990s, technologic advances have revolutionized daily life for people throughout the globe (35). Information communication technology is being increasingly used in health care settings, and has the potential to contribute significantly to health care provision, both as regards cost savings and quality of care. A WHO resolution on eHealth in 2005 encouraged member states to collaborate and provide mutual support for its integration into health systems to improve health care, surveillance, and education. Although there remains a "digital divide" with patchy provision of information communication technology access globally, rapid advances in mobile telephone and wireless technology, and its increasing availability in otherwise resource-limited settings, are improving this situation (35). Integrating control programs with web-enabled applications and wireless communication offers the potential for significant improvements in TB service provision, with major benefits for the global fight against TB. In this review, the researchers describe the broad range of tools and applications available from the Internet or which incorporate real-time electronic data transfer, aimed at improving the management of TB. Web-based tools for TB focus on some key areas. Such as: - diagnosis, treatment, contact tracing and epidemiology, service performance monitoring and quality assurance and teaching and training.

Web-based technology can contribute to care of patients with TB, for example, through use of emails to speed up communication, obtain second opinions, and provide educational materials (35). More complex systems can be used to document and track patients' progress through the treatment process, monitor adherence, detect those at risk of failing follow-up, and improve speed of communication within and between

institutions. At a national level, networked electronic patient records can link into national surveillance systems and also provide a valuable research resource.

2.8. TB Laboratory Information Management Systems.

Laboratory information management systems facilitate the recording and sharing of information regarding samples, results, quality indicators, and instruments. They can also be used to share regulatory and safety information as well as training materials, and a number of open access systems are now available. The ongoing training and maintenance costs are a challenge in resource-poor settings, but if they are linked to improved laboratory networks and prompt timely appropriate treatment in the field, they have the potential to save money. Much work has been done in Peru by Blaya, Fraser, and others to improve TB laboratory services and results management systems, with very clear benefits (36). They demonstrated 87% reduction of reporting errors in health centers using the e-Chasqui electronic laboratory information system compared with those using a paper-based system through reductions in missing results (36). In addition, the use of personal digital assistants resulted in faster processing of sputum smear and TB culture results. However, their work illustrated that the improvements only extended as far as the geographic reach of the electronic hardware introduced, i.e., health centers without direct access to the information system did not benefit, highlighting again the importance of investing in comprehensive information technology infrastructure (37).

In the future, novel web-based technologies may allow the results of diagnostic tests carried out in the field to be integrated rapidly with laboratory information systems. One group described the use of mobile electronic devices both to perform serologic testing for HIV and to upload results automatically to a database in “the cloud”, from where they were synchronized with an electronic health record for patients in Rwanda (38).

2.9. Directly Observed Therapy Monitoring Systems.

A key strategy in global TB control is the use of directly observed therapy to ensure that patients adhere to medication and complete prescribed treatment courses. In areas

of high TB prevalence, however, universal directly observed therapy may be unsustainable due to limited health care staff and infrastructure capacity. The use of electronic medication monitors has been advocated as an adjunct to directly observed therapy. These devices record when medication is removed from the container, thus providing a record of adherence. The simplest devices include a built-in electronic display, but some are able to transmit data to a central point via a telephone or wireless connection, allowing remote monitoring (39). Their use could allow health care workers to target directly observed therapy and treatment counseling to patients who are failing to comply with therapy, and could therefore result in improved treatment adherence, more efficient use of staff time, and increased program cost-effectiveness.

Another recent development includes the use of web-based technology to support directly observed therapy through "video-observed therapy" (40). This is increasingly being used in the USA for selected patients, and has the advantages of reduced travel costs and time for staff, easy regular visual contact, and increased privacy for patients.

2.10. Patient Tracking Systems

Electronic tracking systems to monitor effective treatment and follow-up of patients identified with multidrug-resistant TB or HIV have been reviewed by researchers (41). They concluded that committed community health care workers provided with personal digital assistants or smart phones would be able to trace and treat patients who are lost to follow-up or never initiated treatment, to ensure that treatment courses are completed. The web-based tracking and results system in Peru, also now shared with the Philippines and elsewhere, bring clear benefits in reducing delays and errors, and improving service efficiency, although it is not yet clear if such systems are cost-effective in the long term (42).

2.11. Tuberculosis Patients Improvement System

Appropriate management of TB patients requires a comprehensive approach, including diagnostic facilities, expert healthcare staff, an uninterrupted supply of drugs, and continuing treatment. It also requires improved adherence by TB patients to chemotherapy through health education, community involvement in the social support of TB patients and good case follow-up (43).

At present, the Chronic Care Model (CCM) is considered the standard of care for management of chronic diseases. The model comprises of six interrelated components that interact to promote high-quality care for patients with chronic disease (43). The six components include: healthcare organization, self-management support, delivery-system design, decision support, the community and an information system. The service system at the TB Clinic was improved, in terms of accessibility, waiting time, and provider behavior. The physicians adopted the 5A technique (assess, advise, agree, assist, and arrange) to provide effective self-management support, which included goal-setting, action planning, problem solving, and follow-up (43). This phase also included counseling for TB patients. Communication between doctors and patients was also improved via the delivery-system design. The physicians were well-trained in DOTS, to ensure they could provide effective treatment for TB patients. This was done under the decision-support component of CCM. Care was coordinated by sharing clinical information with patients and providers. Patient appointments were arranged by treatment schedule. The main changes carried out to improve the hospital service system at the TB clinic were (43):

1) Health care organization which include ownership and support, implementation of changes recommended for improvement, the doctors and staff of TB Clinic was not be changed, rewards for good work by healthcare staff at the TB Clinic were given, and adequate supplies of anti-TB drugs were assured.

2) Self-management support - health care staff worked on the concept of the central role of the patient in the management of disease, health care staff used the "5A" approach while working with patients, health care staff provided information about TB, such as the course of treatment, side-effects of the drugs, and preventive measures.

3) Delivery system design - staff duties were made to help them work as a single unit, unnecessary steps for service provision were eliminated, reducing waiting times, a separate waiting room was provided to help patient feel more secure, there was discipline at the TB clinic where every patient waited for his turn by appointment, reports from the laboratory were sent directly to the TB Clinic instead of being handed to patients, which created treatment delays, and scheduled follow-ups reduced default rate.

4) Decision support- the health care staff used up to date knowledge of the TB DOTS program for treatment, health care staff applied the concept of CCM effectively, healthcare staff provided written instructions to patients with a clear date for the next

appointment, staff provided necessary education regarding health problems of the TB patients.

5) Community-fortnightly visits were made by health care staff to selected communities, Linkage of services with community resources were made.

6) Information system - systematic follow-up of TB patients was carried out, timely reminders were given to patients, monthly meetings of health care staff with hospital administration were carried out to solve problems and bring about further improvement.

2.12. Related Works on TB Care Information System

The study conducted in USA (37) showed that managing and monitoring tuberculosis using web-based tools in combination with traditional approaches. Most tuberculosis challenged high levels of drug resistance in many parts of the world, and availability of accurate and rapid diagnostic tests. The increasing availability and reliability of Internet access throughout both affluent and resource-limited countries brings new opportunities to improve TB management and control through the integration of web-based technologies with traditional approaches (37). In this study, they explore current and potential future use of web-based tools in areas of TB diagnosis, treatment, epidemiology, service monitoring, and teaching and training. The purpose of this study was to integrate control programs with web-enabled applications and wireless communication offers the potential for significant improvements in TB service provision (37).

The study conducted in China in 2005 launched a web-based, case-based electronic reporting and recording system for tuberculosis (TB) information management system of the country (34). This study delivered the system with capability of holding TB patients detailed treatment data and treatment outcomes, including demographic information, clinical data and drug susceptibility testing results that are stored using Oracle database.

The study conducted in South Africa on how to completeness and concordance of TB and HIV surveillance systems for TB-HIV co-infected patients .The study focused currently maintains separate surveillance systems for tuberculosis (TB) and human immunodeficiency virus (HIV) in a country (44). There are future plans for integration of these systems; however, the consistency of information across the existing systems has

not previously been assessed. It determined the completeness and concordance of data in the TB and HIV surveillance systems for TB-HIV co-infected patients (44).

Computerized surveillance system of tuberculosis was how to develop to be user-friendly and to allow the evaluation of current TB problems and control issues in Japan. This study not only introduces the new system and its results, but also discusses the role of the TB surveillance system for national TB control. In Japan, the reporting and recording of TB is mandatory under the Act on Prevention of Infectious Diseases and Medical Care for Patients Suffering from Infectious Diseases (the Infectious Diseases Control Law) (45). The proposed system used computerized TB surveillance system. The database of TB surveillance system terminals connected to a central computer through nationwide official private networks (45).

A Case Study conducted on the Web-Based Information Systems Development in New Zealand explores the current software development methodologies used by organizations in developing WWW-based information systems (46). A case study approach is used to investigate, in the context of the organization, how various WWW-based information systems are developed and the reasons why particular strategies are used. The organizations were selected on differences in type, size and information systems developed. The cases were analyzed based on the software process model, methodology, tools and techniques within an organizational context. The core finding of the research was that the development of WWW-based information systems is dominated by the challenges presented by new technology. In addition, organizations take a structured problem solving approach rather than adopting methodologies specifically designed for the WWW. The results of the research also indicated that deficiencies existed in the development strategies used, principally in the area of inadequate guidelines and lack of documentation (46).

A case study conducted on Web Service-based Healthcare Information System (WSHIS) for Interoperability Concern in Healthcare Field in the United Kingdom was a new distributed middleware technology (47).Web Services are applied in the proposed

Healthcare Information System (HIS) to address the issue of system and language interoperability raised from existing Healthcare Information systems. With the development of HISs, hospitals and healthcare institutes have been building various HISs for processing massive healthcare data, such as, systems built up for hospitals under the NHS (National Health Service) to manage patients' records. Nowadays many healthcare providers are willing to integrate their systems' functions and data for information sharing. This has raised concerns in data transmission, data security, and network limitation (47). Among those issues, system and language interoperability are some of the most obvious issues since data and application integration is not an easy task due to differences in programming languages, system platforms, Database Management Systems (DBMS) used within different systems (47). As a new distributed middleware technology, Web service brings an ideal solution to the issue of system and language interoperability. Web service has been approved to be very successful in many commercial applications (e.g. Amazon.com, Dell computer, etc.); however it is different to healthcare information system. As the result, Web Service-based Integrated Healthcare Information System (WSIHIS) is proposed to address the interoperability issue of existing HISs, but also to introduce this new technology into the healthcare environment.

Another study done in Peru A web-based laboratory information system to improve quality of care of tuberculosis patients which occurred in resource-poor settings experience large delays in starting appropriate treatment and may not be monitored appropriately due to an overburdened laboratory system, delays in communication of results, and missing or error-prone laboratory data (48). The objective of this system is to describe an electronic laboratory information system implemented to alleviate these problems and its expanding use by the Peruvian public sector, as well as examine the broader issues of implementing such systems in resource-poor settings (48). The system proposed how to support a web-based laboratory information system "e-Chasqui" has been designed and implemented in Peru to improve the timeliness and quality of laboratory data (48). It was deployed in the national TB laboratory, two regional laboratories and twelve pilot health centers. This system was designed to support a national TB laboratory network connecting all participating institutions. Using needs assessment and workflow analysis tools, e-Chasqui was designed to provide for improved patient care, increased quality control, and more efficient laboratory monitoring and reporting.

CHAPTER THREE

3. METHODOLOGY

3.1. Study Area and period

This project studied Wolkite Town Health office, in the administrative center of the Gurage Zone of the South Nations, Nationalities and Peoples' Region (SNNPR).This Town is located at latitude and longitude of 8^0 17'N 37^0 47'E/ 8.283^0 N 37.783^0 E , and an elevation between 1910 and 1935 meters above sea level. Based on the 2007 census conducted by the Central Statistical Agency, Wolkite Town has a total population of 28,866 of whom 15,074 are men and 13,792 women. Those people get a health service from the health center, which is 155 km away from Addis Ababa in southern direction. This project has been conducted from January up to June 2016 GC.

3.2. Study Design

This Project follows the design science research method (49). This method is used to develop innovative artifacts that solve social problems. Design science is inherently a problem solving process. Using this method solve patient follow up system for treatment, data records and documentation. The design science research method makes the process of developing TB patient follow up system more flexible, easily maintainable and scalable. It also supports the use of an iterative process model which helps to improve the system step by step in a cyclic way until it satisfies the users. It also involves a rigorous process to design artifacts to solve observed problems, to make research contributions, to evaluate the designs, and to communicate the results to appropriate audiences. Such artifacts may include constructs, models, methods, and instantiations. On the other hand, design-science research addresses important unsolved problems in unique or innovative ways or solved problems in more effective or efficient ways. Object oriented analysis and design methodology is used for requirement analysis and design.

3.3. Data Gathering Source

All health workers who were working in the TB department for the last six months, Health Center Manager, TB focal person, TB inpatients and HMIS focal person were all involved in the study.

3.4. Requirements Collection Procedure

This Project identified business and system requirements. The requirement collection procedure was included interview and document analysis at the Health Center.

3.4.1. Interview

The interview sessions were conducted in groups and individually, face-to-face interview in working places. The responses of the respondents were recorded in audio based and taking a short note which was important input for designing a web based TB patients follow up information system.

3.4.2. Document Analysis

Regarding document review made from the health center assess routine data recording, processing and reporting, compiled documents, formats ,patient registration book forms, guidelines and other formats were taken as initial requirement for the system design.

3.5. Data Analysis Procedure

The Unified Modeling Language (UML) technique is the primary modeling language used to analyze, specify, and design new proposed systems .The data collected through interview, observation and document review were summarized by UML modeling at varies phases. The aggregated data were conducted based on the Federal Ministry of Health Tuberculosis Prevention and Control Program Manual.

3.6. System Development Phases

In this study, the Object Oriented system development is followed to develop the system, which includes object oriented analysis and design phases.

The object-oriented methodology views a system as a bottom-up approach to systems development (50). To start with, it describes the system through a set of interacting objects to perform business processes. It uses a set of diagrams or models to represent various views and functionality of a system and is commonly known as Unified Modeling Language or UML. When these models are used along with a particular method of systems development, the OO approach later became known as the Unified process (50).

3.6.1. Object-Oriented Analysis (OOA)

OOA emphasizes an investigation of the problem and requirements, rather than a solution. It concerns with determining the system requirements and identifying classes and their relationships that make up an application. This phase also called requirement analysis. The classes identified in this phase represented using the contextual or class models and also their attributes and relationship are expressed. Therefore the investigator develops the domain model in this phase using one of UML artifacts (class diagram).

3.6.2. Object-Oriented Design (OOD)

The study used OOD to define objects and how they collaborate to fulfill the requirements independent of implementation. During object oriented design phase of the system in this study emphasized on designing web based system objects, classes with their attributes, methods, and interfaces using UML artifacts class diagram. Then designing entity objects in the system database with their attributes and association between entity objects and designing/prototyping user interface for the system where a user in the health facility interacts. More over the design prototype user interface were evaluated based on heuristic evaluation method.

3.7. Analysis and Design Technique

During designing this system were used Unified Modeling Language (UML modeling) for modeling the components of the system. Such as:-

- Contextual diagram:-It shows the entire system in context with its environment. It shows the overall business process as just one process and also shows how a system that is being modeled is positioned in an environment with other systems and processes.
- Use case model: - It is the simplest and most effective technique for modeling system requirements from a user's perspective.
- Design class model:-It shows attribute and methods of the each class.

- Sequence diagram:-It used to describe patterns of communication among set of objects which are participated in the use case. Communication between objects is represented by message passing between the objects.
- System Architecture: - The system uses dynamic web technology, i.e., adding and retrieving data to and from the data store whenever requested is possible.
- ER model:-It is one of the most popularly used semantic data models. A semantic data model refers to a data model that supports a richer set of modeling constructs for representing the semantics of entities, their relationships, and constraints.

3.8. Analysis and Design Tools

Under this project designing a web based TB patients information system Microsoft Visio premium2010 was used as software tool. At system development the implementation and test phase will be use:-

Front end: HTML hyper text markup language is used to create electronic documents (called pages) that are displayed on the World Wide Web (www). CSS (cascading style sheet) allows specifying things. It is the part that lets control the appearance of the web page. HTML also provide a basic structure of the page, up on which CSS are overlaid to change its appearance one could HTML as the bones (structures) of the web page, and CSS as its skin (appearance).

Middle ware: PHP (Personal Home Page) is maintaining personal home page which is communicate with databases. it combined with MY SQL cross -platform.

Back end: is a database language that lets you store and retrieve the data as efficiently as possible. There are many databases that support the use of SQL to access their data.

3.9. Operational Definition

Diagnosis: It is systematic assessment of all the evidence derived from a carful history, clinical examination and relevant investigation.

Evaluation Usability: is itself a process that entails depending on the method employed.

Follow Up: should be assessed two weeks after treatment initiation, at the end of the intensive phase and every two months until treatment completion.

Health Facility: are places that provide health care**.** They include hospital, specialized care center, health centers, and clinics.

Information System: a transformation of data consists of basic fact into an output that is valuable to users.

Patient: people who get service from health facilities.

Treatment Completed: a patient who completed treatment, but who does not have a negative sputum smear or culture result in the last month of treatment and on at least one previous occasion.

Treatment of TB: cure the TB patient and restore quality of life and productivity, prevent death from active TB, prevent the development and transmission of drug resistance.

3.10. Ethical Consideration

The project was carried out after getting permission from the ethical clearance committee of Addis Ababa University, Medical Faculty through School of Public Health. Data were collected after getting written permission from Wolkite Health Center. Information sheet and consent forms were delivered along each interview and all interviewees/respondents had been asked their willingness to participate in requirement gathering; and informed verbal consent would also be obtained from all study participants and from every interviewee after the objective of the study informed.

CHAPTER FOUR

4. DISCUSSION OF RESULTS

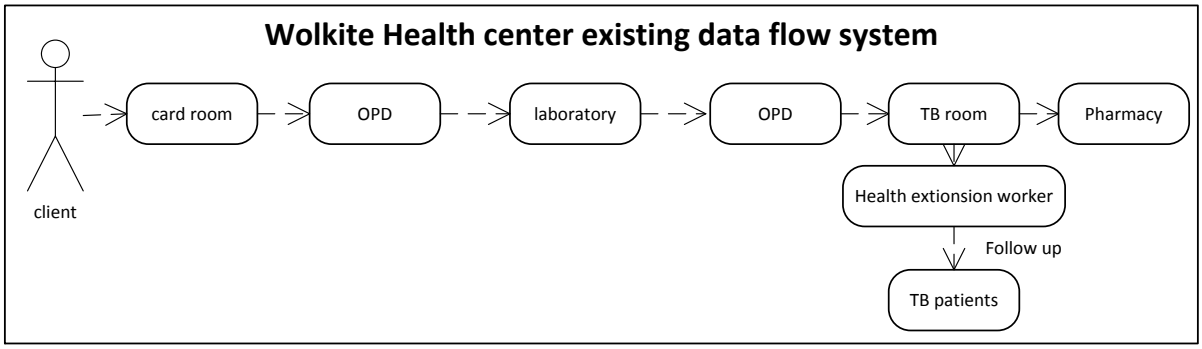
4.1. Introduction

The information about the existing system was collected using in key informant interview and document review. The designer is designing the system by using different techniques. Then raw data was structured using different system modeling tools. Under this chapter the current system, the business process, the functional and non-functional requirements, new system design and evaluation of usability are presented.

4.2. System Analysis

4.2.1 The Current System

The result from the interview shows that the current TB patient follow up information system was managed by manual methods. The Health center existing data flow system shows as follow.



The investigator tried to review the current system of the health facility to identify gaps in the current system. The findings showed problems in data process, reports or communication, procedures, people, software and hardware.

4.2.1.1. Data and Process

The main services delivered by the health centers included Out Patient Department (OPD), Maternal and Child Health Care (MCH), Family planning (FP), Expanded Program of Immunization (EPI); Tuberculosis (TB), Eye Care (EC), Voluntary Counseling and Testing (VCT), Anti Retroviral Treatment(ART) service. The TB Patients follow up treatment systems has intensive and continuation phases. The intensive phase starts from day one of the TB treatment, aimed to prevent the emergence of drug resistance and determines the ultimate

outcome of the regimen. This phase usually lasts two months and is followed by the continuation phase which is important to ensure or completion treatment and necessary in order to avoid relapse after completion of treatment.

In the health Center data and information processing of the existing system are addressed the following points. Information processed in the current system held manual or paper-based record system. This sub-system maintains data about individual TB patients history , clinical data (e.g. date of TB diagnosis, TB treatment phases, HIV test result, previous treatment history), bacteriological data (e.g. sputum smear and culture results), drug susceptibility testing results and treatment outcomes (e.g. cured, treatment completed, died, failure, defaulter and transferred). All other forms (clinical records such as TB treatment cards and discharge letters, registers of contacts and TB suspects, referrals, requests for investigations, prescriptions, drugs and laboratory supplies order forms) remain paper-based. All patient data are recorded based on national standard TB prevention and control program manual. In the facility individual patients file stored in TB room.

The following problems identified during patients follow up and treatment regimen (51):-

- The patients did not take medication at the right time.
- Sometimes the patients did not finish the anti TB drug which is the case to relapse, failure or defaulter.
- Changing address (living place kebele or house).
- The patient coming from surrounding woreda kebeles faced transportation problem
- The patients assume fully cured from the disease.
- Forget to take medication.
- The patients need day to day follow-up and counseling.

4.2.1.2. Communication

Reporting is used to systematically monitor and evaluate progress of patients and treatment outcome as well as the overall program performance. The report generated from previously recorded TB registration book. In the health center (in facility), there is no system to support for data analysis in the existing system. The TB focal person undertakes data analysis using health center clinic service quarterly delivery report form. The reporting of TB and TB/HIV collaborative activities is integrated into HMIS and all forms and registers are standardized. He /She needs Tuberculosis case detection rate (all forms), Tuberculosis retreatment rate, Tuberculosis treatment outcome, TB case detection through community TB care, proportion of TB case(all forms) provided treatment observation (DOT) by community among all TB cases ,number of MDR TB case detection and etc. Reports are prepared monthly in printed

format on patient information submitted to facility HMIS focal person, and quarterly submitted to health unit and zone health department for TB coordinators. Communication is made only using paper based recorded documents.

4.2.1.3. People

The health center TB focal person can access and modify any information system concerning Tuberculosis patient data in existing system (51). During patient data recording, the focal person is a responsible for any errors and missing values. The TB focal person is accountable and responsible to make reports as acquired by stakeholder. The health center has two IT professionals who enter the data to HMIS formats and maintain the existing system. Most of the health professionals have no computer skill within the health center.

4.2.1.4. Procedure

TB control staff in the health center is familiar with the existing health information policies and procedures .The existing systems contains the following procedures.

- Patient sputum smear examination request should be registered ,
- Laboratory diagnosis result should be registered,
- TB suspect patient should be registered in log book,
- The TB patient should take the medication every morning at health center ,
- TB patient treatment follow up should be monitored by Health Worker and kebele HEWs.

4.2.1.5. Software

The health center has been planned to train their health workers about computer skill to improve health information system and specific soft ware application. But, currently there is no any applicable soft ware to improve TB patients follow up system and no computer network for sharing information.

4.2.1.6. Hardware

The health center currently has six computers which located in facility head, ART, OPD, Eye Care, HMIS and secretary. They use this computer for the purpose of preparing report, data records and writing letters.

4.3. The Proposed System

The proposed new system is applicable at the health facility to TB patients follow up information system. The Web client provides an interface that will allows the professional users on the health care provider side to visualize, navigate, and analyze patient and text message data (52).

This proposed system would have great importance and will be used as patient's data record management system; patients follow up system and report generating system. Depending on assessment of the current system the investigator finding new system that will enable the patients to remind the taking medication on a recommended time, remind the appointment schedule date and generate the reports. Additionally this system will solve the problem of patients treatment success rate i.e. relapse failure, defaulter.

4.3.1. User Requirements

User requirements (also called Stakeholder requirements) describe the tasks the users must able to accomplish with the product (53). It is defines abstract requirements describing the system services which people need to use the system and to integrate it with their business processes. User requirements are usually captured in use cases or scenario descriptions. Apparently the user requirements represent the system's behavior from the user's point of view.

4.3.2. Stakeholders

Stakeholders are individuals or organizations that could influence or be influenced directly or indirectly by the system.

Table 1: Stakeholder Roles and Responsibility

s.n	Stakeholders	Role and Responsibilities
1	System Administrator	➢ Responsible for organizational structure, creating and updating user account, set up registration form, set up patient identification number, set up patient treatments.
2	TB focal Person	➢ Responsible for TB patients information registry, ➢ Responsible to record TB treatment on patient cards ➢ Responsible for reminding the patients, ➢ Responsible for requesting the system to generate reports
3	Health professionals	➢ Responsible for patients to inform about the dangers of irregular or incomplete treatments. ➢ Responsible for providing follow up every patient takes the recommended drugs in the right combination, on the correct schedule, and for the appropriate duration.
4	Patients	➢ Responsible to provide appropriate information and address ➢ Responsible for coming at schedule , ➢ Responsible to take a medication on recommended duration and time ➢ Responsible to consultation with health worker for the status of his/her health
5	HEWs	➢ Responsible for Screening of contacts of TB patients ➢ Responsible for Identify and refer TB suspects ➢ Continuously health education TB patients ➢ Support and motivate TB patents.
6	Physician	➢ Responsible to train and support TB treatment supporters ➢ Provide timely feedback to health workers ➢ responsible for Supply anti TB drugs ➢ Facilitate adequate supply of recording and reporting materials
7	Laboratory technician	➢ Responsible for providing patient diagnosis result

4.3.3. Software Requirements

Software requirements consist of all the requirements the software must demonstrate for the system to meet the user requirements (53). They are derived from analysis of user requirements. Software requirements include the so-called functional requirements and non-functional requirements.

4.3.4. Functional Requirements

Functional requirements (behavior requirements) define what the system does, namely, the functions (actions) of the system (53). They describe all the inputs and outputs to and from the system as well as information concerning how the inputs and outputs interrelate.

Table 2: Functional Requirements

ReqID	Requirement Description	Use case
RQ-1	The system should identification of user and administrator	UC-1
RQ-2	The system should enable legal user log in to the application	UC-2
RQ-3	The system should enable the users (data clerk, TB focal person) to register individual patients information	UC-3
RQ-4	The system should enable the health professionals to show patient information	UC-6
RQ-5	The system should enable the users (TB focal person, health professional, physician, HEWs) to track patients' demographic information.	UC-6
RQ-6	The system should enable the TB focal person to follow up treatment	UC-6
RQ-7	The system should enable the users (TB focal person, physician) to view the health laboratory diagnosis result request.	UC-5
RQ-8	The system should enable the TB focal person to show previously ordered patients medication.	UC-4
RQ-9	The system should enable the user to send schedule dates for patients check up	UC-8
RQ-10	The system should send the remind medication for patients	UC-7
RQ-11	The system should enable the system administrator for HEWs to remind patients schedule dates	UC-8
RQ-12	The system should generate monthly and quarterly standard reports	UC-9
RQ-13	The system should enable the administrator create, delete update facility user account	UC-1
RQ-14	The system should enable the health center head manage the facility services	UC-2

Remark: RQ =Requirement Id, UC=Use Case Id

4.3.5. Non-Functional Requirements

Non-functional requirements define the constraints of the system as it performs its functional requirements (53). They include a description of the system's usability, reliability, performance, security, maintainability, portability, implementation, interface, operations, packaging and legal obligations.

4.3.6. Contextual Model for New System

Context-aware systems are applications that adapt to several situations involving user, network, data, hardware and the application itself. Researchers in context-awareness have concentrated on how to capture context data and to carry it to the application (54). Data centered applications exchange information with users at different levels of detail, content and presentation according to several parameters which depend on the user and the environment.

Figure 1 present the context diagram of the proposed system, which is a top level view of the information system that shows the system's boundaries and scope. It also shows how the interfaces with the outside world.

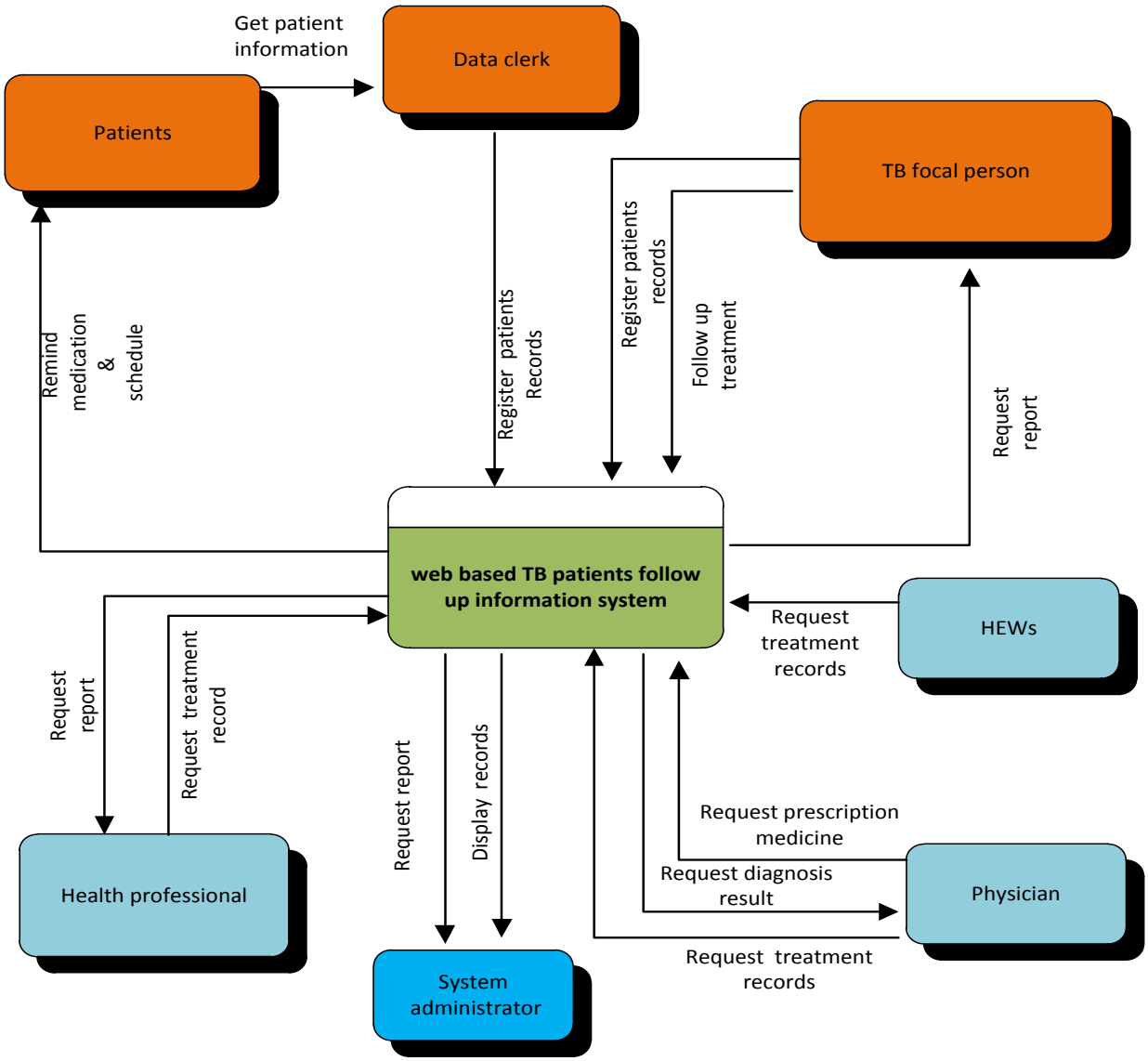


Figure 1: Contextual Model for New System

4.3.7. Use Case Modeling

Use cases are the primary drivers for all of the UML diagramming techniques (55). The use case communicates at a high level what the system needs to do, and all of the UML diagramming techniques build on this by presenting the use case functionality in a different way for a different purpose. Use cases capture the typical interaction of the system with the system's users (end users and other systems). These interactions represent the external, or functional, view of the system from the perspective of the user.

4.3.7.1. Use Case Diagram

A use case illustrates a unit of functionality provided by the system. The main purpose of the use-case diagram is to help development teams visualize the functions of a system, including the relationship of "actors" (human beings who will interact with the system) to essential processes, as well as the relationships among different use cases. Use-case diagrams generally show groups of use cases either all use cases for the complete system, or a breakout of a particular group of use cases with related (55). Use simple lines to depict relationships between actors and use cases, as shown in Figure 2.

4.3.7.2. Use case System Analysis Models

A use case diagram illustrates in a very simple way the main functions of the system and the different kinds of users that will interact with it (55). Use cases are used to describe the functionality of the system and as a model of the dialog between the actors and the system. It is important to remember that use cases are used for both as-is and to-be behavioral models. As-is use cases focus on the current system, while to-be use cases focus on the desired new system (55).A use case describes a function provided by the system that yields a visible result to the actors. In the proposed system, the following actors and use cases are identified. Figure 2 shows use case diagram of the system. List of Identified actor and use cases.

The following actors have identified to interact with the proposed system:

- Data Clerk
- Administrator
- TB Focal Person
- Physician
- Health Professional
- HEWs

Additionally the designer has identified the following use cases for the new proposed system:

- Login
- manage user account
- Registration TB patient
- Request diagnosis result

- prescription medicine
- Follow up anti TB treatment
- Remind medication
- Remind patients schedule dates
- Generate TB patient reports

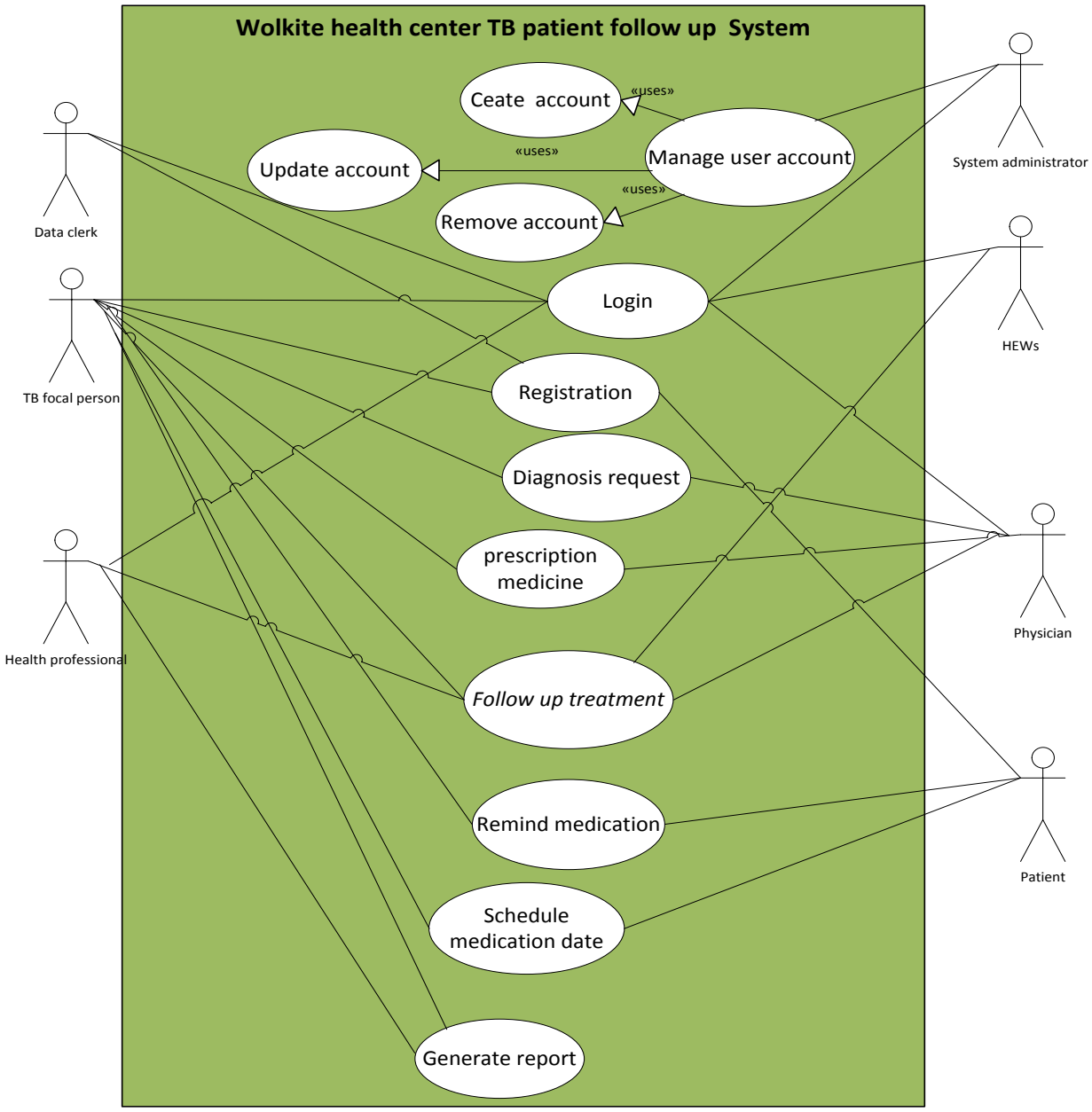


Figure 2:Use Case Diagram For TB Patient Follow Up System

4.3.7.3. Use Case Narrations

The use cases narrations are used to describe each process identified in a use case diagram. It is a significance to make the end user to understand the process of the system.

Table 3: Manage User Account Use Case

Use case ID	UC-1
Use Case Title	Manage user account
Use case Description	This use case describes the user to administer their personal information.
Primary Actor	System Administrator
Trigger	The administrator login into the system
Pre-Conditions	The account of user must exist and authorized
Post-Conditions	The system manage the user account
Main scenario	1. The system displays main menu user interface 2. The administrator open user account option 3. The system displays user account list 4. The administrator select the list user account information 5. The system confirms the inserted /updated/removed records 6. Ends use case
Alternative courses	4a. If the user wants to create account for user records. a. The user click on create account button. b. The system displays a form to create the user account. c. The user fills the required information and click on submit button. d. The system confirms the inserted data. e. The system saves new account. 4a.1. If the user wants to remove the user account. a. Select and click the user account. b. The system displays confirm account remove c. The user clicks confirm remove button. d. The system removes the selected user account from the database
Frequency of Use	>25 /months

Table 4 :Login use case

Use case ID	UC-2
Use Case Title	Login
Use case Description	This use case describes the user enable to enter into the system
Primary Actor	Users (TB focal person, Data clerk, system administrator, health professional, HEWs, physician)
Trigger	The users of the system logs into the application with the user username and password
Pre-Conditions	The user has known user name and password which is existed within the system.
Post-Conditions	The system displays system main menu interface.
Main scenario	1. The system display main menu login window 2. The users click login button. 3. The system displays login interface 4. The users enters the username and password 5. The system verifies the username and password 6. The user logged in to the system then system will display the main menu interface. 7. Use case ends
Alternative courses	4a. If the username or password is wrong 4a.1.The user is returned to step 3 and re-enters user name and password
Frequency of Use	>20 /months
Business rule	The system allows accessing the system. If the user fails to enter valid Username or password, the system locks for 120 seconds automatically.

Table 5:Registration use case

Use case ID	UC-3
Use Case Title	Registration
Use case Description	This use case describes the process of patient registration information system.
Primary Actor	Users (Data clerk , TB focal person and HEWs)
Trigger	User open new patient registration form to record
Pre-Conditions	The user is logged into the system.
Post-Conditions	The system registered patient information in to the database
Main scenario	1. The system displays user interface or user home page 2. The user click registration link from the user main menu 3. the system displays registration form 4. The user fills patient information on the patient registration form and save the records 5. The system verifies the information 6. Use case ends
Alternative courses	4a.If the patient is already registered on the system 4a.1. The system shows messages to enter patient Id and retrieved previous patient records. 4b. If the patient is a new 4b.1.The user add the registration form 5a. If the user clicks on cancel button 5a.1 The system return to the main menu
Frequency of Use	9-15/months

Table 6:Prescription Medicine use case

Use case ID	UC-4
Use Case Title	Prescription medicine
Use case Description	This use case describes the health worker/physician provided/prescribed medicine to the patients.
Primary Actor	Users (TB focal person ,physician)
Trigger	The user receives and access detail patient history information to prescribed medicine.
Pre-Conditions	The user is logged into the system.
Post-Conditions	The patient detail information is available in the database system and retrieves prescription.
Main scenario	1. The system displays prescription medicine main menu user interface 2. The user selects prescription medicine from the main menu option 3. The system displays the prescription medicine form 4. The user click on Add button 5. System displays the prescription medicine detail form 6. The user fills and marks prescription medicine records and click save button 7. The system saves or stored the prescription medicine records on the database.
Alternative courses	4a.If the patient is already provided the prescription medicine records 4a.1 The user search previous prescription medicine records from the system 6a. If the user clicks on cancel button 6a.1 The system return to the main menu 6a.2. If the user clicks on reset button 6a.2.1. The system clear the input box
Frequency of Use	9-15/months

Table 7:diagnosis request use case

Use case ID	UC-5
Use Case Title	Diagnosis request
Use case Description	This use case describes the processes of relevant investigation patient information recording system
Primary Actor	Users (Health professional, TB focal person, physician)
Trigger	The system display assessed patient detail information from the database system
Pre-Conditions	The user is logged into the system.
Post-Conditions	The diagnosis request information is available in the database system
Main scenario	1. The system displays users main menu or user home page 2. The user selects diagnosis from the user main menu option 3. The system displays diagnosis recording form 4. The user fills and marks in diagnosis form with complete information and click save button. 5 The system save or stored the diagnosis information on the database 6. Use case ends
Alternative courses	4a. If the patient is new admitted , 4a.1 The user adds new diagnosis form. 4a.2 if the patient already exist on the database, 4a.2.1 the user enter diagnosis no 4a.2.2 The system retrieves previous patient records on the database. 5a. If the user clicks on cancel button 5a.1 The system return to the main menu 5a.2. If the user clicks on reset button 5a.2.1. The system clear the input box
Frequency of	>90/months

Table 8:Use case for Patients treatment follow up

Use case ID	UC-6
Use Case Title	Treatment follow up
Use case Description	This use case describes the processes of the assessment and management of patient information system
Primary Actor	Users (Health professional, TB focal person, physician)
Trigger	1. The system assess patients history registered in database system
Pre-Conditions	1. The user is logged into the system. 2. The system display treatment intervention information.
Post-Conditions	The patients treatment follow up information is available in the database system
Main scenario	1. The system displays users main menu or user home page 2. The user selects treatment follow up link in the user main menu option 3. The system displays intensive and continues treatment follow up phase form 4. The user fills in treatment follow up form with complete records and click on the save button 5. The system save or stored the treatment follow up records on the database 6. Use case ends
Alternative courses	4a. if the patient already exist on the database 4a.1 the system retrieve records from database 4b. if the user new admitted 4b.1 the system adds and updates the existing information on the patient Database. 5a. If the user clicks on cancel button 5a.1 The system return to the main menu
Frequency of Use	>96/months

Table 9:Use case for Patients remind medication

Use case ID	UC-7
Use Case Title	Reminder medication
Use case Description	This use case describes the process of sending reminder text message for medication recording process
Primary Actor	Users (TB focal person, patient)
Trigger	The user logged into the system The system assess patients completed medication time which is registered in the database
Pre-Conditions	The system should have registered medication time
Post-Conditions	The system send automatically a text messages remind for medication and local level health workers or HEWs through their mobile phone address
Main scenario	1. The system displays users main menu or user home page 2. The user selects remind medication from the main menu option 3. the system displays remind medication time form. 4. The user fill patient reminds medication time form. 5. The user clicks on the alert message wizard and write a text message. 6. The user click on send button into the system. 7. The system send automatically mobile text message to the patient or HEWs in the day. 8. Use case ends
Alternative courses	7a. If the patients forget to take medication on recommended time and place 7a.1 The system automatically send alert mobile text message to patients and HEWs with their address. 7a.1.1 If user ignores the text message 7a.1.2 The system automatically send text message to contact person
Frequency of Use	>96/months

Table 10: Use case for Patients remind schedule dates

Use case ID	UC-8
Use Case Title	Send schedule dates
Use case Description	This use case describes the process of sending reminder text message patients for check up diagnosis and next medication time
Primary Actor	Users (TB focal person, patients)
Trigger	The user logged into the system The system displays patient records to be remind for check up diagnosis
Pre-Conditions	The system should have registered patient schedule records in data base
Post-Conditions	The system send automatically a text messages to remind schedule date for registered patients and local level health workers or HEWs through their mobile address
Main scenario	1. The system displays users main menu or user home page 2. The user selects schedule date from the main menu option 3. The system displays date schedule date form. 4. The users fill patient id and date. 5. The user click on the alert message wizard and write a text message. 6. The user click on send button into the system. 7. The system automatically send mobile text message. 8. ends use case
Alternative courses	4a. If the patients miss the schedule date 4a.1 The system automatically send alert mobile text message to patients and HEWs with their address. 4a.1.1 If the user ignores the schedule date 4a.1.2 The system automatically send schedule date to contact person
Frequency of Use	96/months

Table 11: Use case for Patients report

Use case ID	UC-9
Use Case Title	Generate Standard report
Use case Description	This use case describes the process of producing an electronic standard report
Primary Actor	Users (TB focal person, health professional)
Trigger	The user logged into the system The user able to generate report by selecting the report option
Pre-Conditions	1. The user is logged in to the system. 2. All data registered in data base system to generate report
Post-Conditions	The system generate standard reports
Main scenario	1. The system displays main menu user interface 2. The users selects the report from menu option 3. The system displays all data records 4. The users selects and marks the data records to be generated and click on generate button 5. The system generates the report from the database system and displays documented report. 6. The user click save button. 7. The system saved the data on data base 8. End use case
Alternative courses	7a. If the user clicks on export button 7a .1.The system export the report 7b.If the user clicks on print button 7b .1.The system print out the report 7c. If the user clicks on cancel button 7c .1.The system return to the main menu
Frequency of Use	4/months

4.4. Design the System

4.4.1. Design Class Diagram

The class diagram shows how the different entities (people, things, and data) relate to each other; in other words, it shows the static structures of the system. A class diagram can be used to display logical classes (56). The designer develops the class diagram for design TB patients follow up information system as follows in tables 12.

Table 12: The concept of class diagram attribute and method

Concept	Attribute	methods
Manage User Account	User Id User First Name User Last Name User Password User Type	Login Add User Remove User Update User
Administrator	User Type Admin First Name Admin Last Name User Name Password	Login Add user Remove user Update user
Employee	Employee Id Employee First Name Employee Last Name Password Employee Type	Login Update Show report
Registration	Register Patient Id Register Date Patient First Name Patient Last Name Weight Mobile No	Get: string () Set: void ()

Concept	Attribute	methods
Follow up	Follow up No Follow up Date Follow up Type Treatment Outcome Type	Get: string () Set: void ()
Remind Medication	Medication No Medication Date Medication Type Prescribed Medicine Hews Mobile No Facility Name Patient Address	Get: string () Set: void ()
Remind Schedule Date	Schedule No Schedule Date Schedule Type Patient Address	Get: string () Set: void ()
Report	Report No Report Date Report Type User Type	Submit() Display () Get: string () Set: void ()
Diagnosis	Diagnosis No Diagnosis Date Diagnosis Type Diagnosis Result	Get: string () Set: void ()
Prescription medicine	Prescription No Prescribed Date Prescription Type Patient First Name	Get: string () Set: void ()

Designing the TB patient follow up information system create the software classes. During the analysis, after defining the use case model, the designer came up with a set of conceptual classes and a conceptual class diagram for the entire system. As mentioned earlier, these come from a conceptual or essential perspective. The software classes are more 'concrete' in that they correspond to the software components that make up the system. In this phase there are two major activities.

1. Come up with a set of classes.
2. Assign responsibilities to the classes and determine the necessary data structures and methods.

In general, it is unlikely that the designer can come up with a design simply by doing these activities exactly once. Several iterations may be needed and classes may need to be added, split, combined, or eliminated. In the analysis, the designer came up with a set of conceptual classes and relationships (57). Based on the identified concept and attribute in the above table12, the designer demonstrate the class diagram for designing TB patients follow up information system as following in Figure 3.

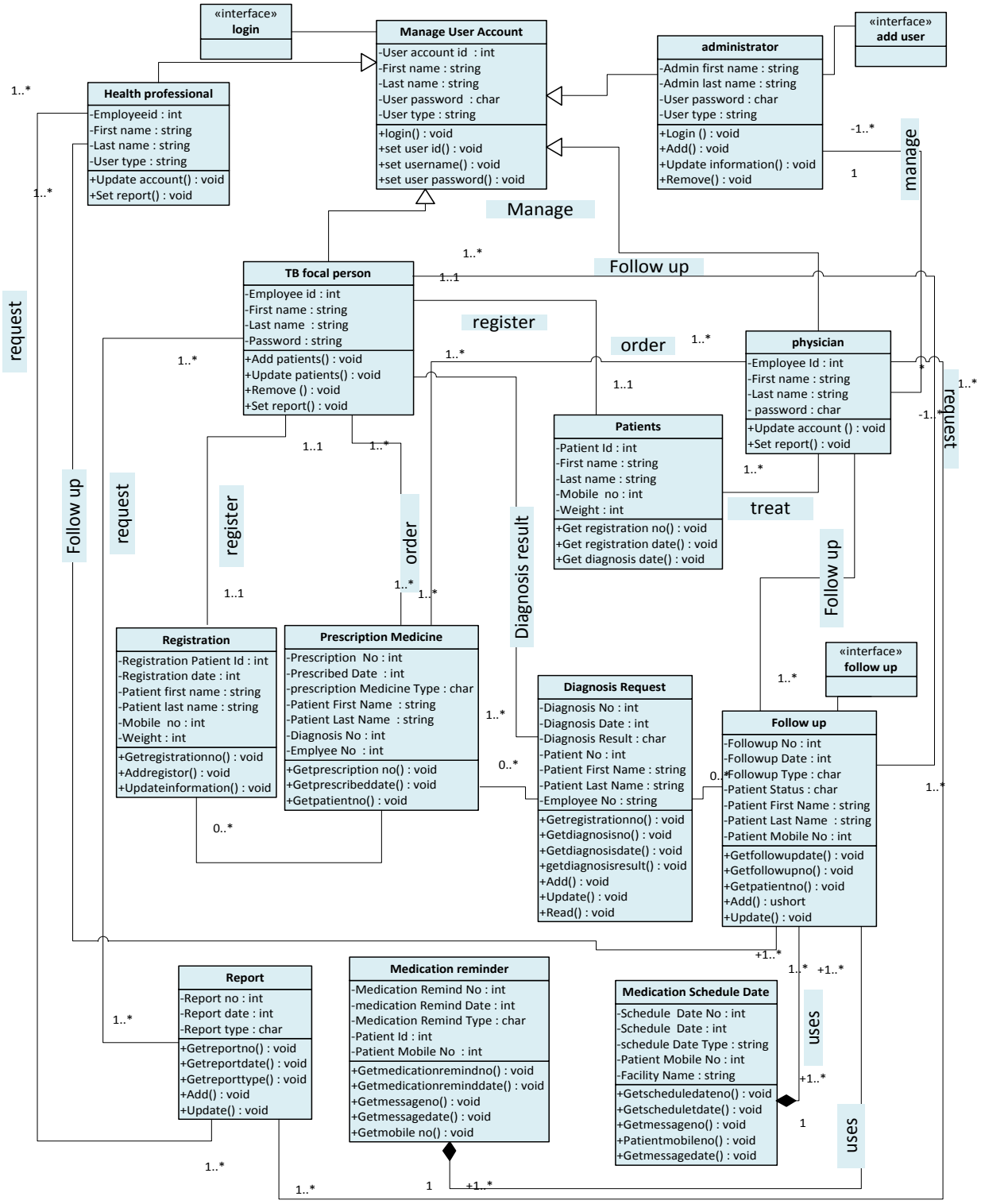


Figure 3: Design Class Diagram

4.4.2. Sequence Diagram

Sequence diagrams: A sequence diagram is an interaction diagram that details exchange of messages among classes.. Sequence diagrams are organized according to time. Time progresses as you go down the page. Each vertical line is labeled at the top with the class name followed by a colon followed by the instance name. The objects involved in the operation are listed from left to right according to when they take part in the message sequence (57).

The diagram captures the behavior of a single use case. It shows objects and the messages that are passed between these objects in the use case.

A good design can have lots of small methods in different classes. Because of this it can be difficult to figure out the overall sequence of behavior. This diagram is simple and visually logical, so it is easy to see the sequence of the flow of control. The use case is runs in the server side in the following figure 4.

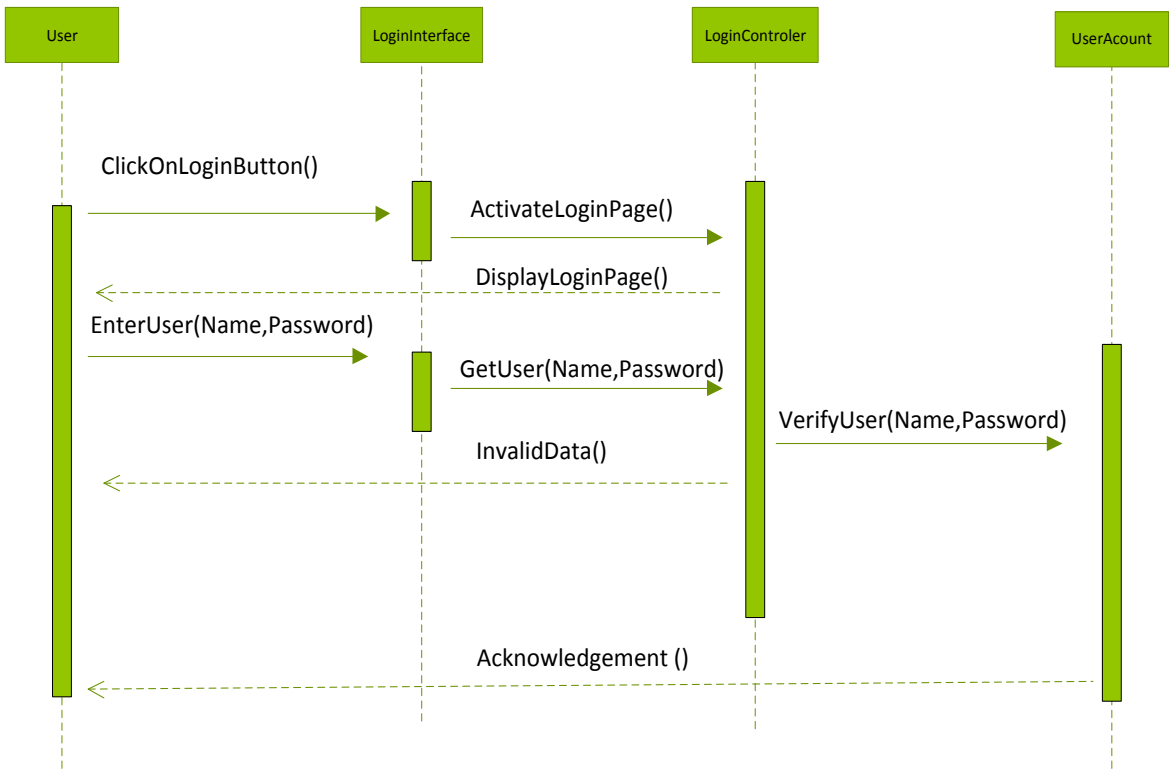


Figure 4: Log in sequence diagram

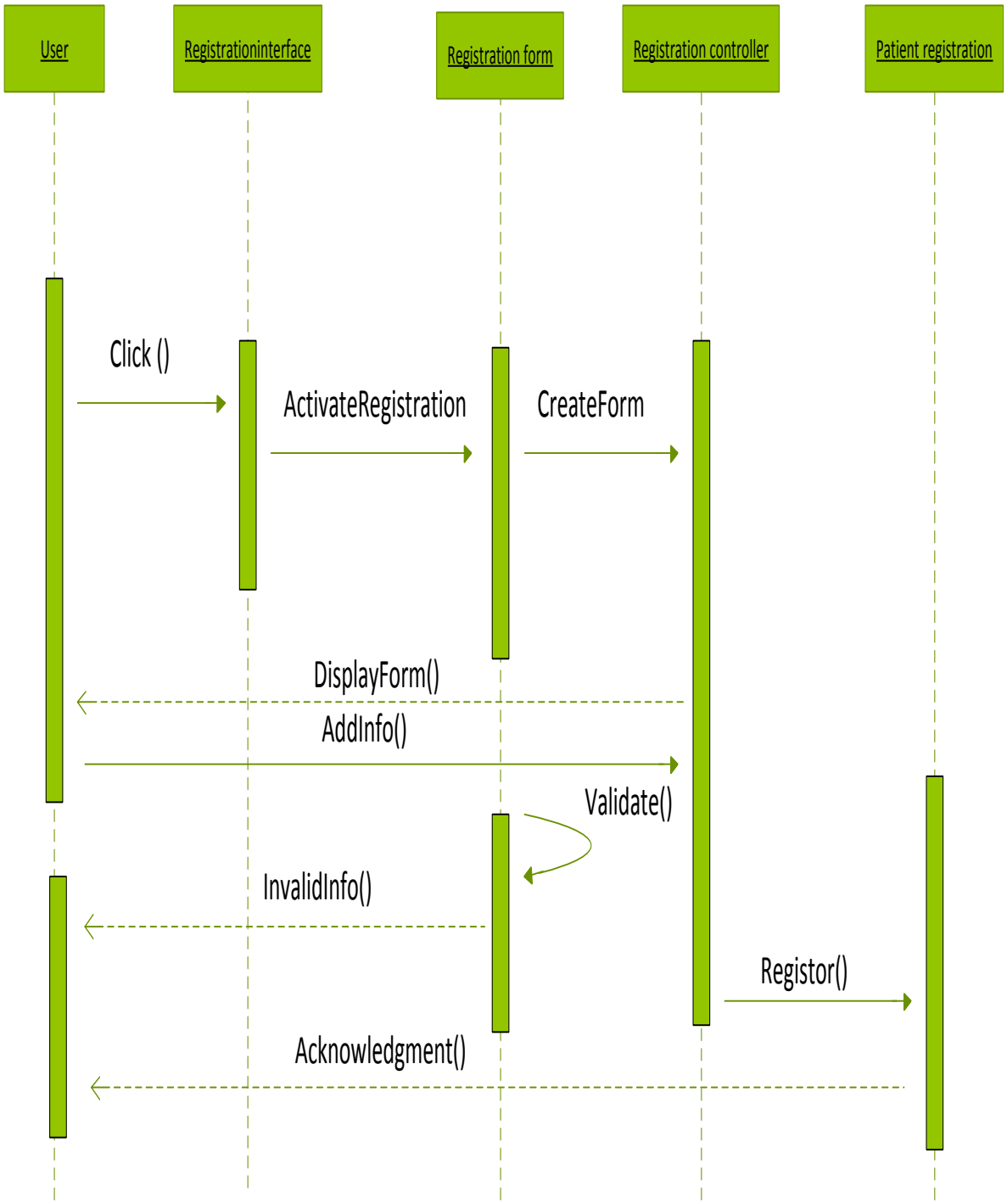


Figure 5:Registration sequence diagram

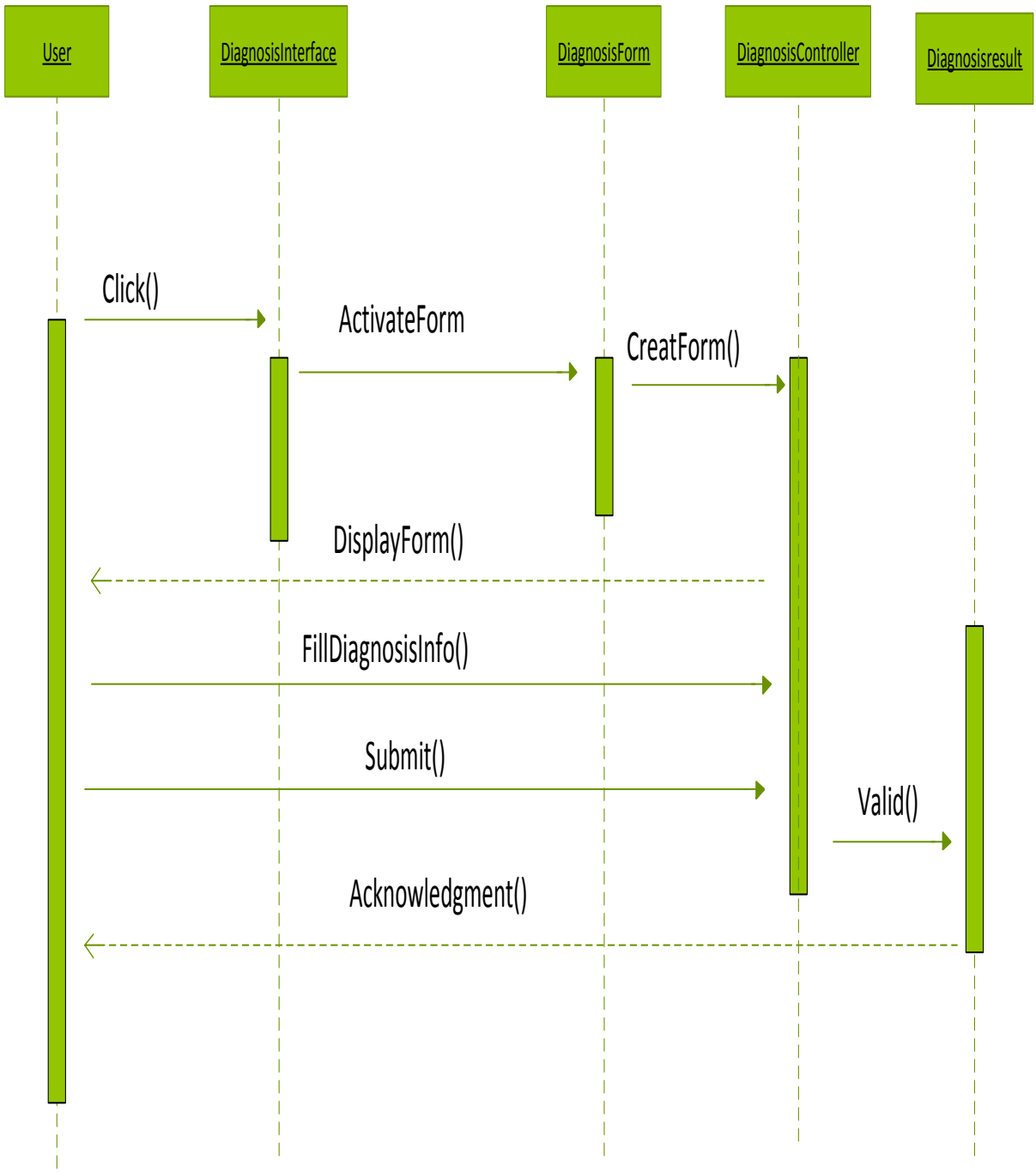


Figure 6:Diagnosis request sequence diagram

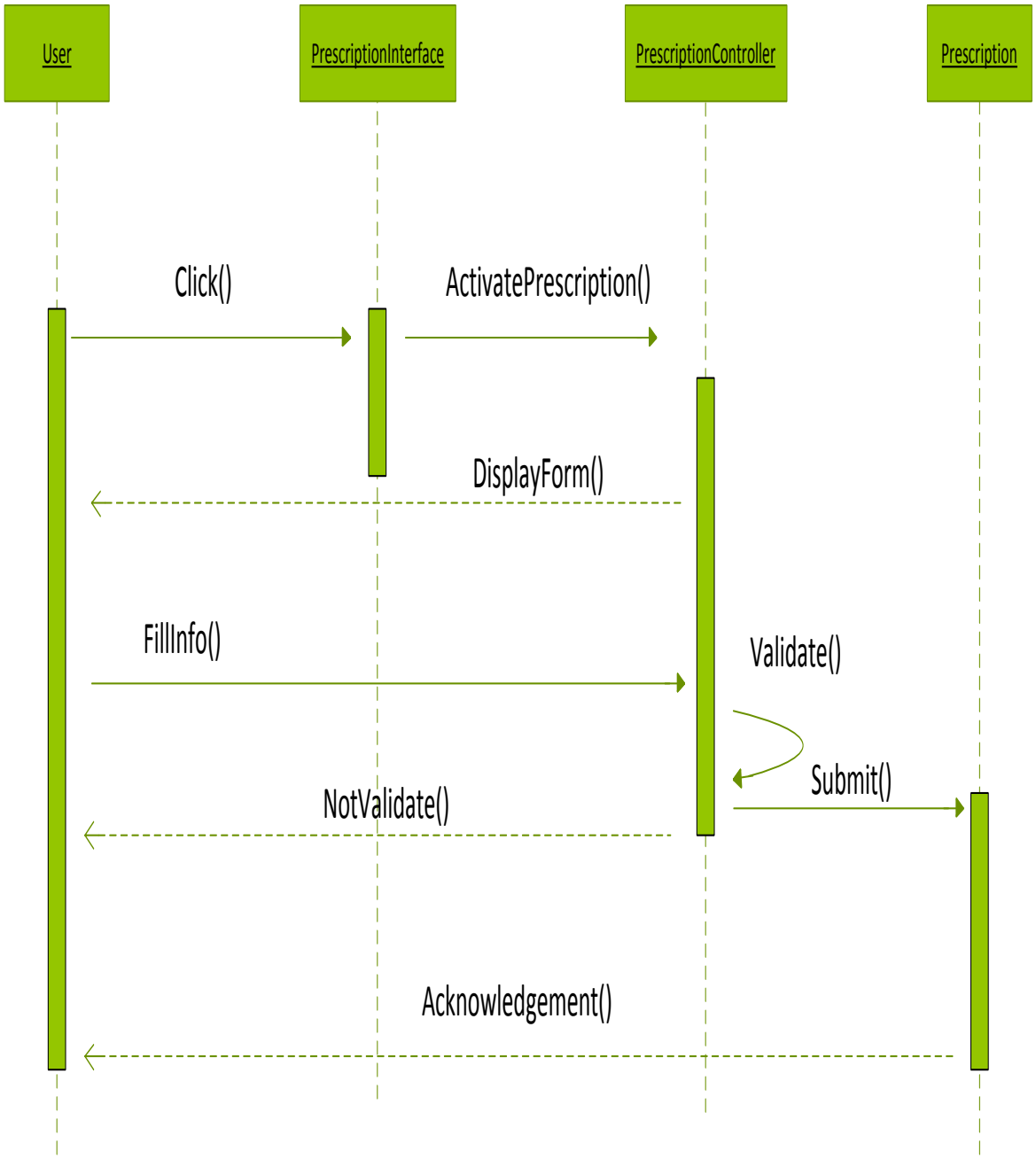


Figure 7:Prescription Medicine Sequence Diagram

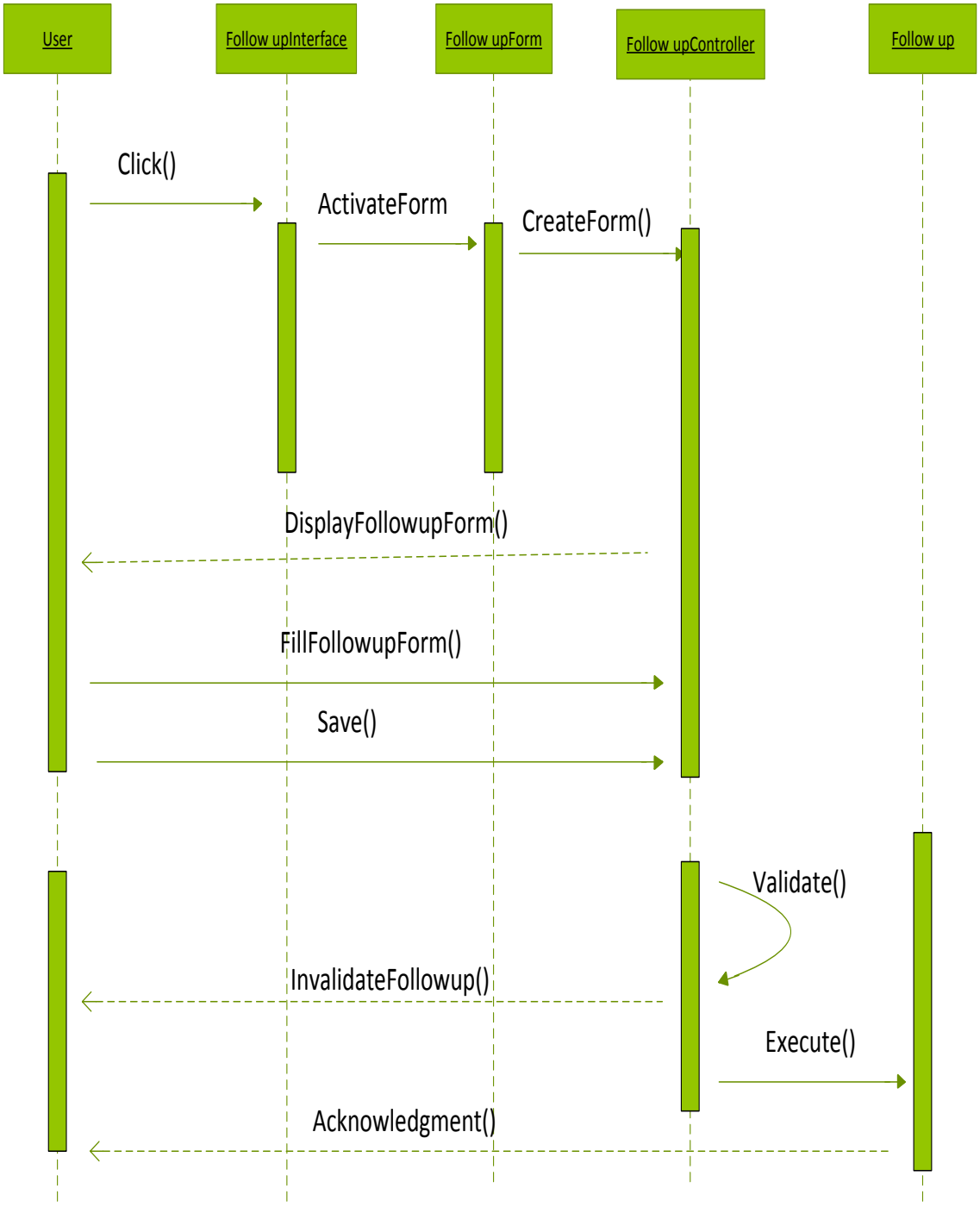


Figure 8:Follow Up Sequence Diagram

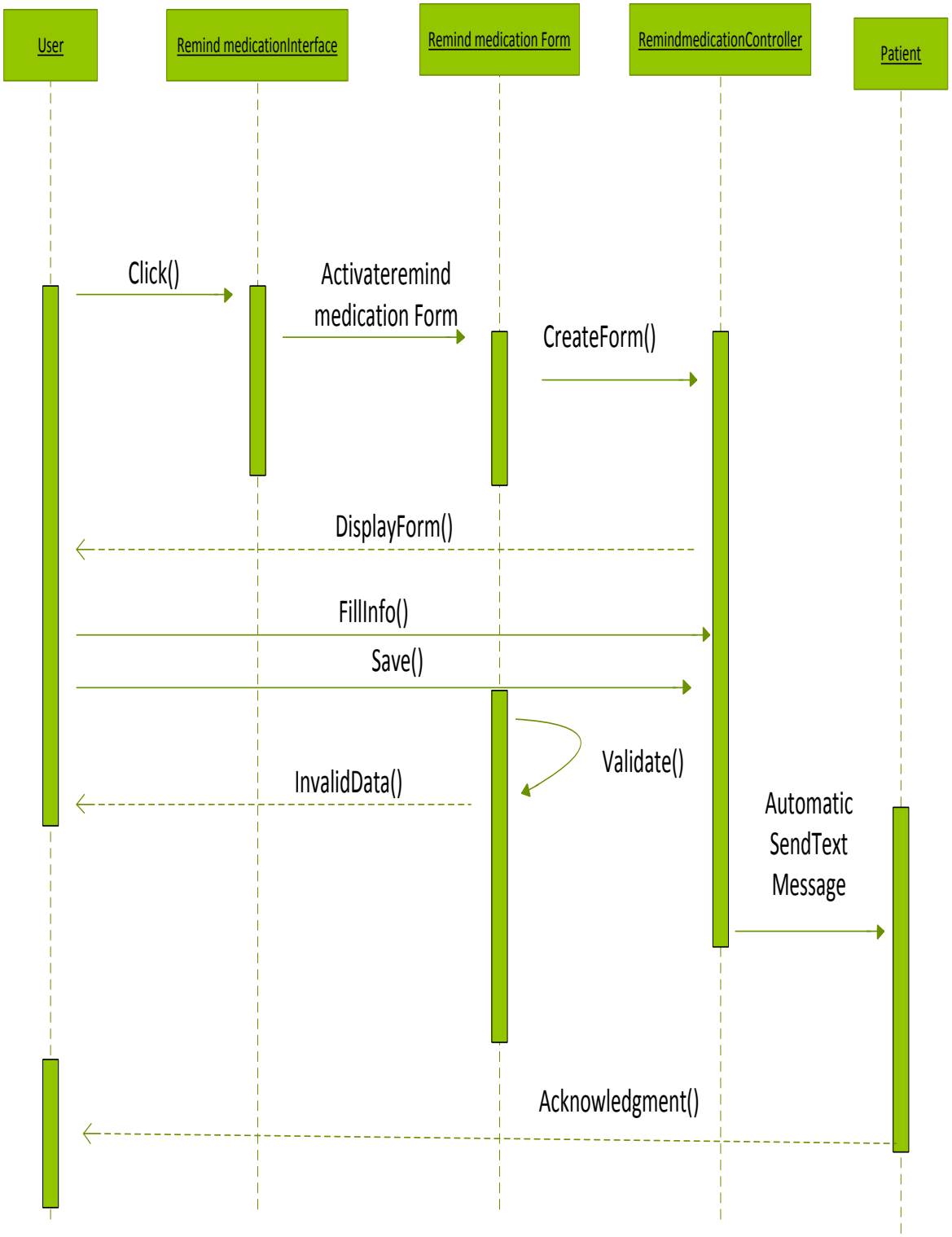


Figure 9: Medication Remind Sequence Diagram

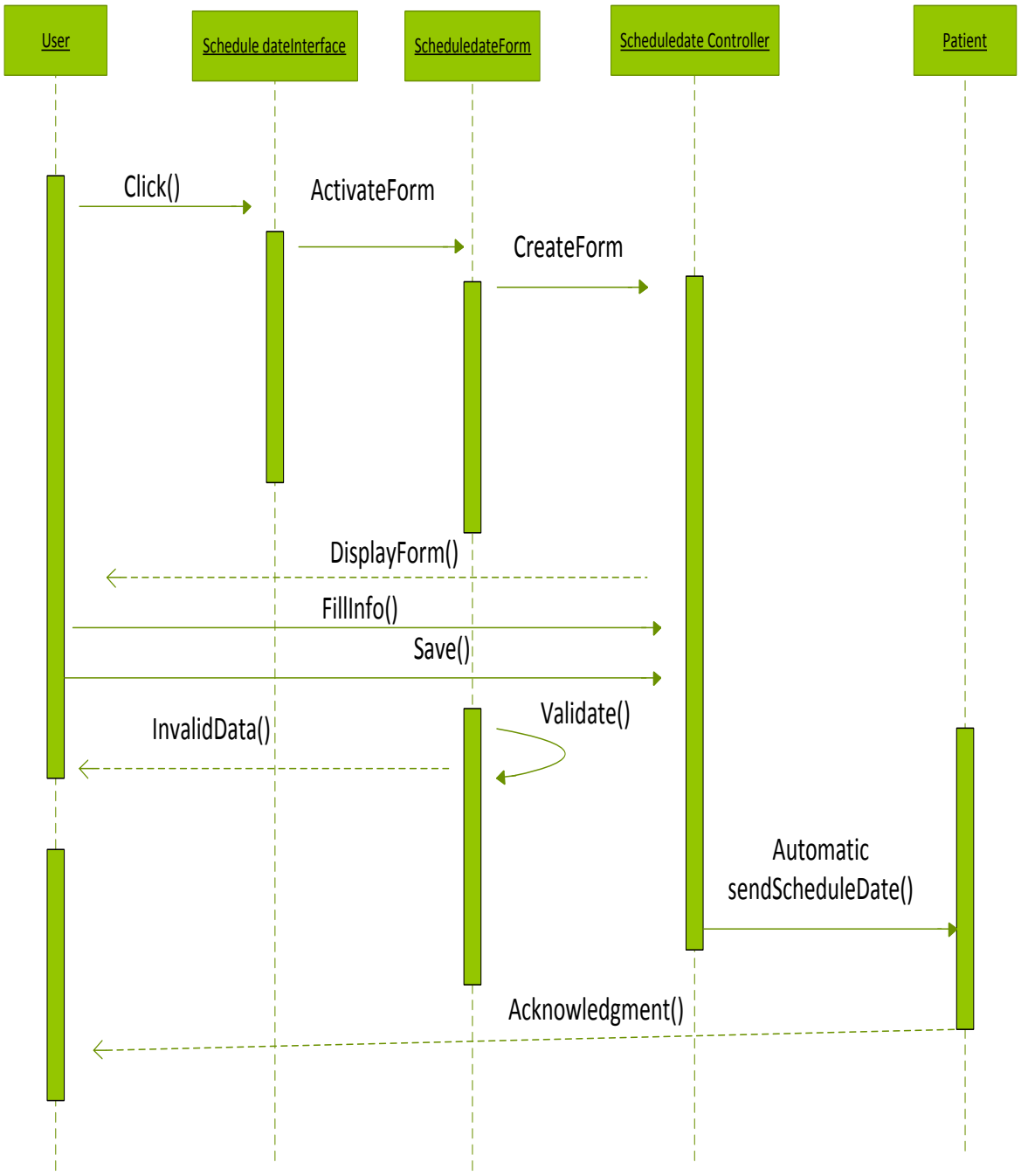


Figure 10:Remind schedule date sequence diagram

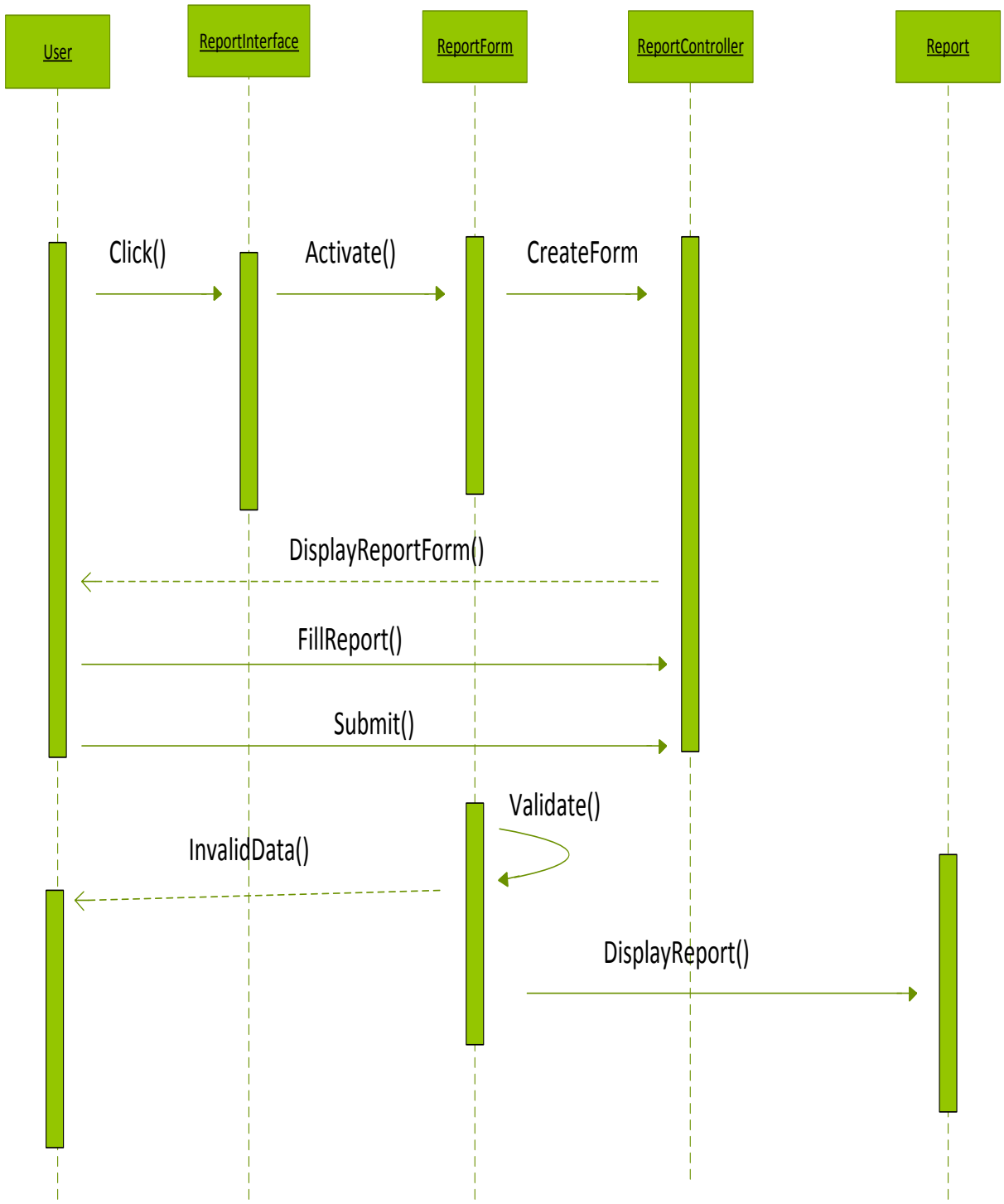


Figure 11:Report Sequence Diagram

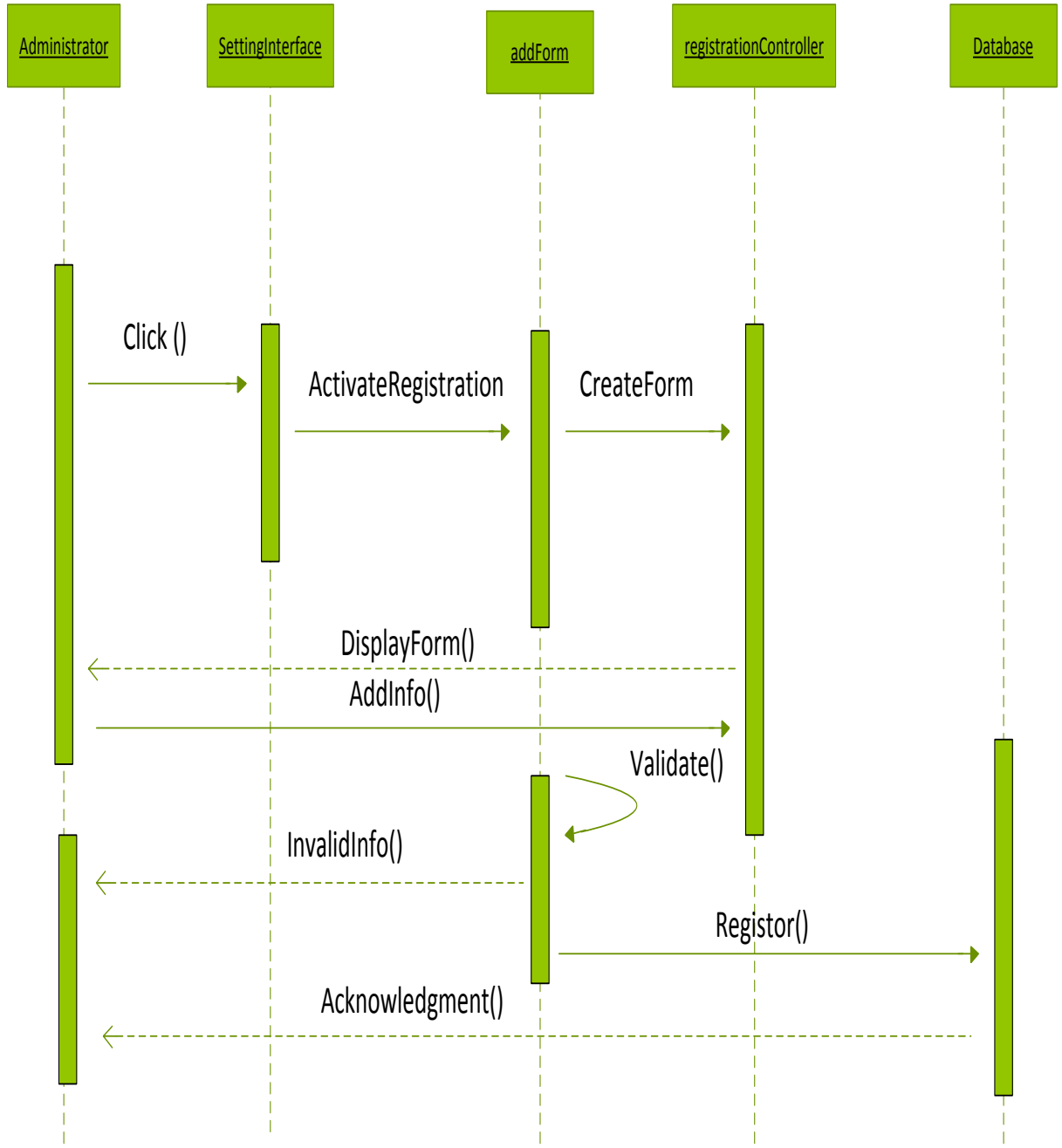


Figure 12:Add Account Sequence Diagram

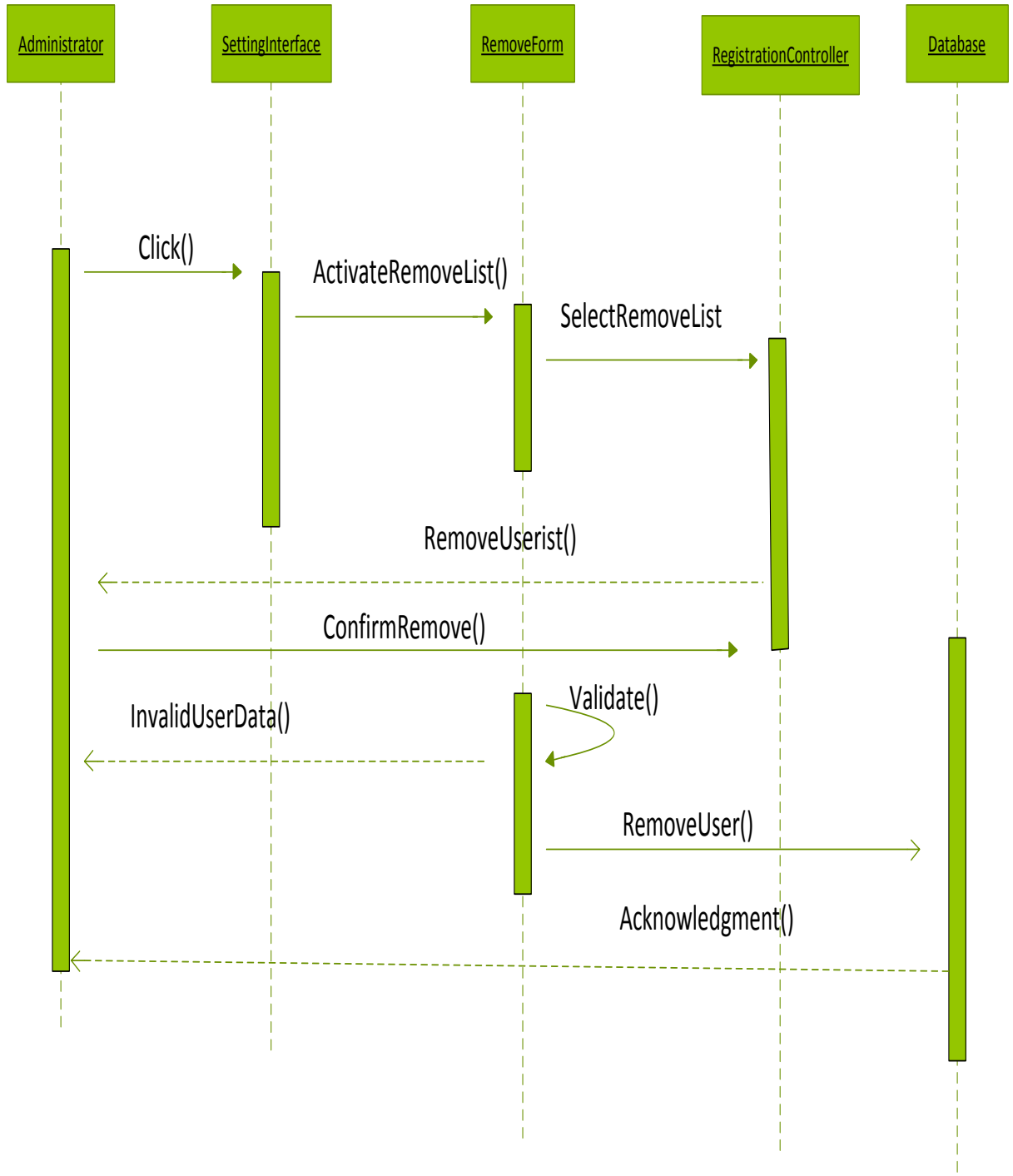


Figure 13: Remove account sequence diagram

4.4.3. Activity Diagram

Activity diagram describes activities and flows of data or decisions between activities (58). It shows the procedural flow of control between two or more different entities (people, things, and data) while processing an activity. It provides a very broad view of business processes and it can be used to break out the activities that occur within a use case. This diagram is useful in showing work flow connections and describing behavior that has a lot of parallel processing. When you use an activity diagram you can choose the order in which to do things. It states the essential sequencing rules to follow. It is different from a flow chart in that it shows parallel processes, not just sequential processes .The following figure show us the proposed activity diagrams.

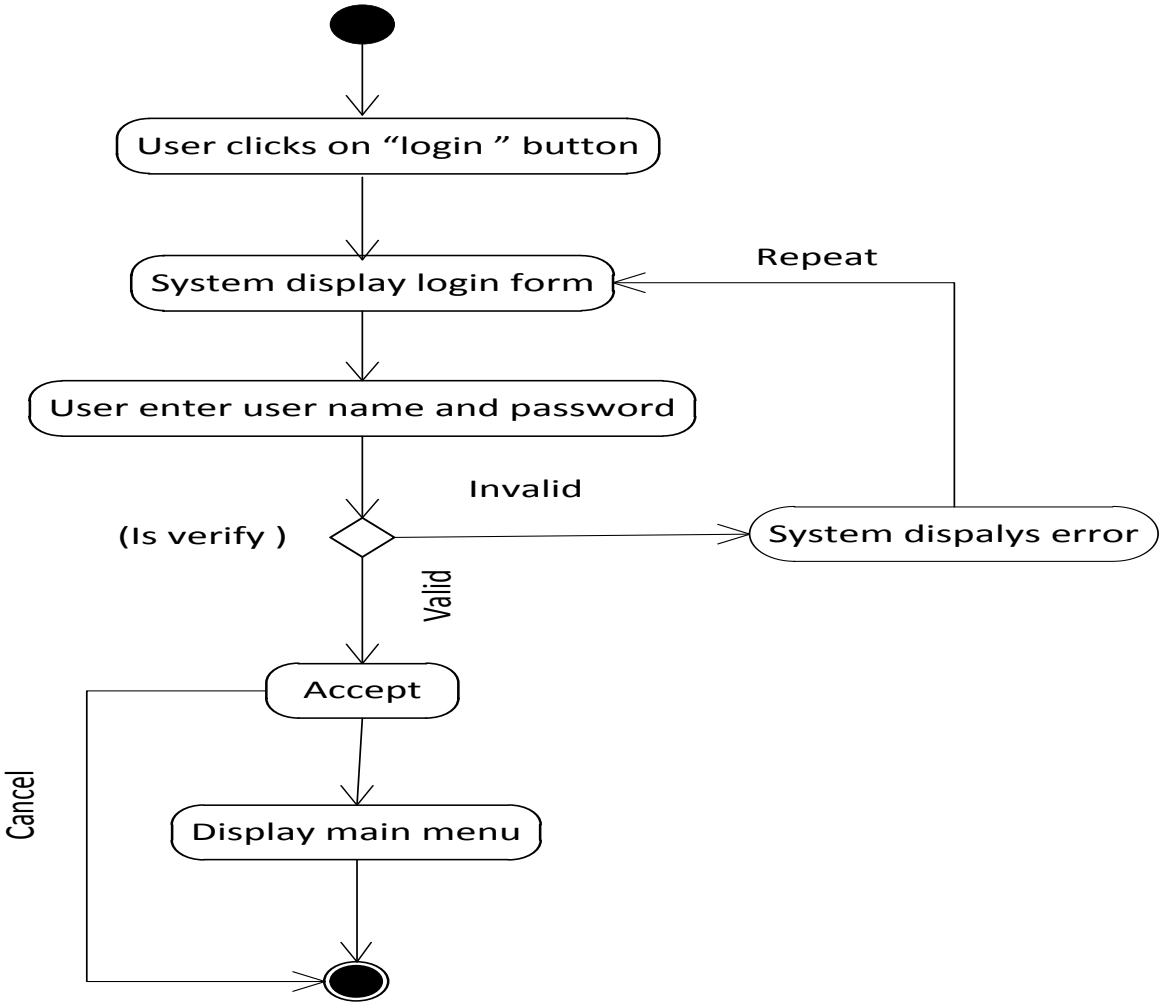


Figure 14:Login Activity Diagram

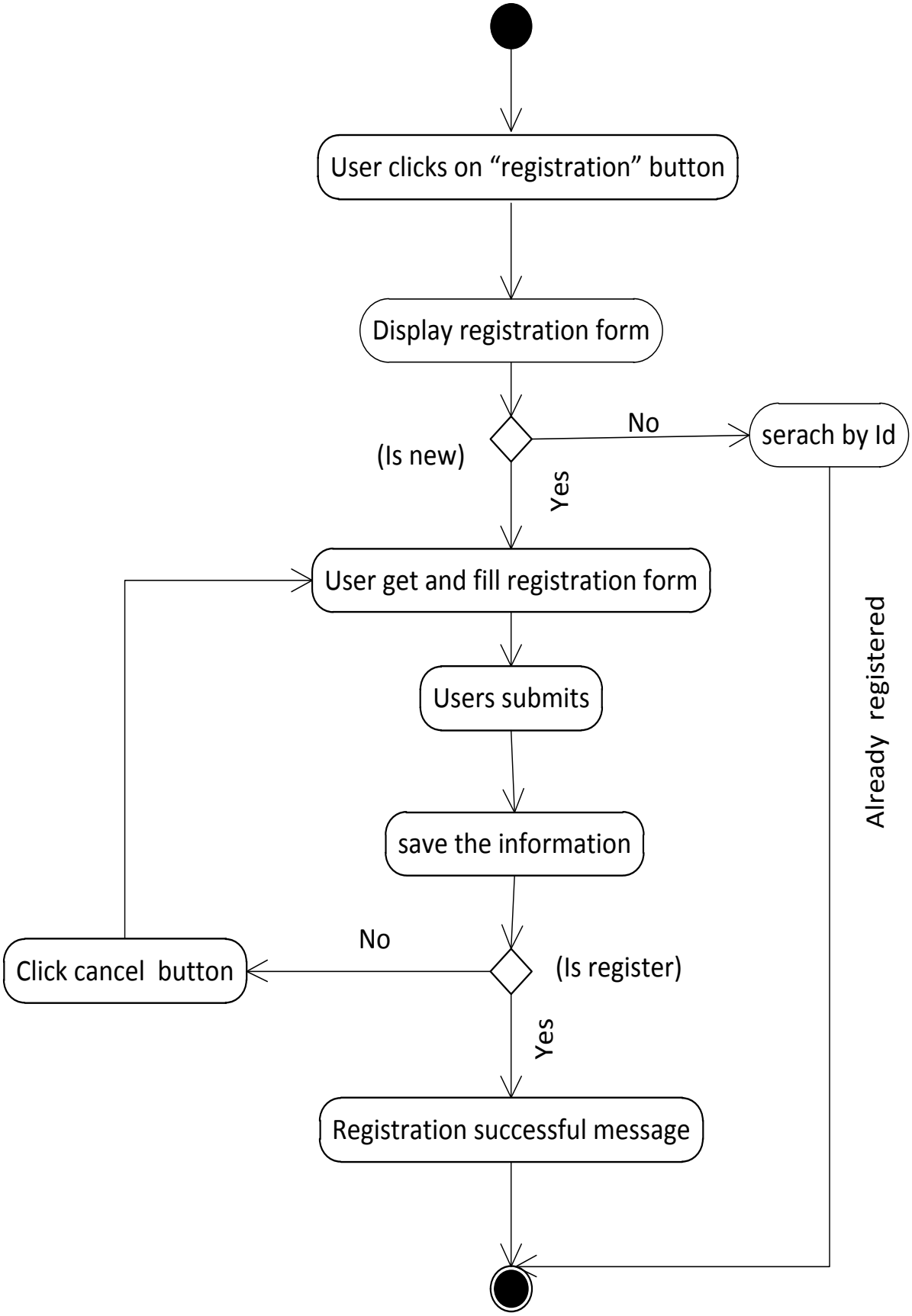


Figure 15:Registration Activity Diagram

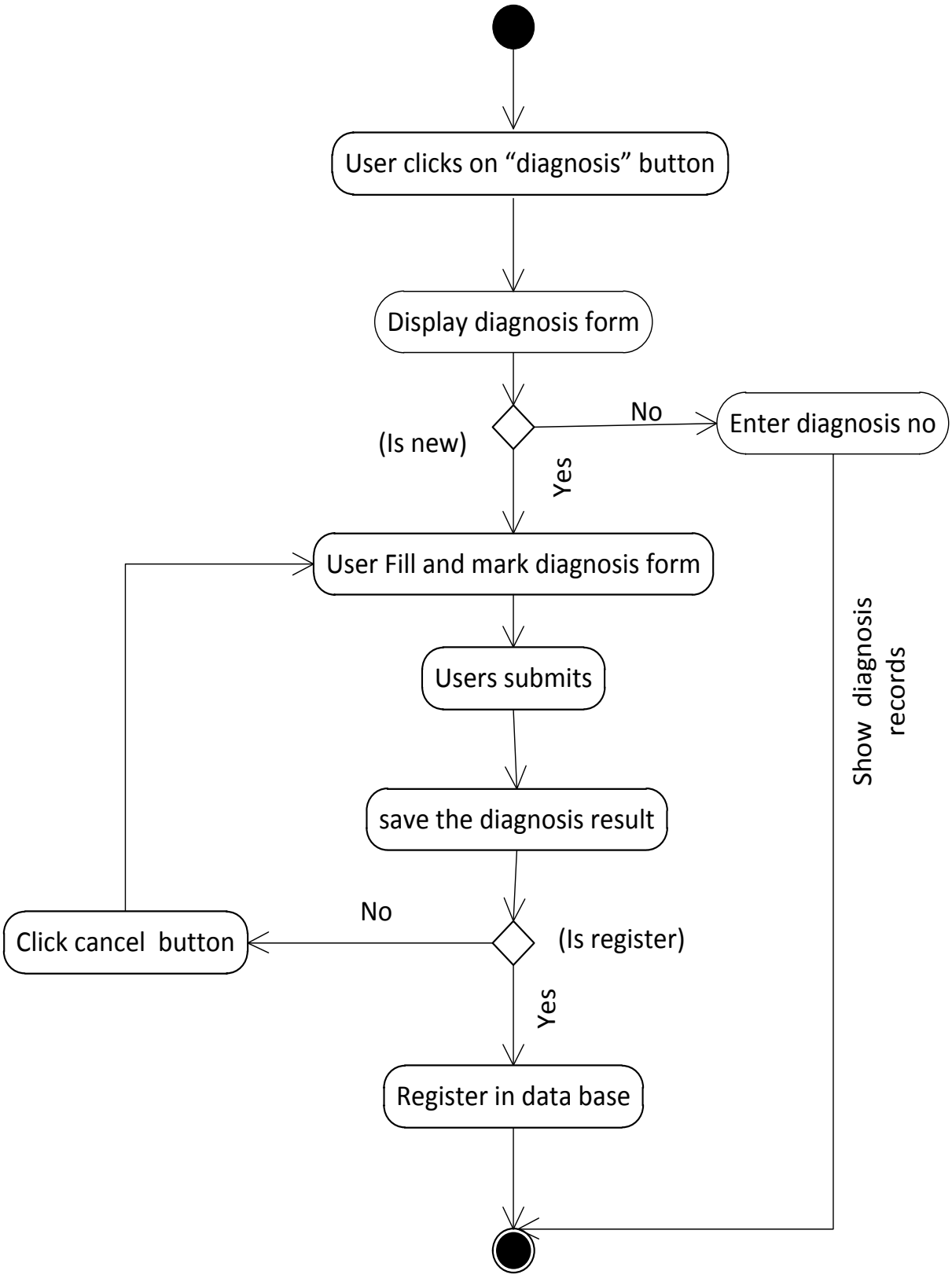


Figure 16:Diagnosis Request Activity Diagram

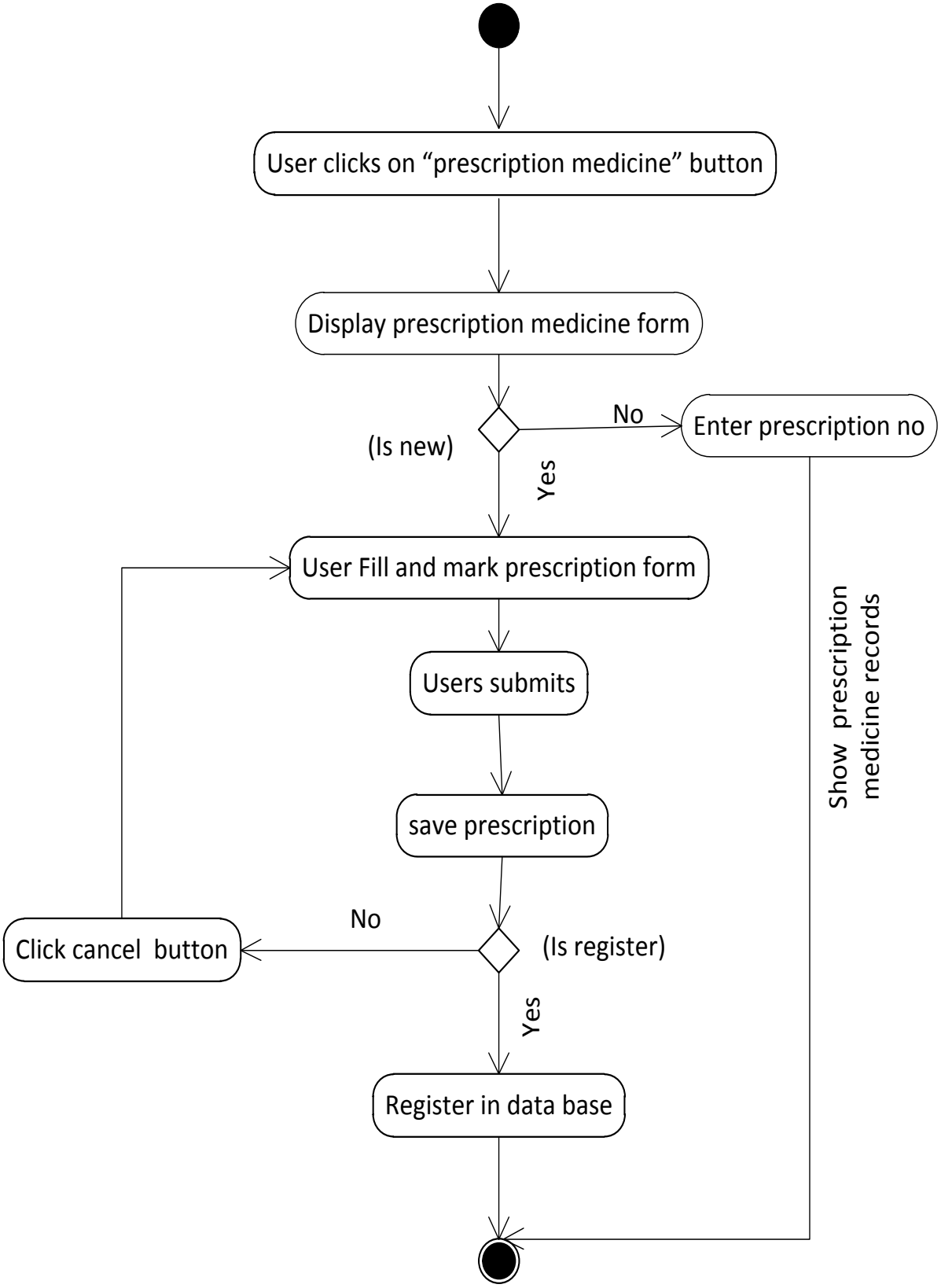


Figure 17:Prescription Medicine Activity Diagram

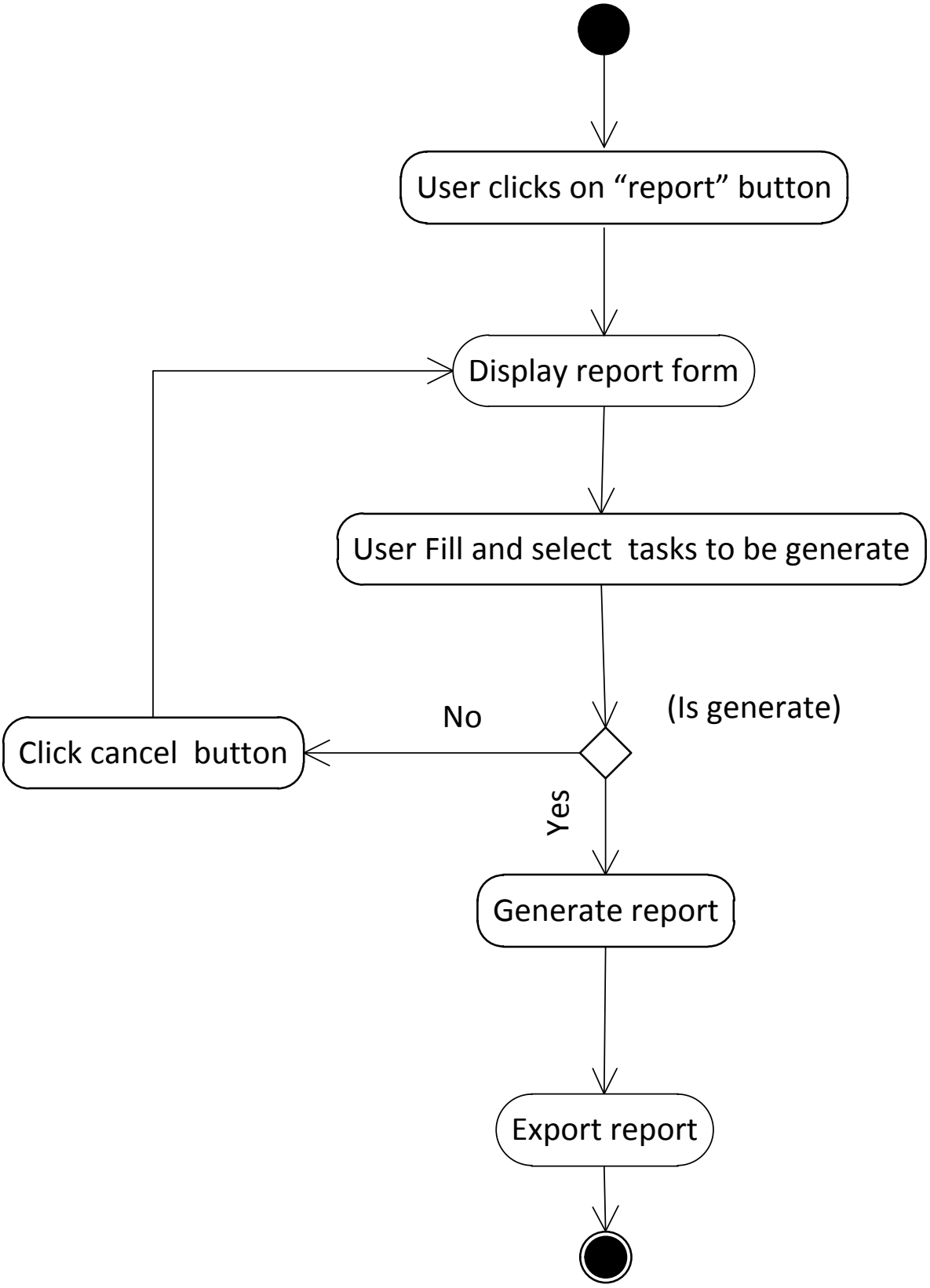


Figure 18: Report Activity Diagram

4.4.4. System Architectures design

A network architecture in which each computer or process on the network is either a client or a server (59). Servers are powerful computers or processes dedicated to managing disk drives (file servers), printers (print servers), or network traffic (network servers). Clients are PCs or workstations on which users run applications. Clients rely on servers for resources, such as files, devices, and even processing power (59).

4.4.4.1. The Proposed Web System Architecture

This TB patient follow up information system is designed to have a 3-tier Client/Server Architecture. The third tier (middle tier server) is between the user interface (client) and the data management (server) components (59). This middle tier provides process management where business logic and rules are executed and can accommodate hundreds of users by providing functions such as queuing, application execution, and database staging. The three tier architecture is used when an effective distributed client/server design is needed that provides increased performance, flexibility, maintainability, reusability, and scalability, while hiding the complexity of distributed processing from the user. They are also easy to manage and deploy the network and most of the code runs on the server. The protocol of interaction between the client and the server is as follows: The client calls for the business logic on the server, the business logic on the behalf of the client accesses the database (59).

A three tier distributed client/server architecture includes a user system where user services (such as session, text input, dialog, and display management) reside. The middle tier provides process management services (such as process development, process enactment, process monitoring, and process resourcing) that are shared by multiple applications. The third tier provides database management functionality and is dedicated to data and file services that can be optimized without using any proprietary database management system languages. The client/server model accommodates all types of users, it is simple and it works well with today's technologies. Let us now see which are the 3 building blocks of the client/server system, which meet a wide spectrum of client/server needs from the tiny to the intergalactic (59). The 3 building blocks are

1. Client

2. Server

3. Middleware

Let us now view each of the building blocks in detail.

1. The client building block
    - Runs the client side of the application
    - It runs on the Operating System that provides a Graphical User Interface (GUI) or an Object Oriented User Interface (OOUI).This blocks the operating system, passes the buck to the middleware and lets it handle the non-local services.
    - The client also runs a component of the Distributed System Management element (DSM). Where the DSM could be a simple agent on a PC or a front-end of the DSM application on a managing station.
2. The server building block
    - Runs the server part of the application.
    - The server is operating system dependent to interface with the middleware.
    - The server also runs a DSM component, which is once again a simple agent on a managed PC to the entire back-end of the DSM application.
3. The middleware building block
    - It runs on both the client and the server sides of an application and An integrating resource between the clients and servers. It performs the following main activities:
        - translation between the different protocols
        - optimization of the load-balancing
        - security control
        - management of the connections
    - This also has a DSM software component.
    - Where middleware forms the nervous system of the client/server infrastructure.

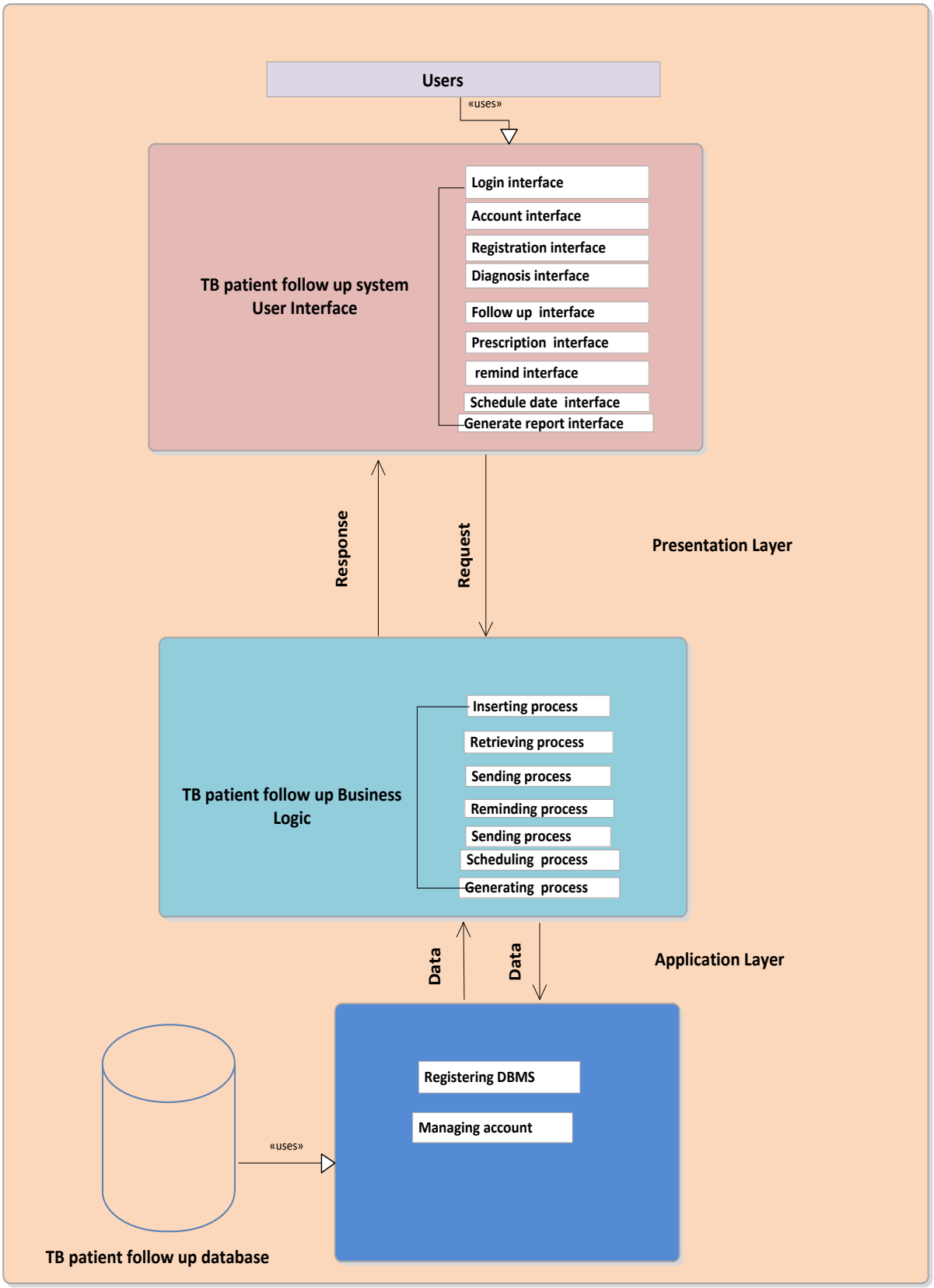


Figure 19: Three-tier Architectural Diagram

4.4.5. User Interface Design

Prototyping is an iterative analysis technique in which users are actively involved in the mocking-up of screens and reports (60). The purpose of a prototype is to show people the possible solution.

A user interface is that portion of an interactive computer system that communicates with the user. Design of the user interface includes any aspect of the system that is visible to the user. Today a wide range of non specialists' use computers, and keyboards, mice and graphical displays are the most common interface. The user interface is becoming a larger and larger portion of the software system in a computer system and a more important portion, as broader groups of people use computers. As computers become more powerful, the critical bottleneck in applying computer based systems to solve problems is now more often in the user interface, rather than the computer hardware or software. Because the design of the user interface includes anything that is visible to the user, interface design extends deep into the design of the interactive system as a whole. A good user interface cannot be applied to a system after it is built but must be part of the design process from the beginning. Proper design of a user interface can make a substantial difference in training time, performance speed, error rates, user satisfaction, and the user's retention of knowledge of operations over time (60). Prototyping benefits are

- services may be identified
- A working system is available early in the process
- The prototype may serve as a basis for deriving a system specification
- The system can support user training and system testing
- Improved system usability
- Closer match to the system needed
- Improved design quality
- Improved maintainability

4.4.5.1. Interface-Flow Diagrams

Interface-flow diagrams show the relationships between the user interface components, screens and reports that make up the investigator application. Interface-flow diagrams enable the investigator to validate the design of TB patients follow up information system user interface (60).

4.4.5.2. The Home Page

After you complete the login page, the system will welcome and redirect you to the home page. On the home page, you'll find the system's main menu.

4.4.5.3. User Interface

As you browse the system, you'll notice that the pages follow a standard layout. For example, at the top of each page you find links to the main modules of the system under the following user interface.

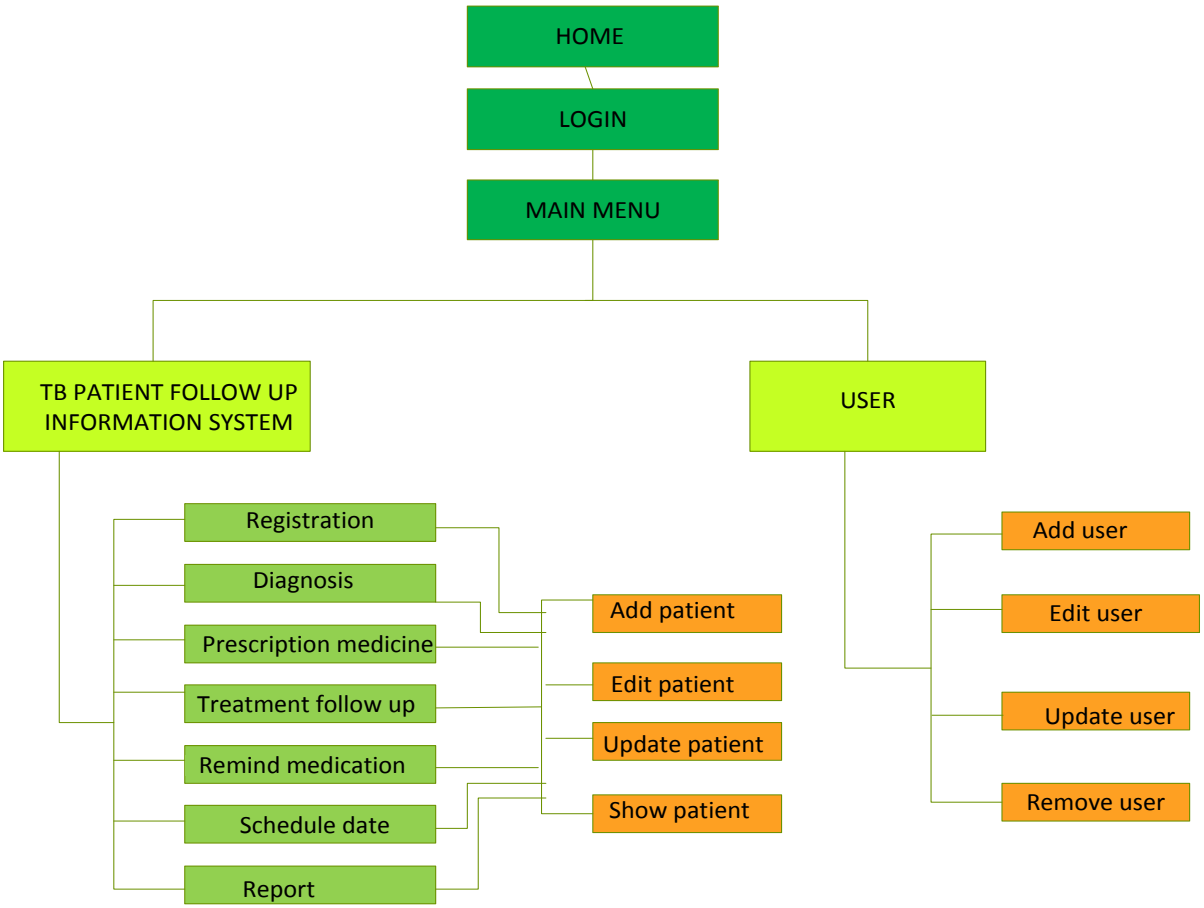


Figure 20: Navigate Diagram

The login page is used to authenticate the user in the system. To enter into the system, the User will enter a user login and password. If you don't have one, you can receive a new one by clicking on the link. The system will check for the User Account and Password. If you have not entered a valid login or password, an error message will be displayed .In this case, repeat the operation.

Figure 21: Login User Interface Screen

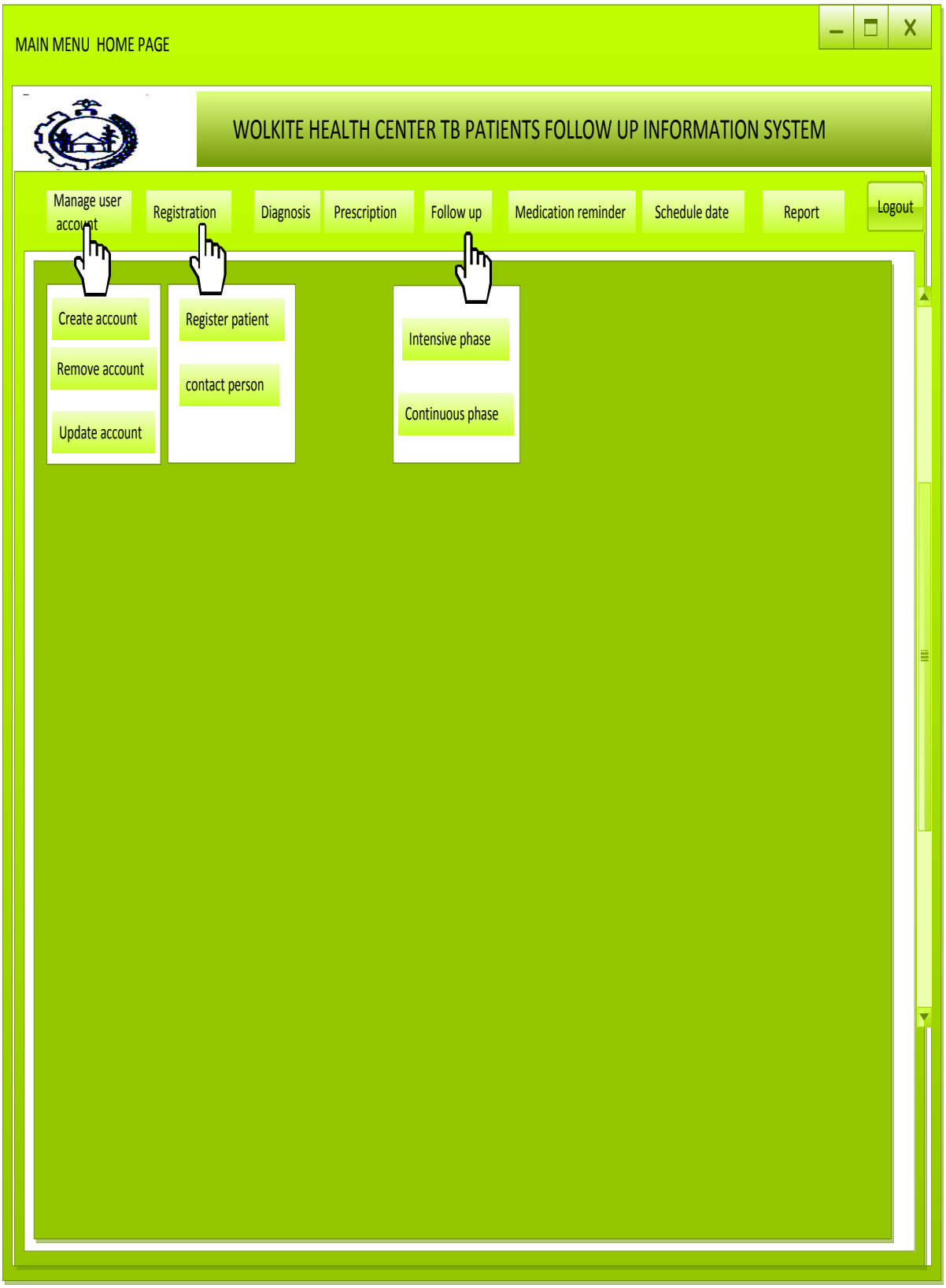


Figure 22:Main Menu User Interface Screen

Go to registration window, user in the main menu page click registration button (Figure 22) , the system will display sub menu patient registration and contact person menu . The user click the sub menu form .To add new patient or contact person information in the registration sub menu form, click on add or search the existing information by patient id. Complete information and click Save to confirm or Cancel to undo.

Figure 23:Patient Registration User Interface Screen

Figure 24:Contact Person Registration User Interface Screen

Go to Diagnosis window, user in the main menu page click Diagnosis button (Figure 22), the system will display Diagnosis form .To add new patient Diagnosis in the Diagnosis form, click on add or show the existing information by patient id. Fill and Mark in all fields displayed and click Save or Cancel to undo.

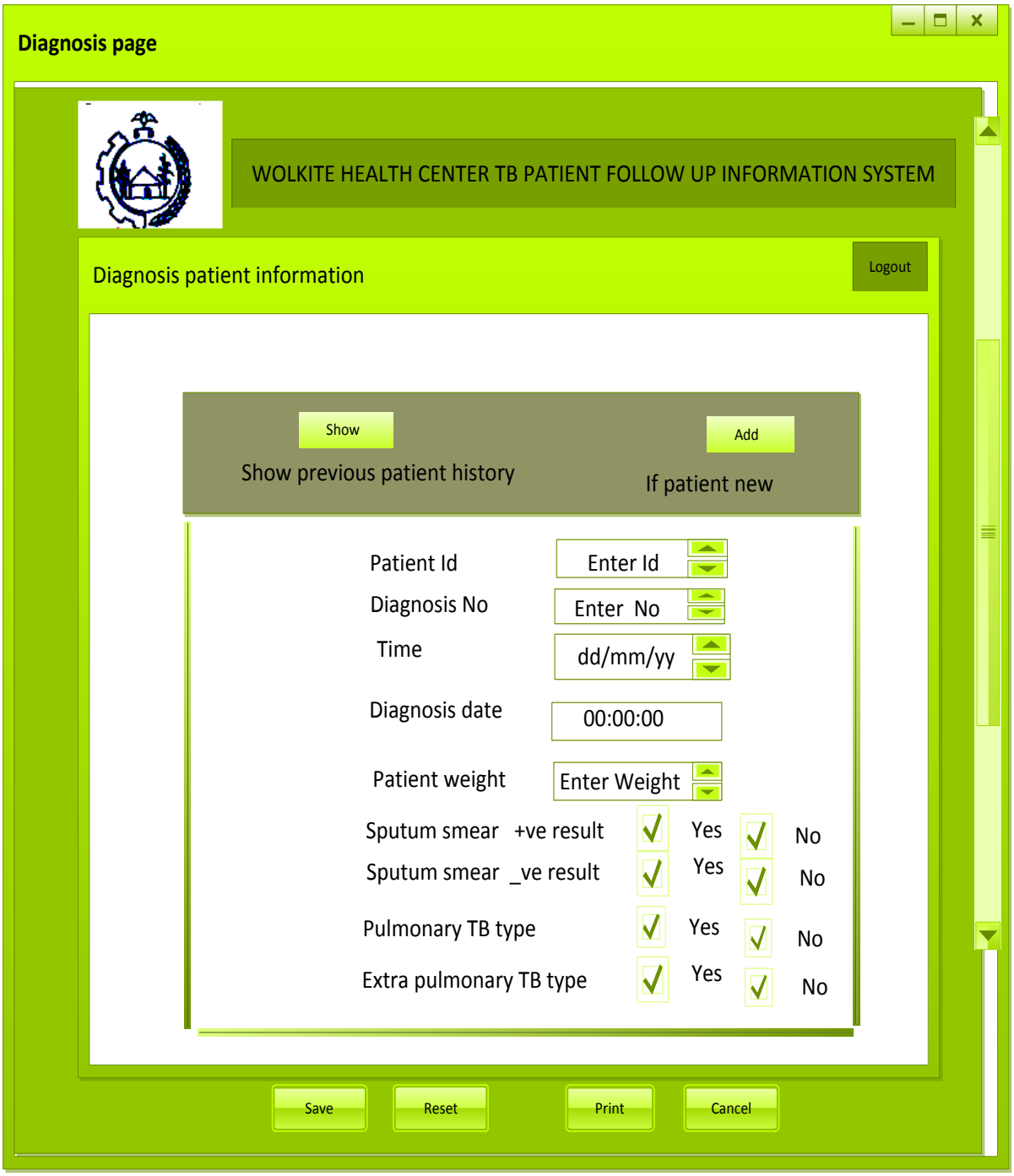


Figure 25:Diagnosis Request User Interface Screen

Go to Prescription Medicine window, user in the main menu page click Prescription Medicine button (Figure 22) , the system will display Prescription Medicine form .To add new patient prescription in the Prescription Medicine form, click on add or show the existing information by patient id . Fill and Mark in all fields displayed and click Save or Cancel to undo.

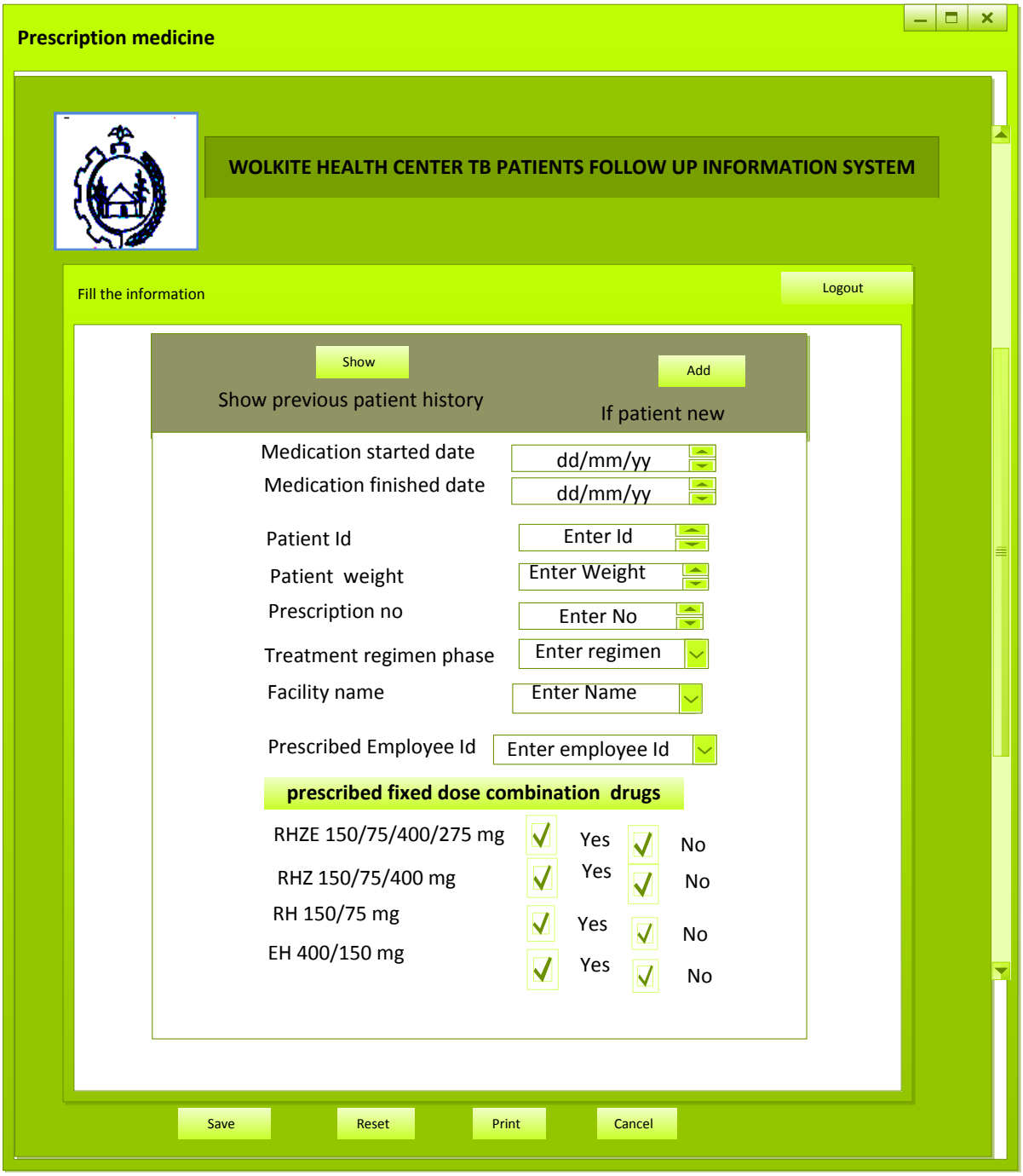


Figure 26:Prescription Medicine User Interface Screen

Go to Follow up window, user in the main menu page click Follow up button (Figure 22) , the system will display sub menu Intensive follow up and continuous follow up menu .The user click the sub menu form .To add new patient intensive follow up or continuous follow up information form in the Follow up sub menu window, click on add or show previous patient history by patient id . Complete information and click Save or Cancel to undo.

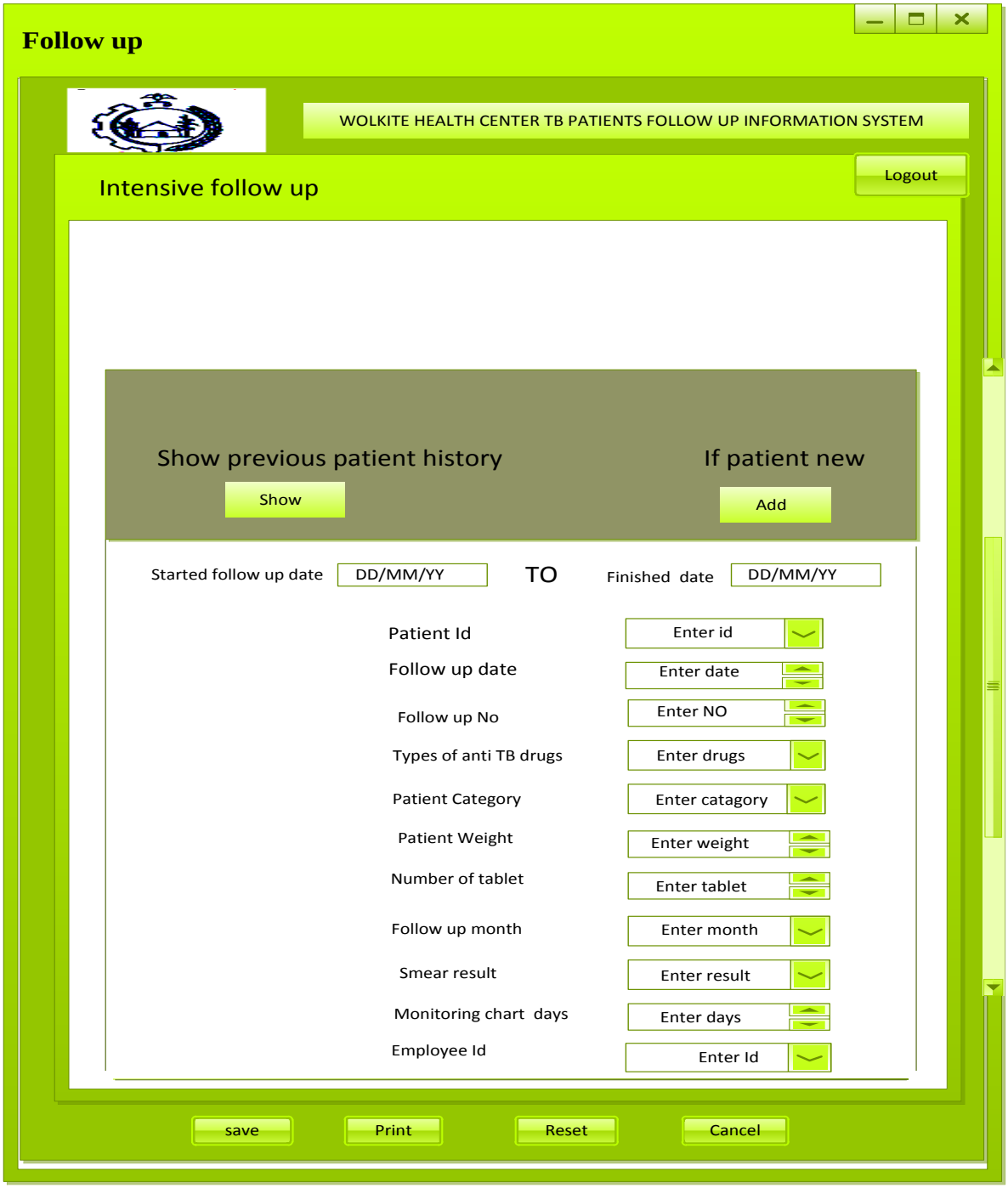


Figure 27:Intensive Follow Up Treatment User Interface Screen

Figure 28: Continuous Follow Up User Interface Screen

Go to Remind Medication window, user in the main menu page click Remind Medication button (Figure 22), the system will display the form. The user defined and authorized by the Health Facilities fill in all fields displayed, and click on Save to confirm. The medication reminder will automatically be sent to the patient with mobile phone address generated by the system. A message will appear informing that the operation was successful. If this message does not appear click cancel to undo the operation.

Figure 29:Remind Medication User Interface Screen

When the user click Schedule date button in the main menu page (Figure 22), the system will display the screen. The user defined and authorized by the Health Facilities fill in all fields displayed, and click on Save to confirm. The medication Schedule date will automatically be sent to the patient with mobile phone address generated by the system. A message will appear informing that the operation was successful. If this message does not appear click cancel to undo the operation.

Figure 30:Medication Remind Schedule Date User Interface Screen

When the user click Report button in the main menu page (Figure 22), the system will display the report screen. The user fill in all fields displayed and select one of these five options from tasks perform activities. The user click generate button can see generated report and click on export to send out the concerned body and click Cancel

Figure 31:Report User Interface Screen

When the system administrator click manage user account in main menu page (Figure 22),the system will display user account from setting options, the user will follow the following procedures:

1. To create a new user account, click on create account and the screen will appear. Enter information in the fields, and click on Save to confirm or cancel to undo it.
2. To update user account, click on update account and the screen will appear. Enter information in the fields, and click on Save to confirm or cancel to undo it
3. To remove user account, click on remove account in the Action column and in the confirmation window that appears, click on OK to confirm or cancel to undo it.

Figure 32:Admin User Interface Screen

4.4.6. Entity Relationship Modeling

An entity-relationship (E-R) data model is a high-level conceptual model that describes data as entities, attributes, and relationships (61). The E-R model is represented by E-R diagrams that show how data will be represented and organized in the various components of the final database. However, the model diagrams do not specify the actual data, or even exactly how it is stored. The users and applications will create the data content and the database management system will create the database to store the content.

This modeling method pays particular attention to relationships the interactions among entities. Relationships require special treatment in the development of databases, because they are the glue that holds information together and because their realization in relational databases is particularly important. Moreover, an E-R model is usually accompanied by a behavioral model, which describes the way that the applications of the information system must behave. Database designer creates new database system.

An E-R model attempts to capture those aspects of the real environment that are necessary for the proper functioning of a business or other system. Not everything about the real environment can be captured by the E-R model (61).

4.4.6.1. Entity Relationship Diagrams

As one important aspect of E-R modeling, database designers represent their data model by E-R diagrams. These diagrams enable the designer and users to express their understanding of what the planned database is intended to do and how it might work ,and to communicate about the database through a common language. The Figures 32 shows TB follow up information system entity relationship diagram

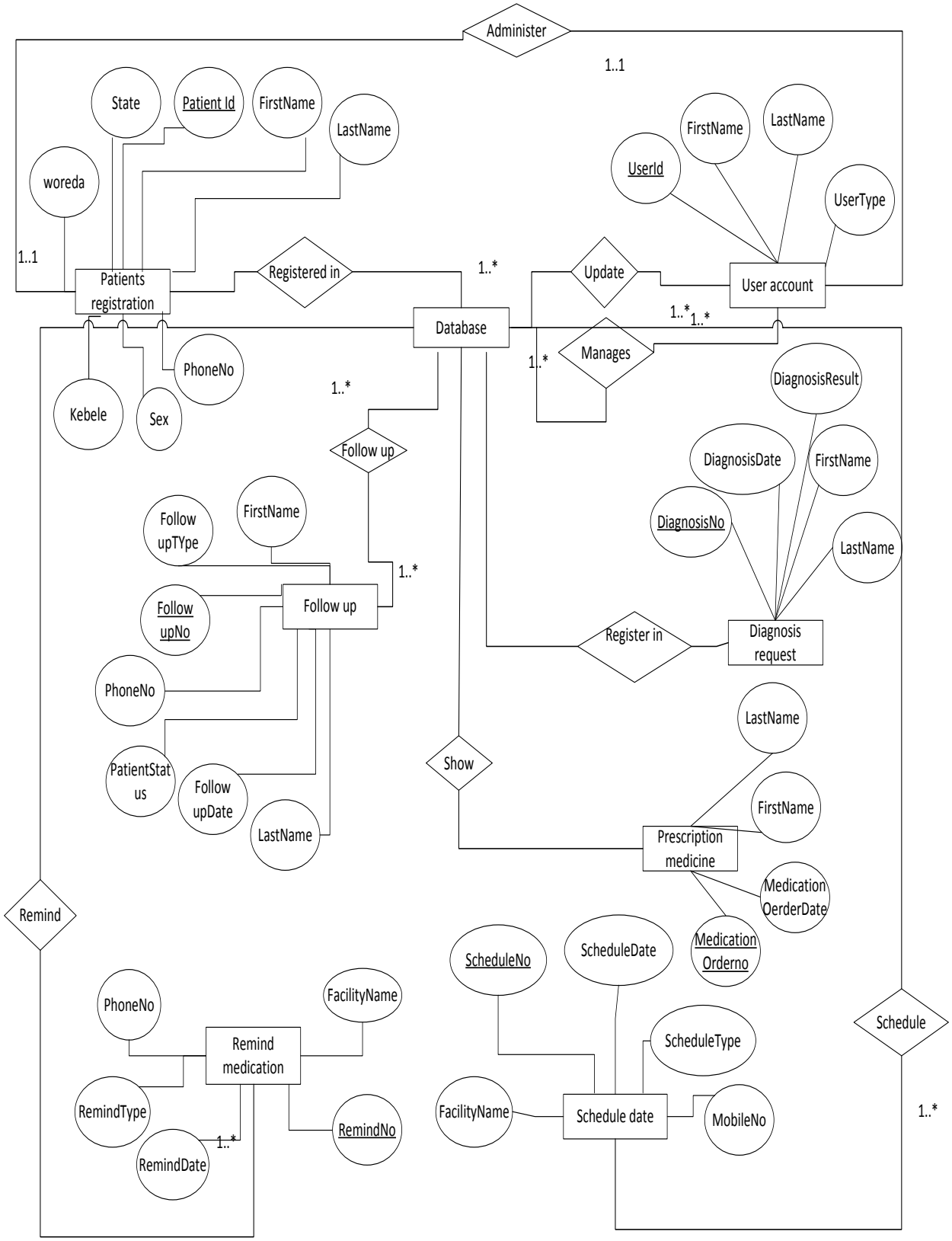


Figure 33: Entity Relationship Diagram

4.5. Evaluate the effectiveness of system usability

The Investigator presented the designed system functionality to respondents to evaluate the effectiveness of the system. Usefulness design TB patients follow up information system is the issue of whether the system can be used to achieve some desired goal. Usability is the extent to which users can use a computer system to achieve specified goals effectively and efficiently while promoting feelings of satisfaction in a given context of use. Usability evaluation (UE) consists of methodologies for measuring the usability aspects of a system's user interface (UI) and identifying specific problems. Usability evaluation is an important part of the overall user interface design process, which ideally consists of iterative cycles of designing, prototyping, and evaluating. Usability evaluation is itself a process that entails many activities depending on the method employed (62).

A questionnaire is a measurement tool designed to assess a user's subjective satisfaction with a design TB patient follow up information system. It is a list of questions that are distributed to users for responses based on system attributes. The goal is to evaluate the effectiveness of the process and the result .The goal is to improve the interface design process and results.

Responses on a questionnaire are usually quantitative and the evaluation of the result demonstrated in table 13.

Questionnaire ratings of the design system on 5-point semantic differential scale (e.g. strong agree=5, agree=4, not decided=3, disagree=2 and strongly disagree=1)

Table 1: Evaluation Checklist

s.n	System effectiveness evaluation criteria	Strongly disagree	Disagree	Not decided	Agree	Strongly agree
1	The design system could increases the performance of the users	-	-	-	40%	60%
2	The design system made the user to save time and cost	-	-	-	20%	80%
3	The system could be automating TB patient data record system.	-	-	-		100%
4	The design system could be helpful to follow up patient in the health facility.	-	-	-	40%	60%
5	The system could be minimizing the TB patient defaulter, relapse and failure.	-	-	-	20%	80%
6	The system could increase TB patient cured success rate	-	-	-	20%	80%
7	The system could be able to improve medication error	-	-	-	40%	60%
8	Implementation of system could provide standard health service to the client.	-	-	-	20%	80%
9	The system could be helpful to remind medication	-	-	-	20%	80%
10	The design system could friendly use to improve patient data quality	-	-	-		100%
	Total evaluation				22%	78%

According to the above table 13, the respondents to evaluate the proposed system effectiveness and functionality of the system were 22 % agree and 78 % strongly agree .

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

This project was conducted with a design of TB patients follow up information system which is significant to improve TB patient treatment in Wolkite Health Center.

- The current system is performing paper based system. In the Health Center the system uses manual method which causes many problems such as duplicated data storage and difficult retrieval, patients did not take medication at the right time, poor patient follow up, patient data lost, wastage of time in maintaining paper work and more. Based on the finding of this research project, the designed TB patient follow up information system is contribute a better understanding to solve the problem being performed by the current manual approach keeping patient data record and follow up.

- The study identified critical requirements from the health facility which the information includes, diagnosis, prescription, follow up and remind medication associated with electronically record. The system supports to remind patient medication and schedule date, provide fast services and enhance health worker performance and speedy retrieve records. Additionally, in this study the national TB prevention and control guideline were used as an input in order to determine the requirements for the new system. Designing TB patient follow up information system met specific objective of the project. This project conducted using design research method. The system undertook gathering user requirement analysis and design phases. The system is analyzed using diagrams such as business use case diagram and context diagram. Additionally, the design phase emphasize how the system collaborate to fulfill the requirements using UML artifacts of class diagram, sequence and activity diagram, designing user interface prototype, and entity relationship database system fundamental for system implementation. All section or components on the user interfaces built to fit in to the software requirements. A design web based TB patient follow up information system was used three-tier Client/Server Architecture model.

- Finally a user interface prototype shows a portion of an interactive computer system that communicates with the user. Design of the user interface includes any aspect of the system that is visible to the user. The investigator evaluates the effectiveness of the system to improve the TB patient follow up system. The investigator evaluate the effectiveness of the system includes different factors, such as performance of the users, to improve medication error, treatment outcome, standardized health service, perceived friendly use and timely delivered to the health workers of the study health center.

5.2 .Recommendations

Based on the finding the following recommendations would be important to solve existing TB patient follow up information system associated problem.

Health Facilities

The health center should install TB patients follow up information system software or computerized system and networking for sharing the information.

The health center should communicate with stakeholders to support electronically analysis and generate recoded patient information system.

Researchers

The investigator would like to recommend future researcher should continue the project to complete all the remaining part of system in software development process.

Furthermore, the future studies could be implemented in TB patient follow up information system and the system provide alert to the patient for medication and schedule date.

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Annexes

Annex 1: interview

ADDIS ABEBA UNIVERSITY
SCHOOL OF INFORMATION SCIENCE AND SCHOOL OF PUBLIC HEALTH
M.Sc IN HEALTH INFORMATICS PROGRAMM

Consent form

My Name is Adem Shikur .I am post graduate student of health informatics program and my project research objective designing a Web based TB Patients follow up information system in the case Wolkite Health Center.

To the respondents:

This interview is formulated how to analysis and design the system based on the information acquired from the respondents. The result of this interview will be utilized for project purpose only. It is hoped that the outcome of this study will contribute to the improvement TB Patients follow up information system Wolkite Health Center. Therefore, you are kindly requested to provide genuine response to the questions that follow.

"Thank you in advance for your Cooperation"

Guide Line of Interview used for Design Web Based Tuberculosis patient follow up information system to identifying requirement of the system and to analyze the system.

1. Data process

1. What type of information do you need for your work (clarify about patient, policies, procedures, equipments, etc)?
2. How do you get that information?
3. What data you need to generate that information?
4. How you process the data into information?
5. How are patients data registered and stored?
6. How do you get patient history?
7. How do you retrieve patient information in the current system?
8. Is there any problem in the current information system? during patient follow up
9. What type of services or treatments the health center provides to patients?
10. How do you followed up the patients?
11. How often are you followed up the patients?
12. Did the patients check up in each treatments phase?
13. How many of the patients are registered phone address?
14. How many of the patients are read a text? Clarify
15. Did the patients complete the treatments?
16. Did the patients take medication on recommended time?
17. How do the patients come on appointment date?
18. How will data confidentiality and security be ensured?
19. How is feedback provided to system users?
20. Where the patients can get services?

2. Report/communication

21. How frequently prepare the report about patient data?
22. For whom do you submit the report?
23. How do you prepare report currently?
24. Where it is stored?
25. Is it easily accessible?

3. People

26. Who is responsible for patient record error and how?
27. Who make the reports?
28. Did the health workers have computer skill?

4. Procedure

29. Do you have guide line to follow up patients treatments?
30. What are patient information recording procedures include?
31. Do have any system to trace the problem?
32. Do you have any integrated system? How?

5. Software

33. Is there any computer software in use for the existing system? List all
34. Is there any planned approach or computer system to improve the current system?
35. Do you have any software used to prepare reports? Which software?

6. Hardware

36. Do you have a computer? How many?
37. For what purpose do you use it?

Annex 2: Evaluation effectiveness of the system

Questionnaire completed at service by the respondents who are from health center. Please mark the options which most appropriately reflect your feeling about using the design system (scales contain: strong agree=5, agree=4, neutral=3, disagree=2 and strongly disagree=1)

1. The design system could increases the performance of the users

   Strongly disagree 1 2 3 4 5 strongly agree

2. The design system made the user to save, time and cost

   Strongly disagree 1 2 3 4 5 strongly agree

3. The system could be automating TB patient data record system.

   Strongly disagree 1 2 3 4 5 strongly agree

4. The design system could be helpful to follow up patient in the health facility.

   Strongly disagree 1 2 3 4 5 strongly agree

5. The system could be minimize the TB patient defaulter, relapse and failure

   Strongly disagree 1 2 3 4 5 Strongly agree

6. The system could increase TB patient cured success rate

   Strongly disagree 1 2 3 4 5 strongly agree

7. The system could be able to improve medication error

   Strongly disagree 1 2 3 4 5 strongly agree

8. Implementation of system could provide standard health service to the client.

   Strongly disagree 1 2 3 4 5 strongly agree

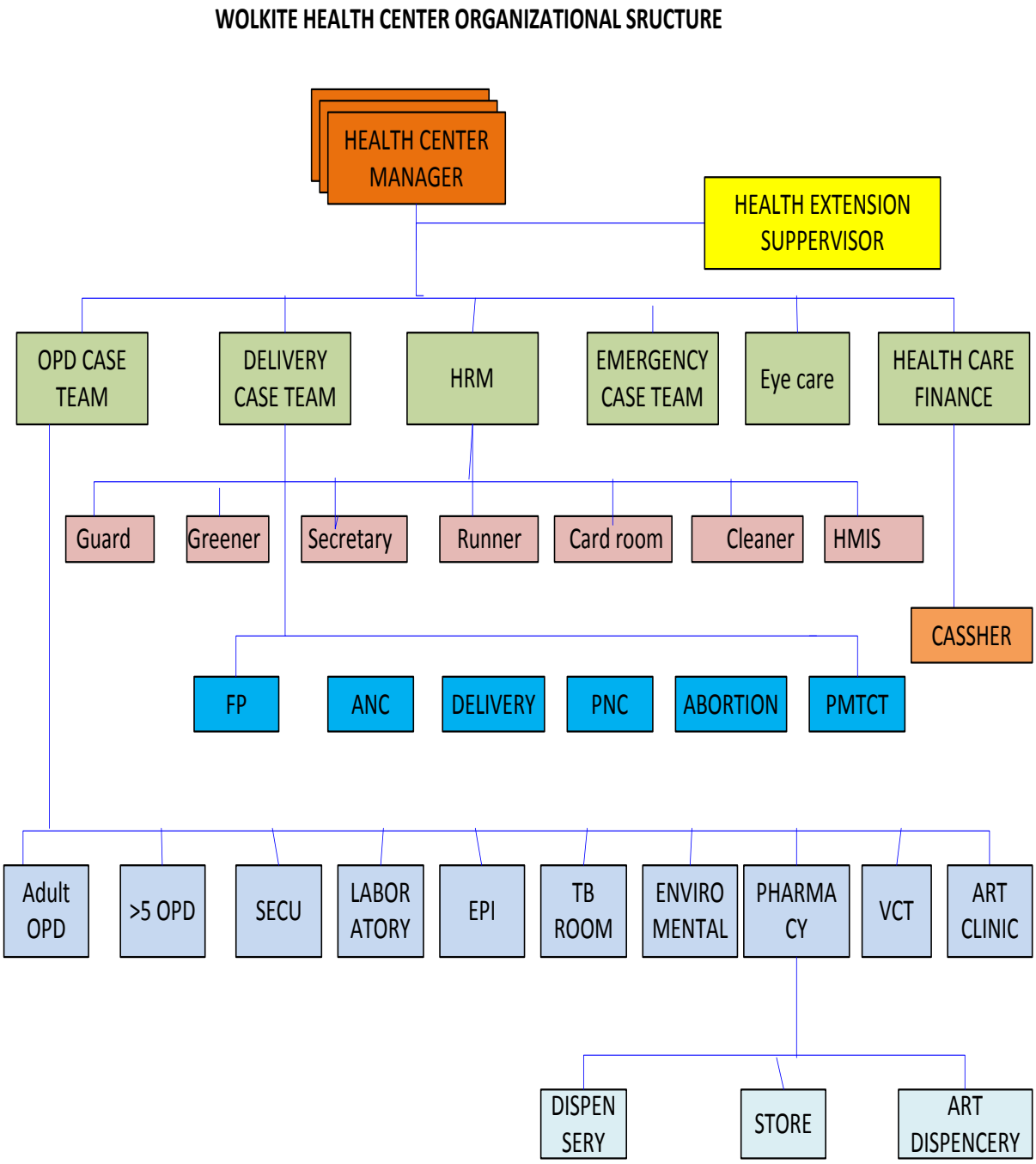
9. The system could be helpful to remind medication

   Strongly disagree 1 2 3 4 5 strongly agree

10. The design system could friendly use to improve patient data quality

    Strongly disagree 1 2 3 4 5 strongly agree

Annex 3:Organizational Structure



Declaration

I declare that this project is my original work and has not been presented for a degree in any other university, any that all sources of materials used for the research acknowledged.

Adem Shikur

This project has been submitted for examination with our approval as university advisors.

Prof. Ahmed Ali

Dr. Temtim Assefa

Place and Date of submission: Addis Ababa, June, 2016