Designing an Appointment Management System for the Mother and Child Health Department of the Klinik Kesihatan Changlun

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Designing an Appointment Management System for the Mother and Child Health Department of the Klinik Kesihatan Changlun

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Abstract

Information and Communication Technology has been changing the way things have been carried out. Traditionally many work required people to visit the location where the work has been carried out. ICT has been making these services available at their fingertips by hosting these applications online. *Klinik Kesihatan Changlun* is a public general clinic in the state of Kedah. The appointment management which is one of the most important services of a clinic is presently carried out manually here. Both patients and the staff have to face a lot of problems due to the inefficiency of the manual system. If the system can be automated and made available on the internet, it will solve a lot of problems currently faced by them. This project proposes to design an appointment management system for the Mother and Child Health Department of the *Klinik Kesihatan Changlun*. The project has been proposed to follow the formal research methodology proposed by Kuchler and Vaishnavi due to its suitability for small to medium sized development projects. Finally it has been proposed conduct a usability test on the prototype developed for ease of use and user friendliness with the aid of the questionnaire.

ACKNOWLEDGMENTS

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CHAPTER 1

INTRODUCTION

1.1   Introduction

With the development of Information and Communication Technologies (ICT), more and more online services are becoming popular. These online services provide the users with the flexibility of getting their work done without leaving the comfort of their living rooms. Traditionally these services required the people to travel to the place where the services were provided.

*Klinik Kesihatan Changlun*is a community health clinic under the Ministry of Health that serves the people in the area around the city of Changlun. The clinic is of moderate size with two departments namely the Outpatient Department and the Mother and Child Health Department. The Outpatient Department provides general clinical services and the Mother and Child Health Department is a specialized unit providing antenatal and postnatal care for mothers and pediatric care to children up to the age of six years. The Mother and Child Health Department is staffed by 15 healthcare professionals comprising one specialist, one general physician, seven staff nurses and six community nurses. All the services are of outpatient type as the clinic does not have facilities to admit patients for inpatient care. The clinic is equipped with basic laboratory facilities to carry out urine test, blood pressure, weight and height measurements and physical examination of pregnant mothers

and to provide immunization to children along with monitoring of physical and growth. Since the clinic does not have in-patient care facilities for handling deliveries, pregnant mothers are transferred to Alternative Birth Center for delivery. Once a baby is born the monitoring and care of the new born are handled by a visiting nurse from the clinic.

Presently, the entire administration of the clinic including patients' registration and record management is manually controlled. Patients are given a card where the appointments are marked along with an entry in the clinic's patient appointment file. Even the immunization schedule of children is handled manually through two immunization cards. One card is given to the mother of the child and the other card is maintained in the department. The card contains the child's name, date of birth, immunization type and date and time to be administered. The growth of the child is monitored by measuring the height and weight of the child and plotting it on the growth chart of the child maintained in the clinic.

The working hours of the clinic are from Sunday to Thursday from 8:00 AM to 1:00 PM and 2:00 PM to 5:00 PM. Fridays and Saturdays are off days. Patients have to queue during the office hours for obtaining appointments to see the doctors. In order to obtain an appointment suitable for the patients they have to come to the clinic very early way before 8:00 AM as even a slight delay may result in a long wait for seeing the physician. This creates a lot of problems for both the patients and the hospital staff due to the inefficiencies inherent in the present manual system.

The proposed Appointment Management System would help the clinic to improve its services making them more efficient and flexible. With the implementation of the proposed system, the clients will be able to book and follow up their appointments online from their homes making the services available anywhere anytime. The users can check the available slots beforehand and book a time slot that is convenient to them avoiding the necessity of travelling to the clinic several times or waiting in queues unnecessarily. Also, the online alert system included will help the clinic to notify the clients in case, there are changes to the appointments. The system will also help mothers to keep track of immunization schedules of their children and pregnant ladies to keep track of their clinical appointments. Overall this system would improve the services of the clinic making it more efficient.

1.2   Problem Statement

Healthcare providers including hospitals, clinics and dispensaries strive continuously to improve their services to meet the demand of the clients. These demands faced by healthcare providers become stronger everyday due to the factors such as more informed customers, increasing emphasis on preventive rather than curative care, aging population and increasing cost of health care services along with increase in competition due to liberalization of healthcare services (Wijewickrama & Takakuwa, 2005). Service time including both waiting time and treatment time spent at the facility is an important parameter in the quality of service provided. Many prospective clients had moved away from public healthcare providers towards private healthcare service providers due to better quality of

services provided and to avoid congestion and long waiting times (Najmuddin et al., 2010).

Several researchers have tried to model the access time for health services using analytical models in order to understand and identify the dynamics and contributing factors to the patient waiting time in healthcare facilities (Elkhuizen et al. 2007; Kumar & Shim, 2007; Zhu et al., 2010). Zhu et al. (2010) have specially analyzed the appointment scheduling systems in specialist outpatient clinics to detect the factors causing long patient waiting time/clinic overtime using the data collected from a government hospital with the view of detecting the possible factors causing long waiting time. Kumar and Shim (2007) have tried to optimize resource allocation in terms of allocating consultation rooms, doctors' time and patients waiting time. The main conclusion of all these researches is that non availability of prior information about the appointment schedule with respect to the free slots is a major hurdle for the proper management of appointments and allocation of other resources optimally.

A computerized appointment management system will help reduce patient waiting time as the system can be made accessible over the internet and clients can make a booking from their home at their convenient time. This would reduce the time wasted on travelling and waiting as the patient can arrive at the clinic at the scheduled time to see the physician. Since the appointments can be made from home, it would also eliminate the disappointment of non availability of appointment slots. The prior booking system would help the clinic in optimal

utilization of its resources as it will smooth the flow of patients eliminating unexpected surges and long queues.

At present *Klinik Kesihatan Changlun* keeps the appointment schedule of patients manually. Also appointments can only be made on the particular day of doctors' visit from 8:00 AM onwards. There is no special facility for making prior appointment before the date of appointment or selecting the time slot of patient's preference. The present arrangement wastes a lot of time and other resources and also contributes to environmental pollution due to heavy traffic created around the clinic by visiting patients eager to obtain an appointment early on the day.

In the light of this development, this project proposes to design an appointment management system for the gynecology and pediatrics departments with web capability that would help reduce the problems currently faced by the clinic in terms of appointment management. The advantage of the proposed system would be that this prototype system could be used by the *Klinik Kesihatan Changlun* as well as similar clinics countrywide. Using an automated system like this would improve the quality of the services provided by healthcare service providers resulting in more satisfied customers and better utilization of their own resources.

1.3   Research Questions

The following questions have been formulated for the purpose of this study.

- What are the requirements that are to be met in an appointment management system that can be used at the Mother and Child Health Department of the *Klinik Kesihatan Changlun*?

- How can Web technologies be incorporated into an appointment management system successfully?

- How can such a system be designed using the modern development tools?

1.4   Objectives

The main objective of this study is to come up with requirements and design a Appointment Management System for the Mother and Child Health Department of the *Klinik Kesihatan Changlun*.

The sub objectives of this study are:

- To determine the requirements of an appointment management of the Mother and Child Health Department of the *Klinik Kesihatan Changlun*.

- To design an appointment management system incorporating web technology modules.

- To implement the system using ASP .Net with C#.

1.5   Research Scope

The scope of this research is limited to the web based appointment management along with an electronic mail alerting module. The system will comprise two web based user interfaces; one for clients to book their appointments and the other one an administrative interface for the clinic staff. The system will have limited functionality serving only the Mother and Child Health Department of the *Klinik Kesihatan Changlun*.

1.6   Research Significance

The significance of this project is twofold; technical and social.

The contribution to the society includes;

- The reduction of hassle associated with manual operation of appointment management of the Mother and Child Health Department of the *Klinik Kesihatan Changlun*.

- The possibility of scheduling appointments from anywhere just with a few clicks.

- The capability of notifying the clients, in case appointments need to be rescheduled.

- Indirectly helping to reduce environmental pollution by reducing the number of travels made to the clinics by clients.

The technical contributions of the project are as follows:

- A computer based solution incorporating the advanced technologies to manage the appointment administration of Mother and Child Health Department.

- A foundation for future researchers and developers to improve towards a fully fledged clinic management system.

1.7 Organization of the Thesis

This report is organized into five chapters. The major contributions resulting from this research work is presented in Chapter 4. The organization of the chapters is given below:

Chapter 1 presents a review on the introduction, problem statement, research objectives, research questions, scope of the research, and significance of the research. Chapter 2 discusses the detailed literature survey investigating the prior and similar work carried out by other researchers. Chapter 3 introduces the methodology adopted in this research along with requirement gathering process carried out. Chapter 4 explains the detailed analysis and design of the system. Chapter 5 provides the evaluation of the system and the evaluation results. Chapter 6 provides the conclusions of this project.

1.8 Summary

Web based applications have been changing landscape of services automating the non core activities of a business. Healthcare is one area where ICT can be used to improve the quality of services tremendously. Healthcare is a large industry having a large number of stakeholders and different levels of services (Meyer & Müller, 2006). In this project it has been proposed to develop an appointment management system for the *Klinik Kesihatan Changlun*. It has also been proposed that the system be developed combining both web and e-mail messaging due to the ubiquitous nature of these two technologies.

Chapter 2

IMPACT OF ICT ON HEALTHCARE

2.1 Introduction

The adoption and diffusion of Information and Communication Technology (ICT) have considered as indicator of development by many countries. Many countries including both developed and developing have incorporated the technological innovation specifically the investment on ICT in the development agenda (Zheng, 2005). The adoption of ICT in the healthcare sector has been considered as one of the main driving forces in the healthcare reforms in many countries (Gladwin et al., 2003). The adoption of ICT in the healthcare sector is commonly known as e-health. The rationale behind the investment and incorporation of ICT in the national development policies and plans is with the expectation that these ICT based initiatives will accelerate the social and economic development of these countries (Avgerou, 2000).

The development of ICT has been adopted successfully in the healthcare sector in the form of telemedicine. Telemedicine is one of the areas where the ICT and healthcare have been merged together in order to overcome the deficiencies of the delivery of healthcare. Telemedicine has been defined as the use Information and Communication Technology to provide medical information and service. The services provided under the category of telemedicine can be as simple as two healthcare professionals exchanging information with each other with the help of

modern communication technologies or as sophisticated as using advanced communication technologies such as teleconferencing for the purpose of online consultation between providers living in far away locations (Chatrath et al., 2010).

Tang et al. (2010) developed a telemedicine home care management system combining hospital management system and mobile communication to establish a long-term and sustainable health monitoring through the transmission of Multimedia Messaging Service (MMS). They tested this system in Taiwan with the help of 300 participants and 4736 records of blood pressure and sugar measurements. The system has been connected to the hospital management systems of several hospitals and the physicians could link to the system through the health record page of the hospital information system of the respective hospital. The healthcare staff will be alerted through electronic mail in case of any abnormal conditions and they can arrange for the patients to be transported to the hospital for further treatment or observation.

Ma et al. (2010) proposed a method to automatically manage the Electronic Health Records (EHR) of patients using ICT. This system helps manage the health records in a patient centered fashion opposed to the current practice of hospital centered health record management. The health information has been stored in a Secure Digital (SD) card and in a network database. The personal health data has been fingerprint encrypted and then saved to the SD card and network database. The functional modules of the system include health information on women's health during pregnancy, infant and child medical information management. The system model allows pediatricians and gynecologists to check the past health records of patients conveniently without going through paper based files manually. The system

helps the patients in terms of having their entire health record available at finger tips irrespective of where they consult the physician.

Similarly, ICT can also be used to increase the reach of healthcare beyond the conventional boundaries. The recent years have seen an unprecedented increase in the elderly population all over the world and in Asia in particular. The percentage of elderly population in the 1950s was only 14.1% and this is expected to increase up to 17.5% by the middle of this century (Menon & Melendez-Nakamura, 2009). With the growth of the elderly population, the challenge for providing affordable quality healthcare to this elderly population becomes acute. Several researchers have proposed that the development in the field of ICT can be harnessed to provide quality healthcare at an affordable price on a sustainable basis. Firdhous and Karunaratne (2011) studied the impact of the development of ICT in the developing countries with special reference to Sri Lanka and proposed that ICT can be successfully harnessed to meet the healthcare requirements of the elderly.

2.2   Quality of Service in Healthcare Services

Quality in healthcare services is composed of two main components, namely the quality of core activities and quality of other but related activities. The core activities include the professional services provided by the specialists, physicians and other healthcare professionals including nurses, pharmacists and attendants. Other activities include all the other services provided by the service provider. The quality of both activities need to be improved in order to improve the overall quality of services provided (Najmuddin et al., 2010).

Service quality has been defined as an assessment how the customers judge the services provided in meeting their expectations based on their perceptions of the service (Alamgir & Shamsuddoha, 2004). Grubor et al. (2008) have identified the following as the dimensions based on which the service quality of an offering will be assessed.

- Reliability

- Responsiveness or timely delivery

- Assurance (knowledge of the staff and courtesy)

- Empathy or individual customer care

- Tangibles, or service materialization based on physical elements

It can be seen that the timely delivery of the service is an important aspect of service quality. If the delivery is delayed, clients will reject the services provided even if all the other dimensions of the service quality are met. Therefore organizations striving to become the best in the industry must consider the service time as one of the most important factors while maintaining the quality in terms of other dimensions. The service time in healthcare especially in the outpatient departments is composed of two main components, namely the waiting time and the treatment time. In the healthcare services, the treatment time especially the consultation time is not normally considered a waste or inefficiency of the physicians by patients. But the waiting time is always considered to be wasted as it is not spent on any useful work. Long waiting times has been found to be one of the main reasons for clients moving towards private healthcare providers against government providers (Najmuddin et al., 2010). Hence it is important for healthcare service providers to look into the measures of reducing the waiting time of clients.

2.3   Issue of Waiting Time

In healthcare sector, patient waiting is a common issue throughout the world (Jayaweera et al., 2006). Patient waiting is one of the main reasons for dissatisfaction among the clients. The dissatisfaction among the patients on waiting time has normally been expressed as waiting in the patient department, waiting to see a doctor, waiting to be seen in a casualty department, waiting to get into hospital and sometimes waiting to get out of hospital. It is often said that patients have to wait too long in hospitals irrespective of for what it is for (James, 2007). Managing the patient waiting time is an area that requires special attention of hospitals as waiting not only creates dissatisfaction but also resources inefficiencies. The increasing cost of healthcare and the shifting of emphasis towards preventative care as opposed to curative medicine are encouraging the researchers to investigate new ways to reduce the cost of healthcare service while improving the efficiency of patient care services. One of the areas that has attracted the attention of the researchers is the scheduling of patients at clinics and special care services (Wijewickrama & Takakuwa, 2006).

Traditional manual appointment systems have failed to meet the requirements of both patients and service providers in terms of matching supply and demand for urgent or same-day appointments. Traditional appointment systems have also been identified as one of the main contributor to the decreasing of patient satisfaction (Belardi et al., 2004).

Due to the rising cost, service providers seek ways and means to reduce the cost of services. One of the areas that have been considered first for cost cutting is the

ancillary services. Ancillary services have always been considered not to add value to the services provided and hence a cost. In this manner, a service provider always considers the services provided to awaiting patients are a cost. But, more the patients waiting more the cost incurred without any positive return. The services provided to waiting patients include the provision of waiting area, air conditioning, ventilation, lighting, entertainment, etc. A service provider will be able reduce the overall cost of services provided by reducing these additional expenditures, but it will work against the service provider, if alternative methods of improving services were not provided. Hence with the diminished capacity, there is a clear need for analytical tools that can provide better services with the dynamics of patient flows in clinics and hospitals. Variability in both supply and demand, if not managed properly will result in crowding, staff overloads, unmet patient needs and general frustration (McManus et al., 2003).

According to Giachetti et al. (2005), the patient waiting time at clinics is twenty weeks into the future due to the large backlogs. Also patients sometimes spend more than two hours in the waiting rooms of clinics for a twenty minute appointment. Usually clinics have a high rate hovering of appointment slots to the rate over 50%. The researchers state that, it seems the clinics were in crises; yet the managements were though concerned by the poor performance but not alarmed. The reason for the indifference of the service providers was that they were of the opinion and attribute the poor performance of the clinics to the external influences of the patient community they served.

Block appointment scheduling, that is scheduling more than one patient to the same slot is practiced by some service providers. This kind of scheduling is also useful

during high absenteeism of patients. The high rate of no show by patients is not unusual; several studies have confirmed this tendency of patients in their studies (Martin et al., 2003; Moor et al., 2001; Murdock et al., 2002; Tuso et al., 1999). High rates of no show like this make it difficult to improve the quality of health services. At the same time, this kind of behavior contributes to the further escalation of costs of healthcare services. Hence it is necessary educate the patients of good habits. In order to reduce the impact of no show by patients, clinics use the scheduling policy where groups or blocks of patients are scheduled to arrive at the same time (Ho & Lau, 1999).

Many IT solutions have been implemented with the aim of improving the quality of health services by influencing patient behavior (Revere & Dunbar, 2001). These solutions share the common objective of delivering a message designed to influence the behavior of patients. For example, patients are sent alert messages prompting them to take their scheduled medications, attend appointments or appear for recommended screenings. But currently there is very little understanding as to how such messages play a role in influencing the decision making of patients (Krueger et al., 2003).

Many reasons can be attributed to the long waiting times. These reasons include unsuitable algorithm of the appointment systems, unsuitable appointment patterns, insufficient doctors or consultation rooms in a clinic and random arrival of patients. But a most of the researchers are of the view that an effective appointment management system can reduce waiting time significantly (Harper & Gamlin, 2003; Wijewickrama & Takakuwa, 2006).

Zhu et al. (2010) have studied the factors causing the long patient waiting time in outpatient clinics. In this study, they have found that overbooking of appointments beyond the capacities, not starting the consultation session at the scheduled time, uneven distribution of schedules, irregular calling disregarding the appointment schedules, unused session times, are the main reasons leading to long waiting times. The paper further discusses the inefficiencies in the current scheduling mechanisms such as Bailey's rule due to the rigidity of these mechanisms and non consideration of the uncertainties that are prevalent in outpatient clinics. Using a discrete event simulation model, they have proposed a model which is virtually focused at eliminating the anomalies highlighted above to create a smooth appointment schedule. But the model fails to take into consideration that the appointment slots may need to be of different lengths depending on the type of patient and the past information available. Hence the model proposed seems to be too rigid and mainly focused towards a manual appointment schedule.

Kumar and Shim (2007) have looked at a way to arrange consultation rooms in a specialist outpatient clinic with view to maximize the utilization factor while optimizing the patient waiting time. They have carried out a simulation study using queuing models, but failed to identify any solution that would optimize the waiting time of patients.

In order to achieve the optimum match between the patient demand and provider resources, it is necessary to build an appointment management system using modern technology. This kind of appointment system will improve the effectiveness of the

appointment management, continuity of care, and both patient and provider satisfaction.

2.4   Impact of the Internet on Healthcare

The impact of the Internet has been felt in almost every aspect of our lives. Healthcare service can be improved with the proper use of the Internet. If the healthcare information is accessible by both patients and physicians over the Internet, it would help both the patients and physicians tremendously. A physician will be able to access the health report of the patient even at home or from wherever he is currently at. This would help him to prescribe some emergency medication even before he has the opportunity to examine the patient physically. This would be very useful during emergencies. Similarly the internet can be used to improve the quality of the appointment management at hospitals and clinics (Hai, 2000). Also the use of the Internet would help the service providers to lower the cost of healthcare through increased administrative efficiency. The Internet provides both the patients and doctors the flexibility of accessing the appointment management system from anywhere and anytime.

The internet based online systems make the task of administrative staff more flexible. They now will have the capability to carry out their work from anywhere any time. This may even carryout their work from home during weekends balancing their career life along with that of the personal life. Internet also provides better communication facilities and information sharing capabilities among employees working in different departments (Nelson & Lang, 2002).

Internet also can have an impact on healthcare services by improving the service delivery in a more flexible manner. The number of physicians who use the Internet in some fashion to improve their service delivery is increasing every day. Similarly there is an increasing tendency for patients to use the Internet as a medium of communication to contact their physicians (Virji et al., 2006; Houston et al., 2004).

The number of internet users as well as the amount of information available on the Internet are growing at tremendous rate (Ackermann & Hartman, 2000). This provides a new opportunity for patients to become more informed and play an active role in their treatment process. Internet is a potentially powerful and important tool for patient, and medical information sites represent a large proportion of web sites surveys of internet users demonstrate they have great interest in accessing medical information on internet (Fox & Rainie, 2000). Internet as an effective patient health information resource relates to information quality. Medical information on the internet can be highly variable in quality (Croft & Peterson, 2002), as access to the internet continues to grow it is likely that individuals will increasingly use it as a source of healthcare information (Ross, Chapman, Murray, Stevenson, Natin, & Rogstad, 2000). However, there is also a growing concern regarding the quality of information available on the Internet and the negative impact they might have on the patients' mental as well as physical health (Goldschmidt & Liao, 1998).

2.5   Appointment Scheduling Systems

Appointment scheduling systems have been used by various services such as restaurants, gaming centers, sports facilities and private and public clinics. Most of the appointment scheduling systems are used in practice tend to minimize the idle

time or optimize the utilization rate of the service facility while neglecting clients′ waiting times (Ho et al., 1995). In this section, appointment scheduling with special reference to patient management will be discussed.

Wijewickrama and Takakuwa (2008) have evaluated the appointment systems used in hospitals in the light of appointment rules and patient characteristics. In their study, various scheduling algorithms have been evaluated using the data collected from the outpatient division of a large internal medicine department. They combined different scheduling rules to create multiple appointment systems and evaluated those under two different conditions namely, no show and patient punctuality. The main deficiency of this analysis is the restriction of evaluation condition only to two situations leaving the other possible conditions such as delayed arrival, staff inefficiency, prolonged consultation times etc. Hence these models would work only under the very restricted conditions of no show and patient punctuality.

Lian et al. (2010) have taken a look at the effect of schedule fragmentation due to uneven time requirements. They identified that patient-provider cooperation can effectively reduce schedule fragmentation resulting in higher appointment acceptance rate and clinic time utilization rate. The patient-provider cooperation is established by providing a list of available slots ranked in the order of slots starting from slots that would cause less fragmentation to the slots that would cause the most fragmentation. The patients are encouraged but not obliged to select a slot ranked high. They argue that this method would satisfy both patients as well as providers as it tries to strike a balance between the competing requirements of both patients and providers. The authors have failed to identify a method that can automate the

defragmentation process. Hence this solution lacks practical significance due to the heavy emphasis based on the patient-provider cooperation.

Hence it is necessary to come up with an automated system that is flexible enough to manage while handling the uncertainties present in the real world. The system must be capable of using the past information to improve the system with time in terms of efficiency and effectiveness. Thus an ICT enabled patient scheduling system that can take advantage of multiple scheduling rules and past information along with the advanced features like electronic mail (e-mail) would be an ideal solution.

2.6　Related Work

There are several commercial clinic management systems available in the market. This section takes a critical look at these software packages with respect to the technologies used, and advantages and disadvantages of them.

2.6.1　Dynacrates Clinic Management System

Dynacrates Clinic Management System has been developed by Advance Data Systems Private Limited in Mumbai, India (Dynacrates, 2011). This software can handle doctor's appointments, medical billing, patients' treatment history, diagnostics information and the administrative activities of a clinic or a hospital. Figure 2.1 shows the basic architecture of the Dynacrates Clinic Management System. Dynacrates has modules for various users in a clinic. These modules are integrated thus information once entered is available wherever required without the need for re-entering it.

Figure 2.1: Dynacrates Clinic Management System

From Figure 2.1, it can be seen that it is a generic clinic management system that has been created to manage a clinic with multiple specialties. Hence, this system is not suitable for a very specialized clinic like mother and childcare where very specialized schedules like immunization schedules and regular clinic visits by pregnant mothers need to be handled. Also, another short coming of this system is that it lacks a mobile application module that can be used alert clients in situations of changes to their schedules. The proposed system would overcome both these shortcomings as it would be designed and developed especially for the Mother and Child Health Department of the *Klinik Kesihatan Changlun* and would include an e-mail module for alerting.

2.6.2 Total Clinic Automation Solution

Total Clinic Automation Solution (T-CAS) is a web-based clinic management solution that manages all the activities involved in the operation and management of a clinic (T-CAS, 2011). T-CAS is a modular-architecture-based solution that can be customized to contain features and modules as required by clients. T-CAS also supports HL7 and EDI integration. T-CAS includes patient registration, complete patient history, doctor appointments, lab requisitions and results, interfacing with lab equipments, prescriptions, radiology with DICOM support, billing and insurance claims, scheduled reporting, customized report generation, and administrative functions. Figure 2.2 shows the design of the T-CAS clinic management system.

Figure 2.2: T-CAS Clinic Management System

T-CAS is a comprehensive clinic management system that can be used for a general clinic with multiple specialties. T-CAS lacks the facility of the electronic mail that can be used by clinic staff to notify the patients. Since this application has been

designed to be a fully fledged clinic management system, the cost of the system beyond the reach of small clinics that need a simple system to manage only their appointments. The cost of the proposed system would be reasonable, so that even for small clinic to purchase and use as it would be focused towards managing the appointment of mother and child health department. Also it will not be required to employ highly skilled computer administrators to manage the system as it would be light enough for any person with reasonable computer skills to manage.

2.6.3 Health on Click Hospital Management System

Health on Click Hospital Management System is a comprehensive system that can manage all the aspects of a large hospital (HoC, 2011). Health on Click is a modular system that handles each function in an organized fashion without duplicating information. The data management is handled in a streamlined fashion in Health on Click using a single database shared by all the applications integrated to the central system. Figure 2.3 shows the module architecture of the Health on Click hospital management system.

Figure 2.3: Module Structure of the Health on Click HMS

Health on Click is too complicated and expensive for a small clinic to handle its simple appointment management function as this system would need special high end hardware and professional support. Also, Health on Click lacks e-mail support for alerting which is one of the most important functions required in today's busy world.

The proposed system would be cost effective so that even small time clinics can afford it. Since the system would be focused towards managing the appointment of mother and child health department, it will not be required to employ highly skilled computer administrators to manage the system. Also the proposed system will include an e-mail module for alerting patients on changes to the schedule.

2.6.4   MediNous Hospital Management System

MediNous Hospital Management System, developed by Nous is an integrated health information system that addresses the critical requirements of a large hospital (MediNous, 2011). This software has been designed to address all the major functional areas of multi-specialty hospitals. The special features of the MediNous HMS are the multi-currency support, multi-location support that integrates the different functional units located at different physical locations, online investigation report availability, capability to support different information access privileges based on the role, inventory management based on FIFO with earliest expiry date in Pharmacy etc., Figure 2.4 shows the screen shot of the group user manager of the MediNous Hospital Management System. Group user manager help configure the parameters at the group level facilitating to set the most common parameters of a group once and make it available to all the members of that group.

Figure 2.4: Group User Manger of the MediNous HMS

Since the MediNous HMS is a complete application that has been designed for large hospitals with multiple specialties and operates at multiple locations, it is too complicated and too expensive for small clinics. Also, the application does not pay much attention to appointment management as it is a relatively an insignificant component in a large hospital.

The proposed system is targeted towards the appointment management of a mother and child health department. Hence the system will be developed with the objective of maximizing efficiency of appointment management function. This would be a clear advantage of the proposed system over the MediNous HMS. Also, the proposed system would be cost effective to fit into the budget of any small time provider.

2.6.5   Profmax Healthcare ERP

Profmax Healthcare ERP is an Enterprise Resource Planning System, especially designed for the healthcare industry (Profmax, 2011). Profmax is a comprehensive suit that includes modules for supporting all the core, support services and back office operations of large hospitals. Figure 2.5 shows the modular architecture of the Profmax Healthcare ERP.
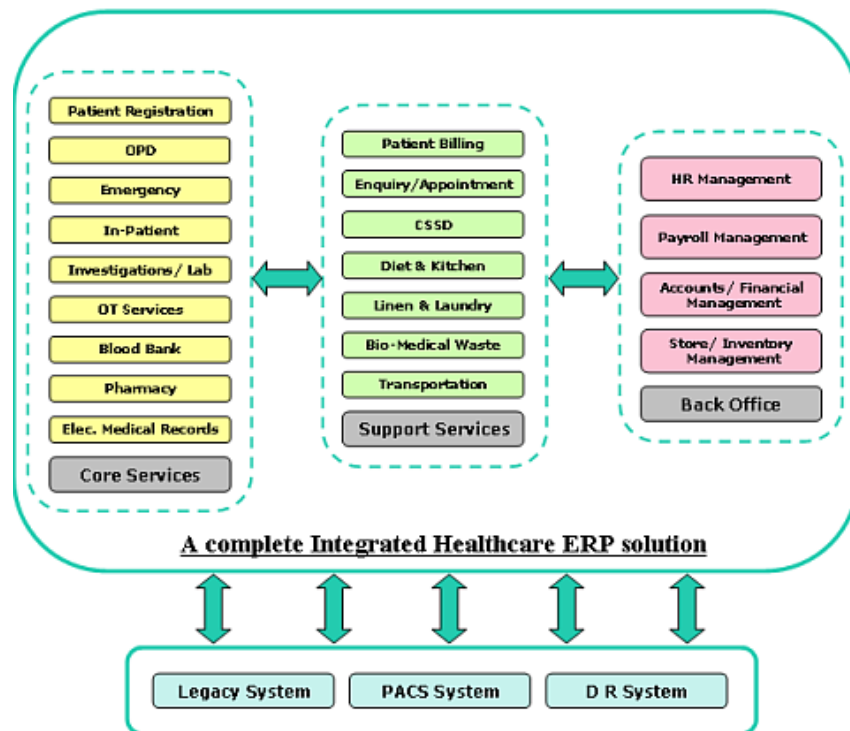
Figure 2.5: Architecture of Profmax Healthcare ERP

Profmax Healthcare ERP has been designed for large hospitals that run operations in a highly professional and organized manner. In order to manage an ERP system even with a base package and a few modules needs highly qualified technical professionals. Hence, the initial cost and the management of the software would be too high for a small specialized clinic.

The proposed system will have several advantages over the Profmax Healthcare ERP. The proposed system will cost much less than the Profmax Healthcare ERP. Also, the proposed system would be more efficient than the appointment management module of the ProfmaxHealthcare ERP as the appointment management module is an insignificant component of the bigger system. Also, the proposed system will include an e-mail module for alerting patients that is totally missing in the Profmax Healthcare ERP.

2.6.6 FreshLogics Clinic Management System

FreshLogicsClinic Management System is fully featured clinic management software developed by FreshLogics Software Systems, India (FreshLogics, 2011). This system has many features that can help manage the functions of a clinic. The main features of the system include management of the reception, printing of prescription, patient record management, and bill printing. Figure 2.6 shows reception module of the FreshLogics Clinic Management System.
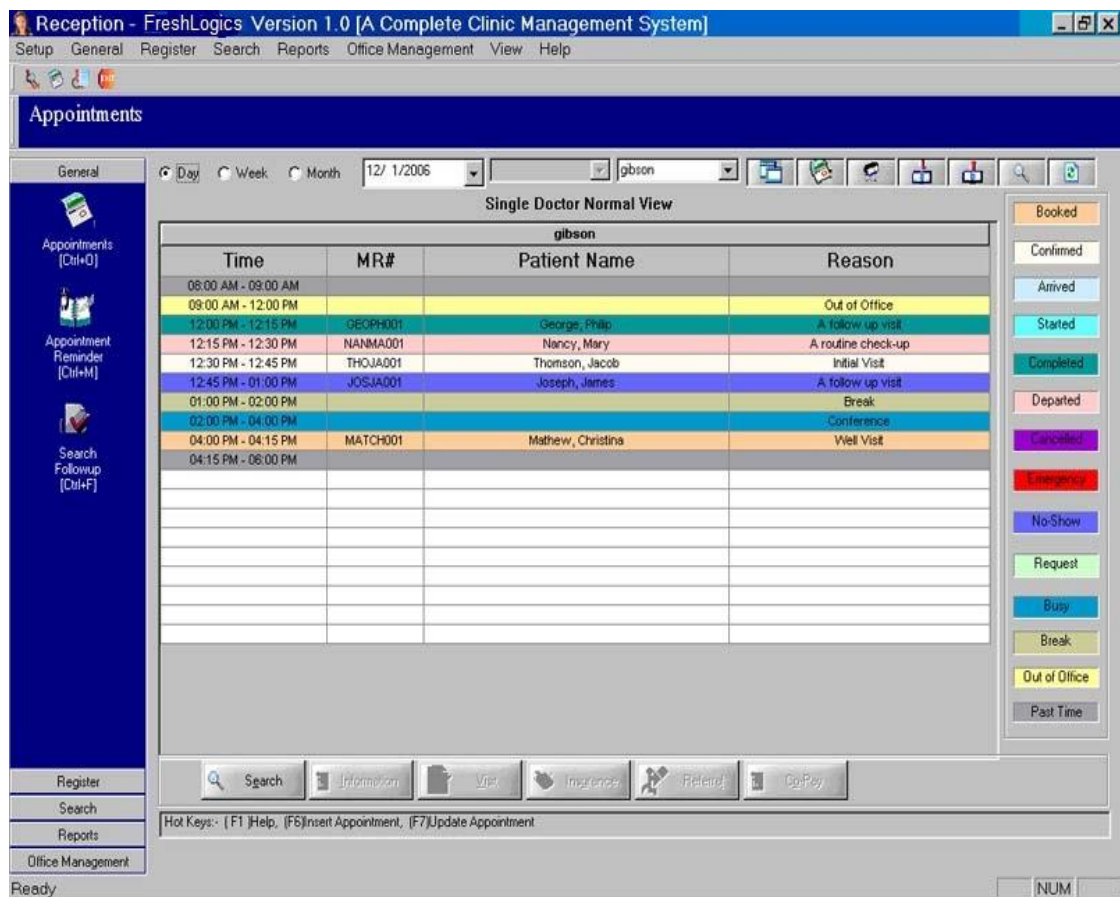
Figure 2.6: Reception Module of the FreshLogics Clinic Management System

The main shortcoming of the system is that this system has been designed for general clinic. This software is not suitable for the management of a specialized clinic like

the Mother and Child Health Department. It lacks features to store the specific immunizations schedules of children and the lab test results of pregnant mothers. Also, this is not a web based system; hence the administration of the system will be cumbersome as it needs to be installed in each and every computer. The patients will not be able to access the system from home for the purpose of booking or changing an appointment. Hence this system will not provide any special services to the patients or reduce their travelling and waiting requirements.

2.6.7   MemDB Clinic Management System

MemDB Clinic Management System is specially built software for the management of small clinics (MemDB, 2011). This software can record all patients, drug, illness and diagnosis information. It also has the capability of supporting historical data including past record of illness and drug use for better diagnostic capabilities. This software will help clinics to achieve effective management of patient records and to improve customer management. Figure 2.7 shows main user interface of the MemDB Clinic Management System.

Figure 2.7: Main Interface of the MemDB Clinic Management System

The main shortcoming of the system is that this is a standalone software that can support only one user station. Hence this system is not suitable for a clinic with multiple stations supporting multiple users. The system cannot reduce the patient travelling and waiting time as the patients will not be able to access the system from home. Hence this is suitable for physicians running their own private clinics only. Table 2.1 summarizes the advantages and disadvantages of the HMSs discussed above.

Table 2.1: Summary of Clinic Management Systems Discussed

System	Advantages	Disadvantages
Dynacrates Clinic Management System	Modular system with multiple functionalities.	Too heavy for deployment at a single specialized department. Lacks mobile communication module and e-mail functionality.
Total Clinic Automation Solution	Comprehensive clinic management system suitable for a general clinic with multiple specialties.	Too expensive for small clinics. Lacks the e-mail application module. Too heavy for deployment at a single specialized department.

Health on Click Hospital Management System	Comprehensive clinic management system suitable for a large general hospital.	Too complicated for a single specialized department. Too expensive. Requires high end hardware to run. Lacks e-mail support.
MediNous Hospital Management System	Complete application that has been designed for large hospitals operating at multiple locations.	Too complicated. Too expensive. Appointment scheduling module is not comprehensive enough.
Profmax Healthcare ERP	Comprehensive ERP system for the healthcare industry.	Designed for large hospitals that has clearly defined roles and procedures. Requires qualified personnel to maintain the system. Too expensive.
FreshLogicsClinic	Fully featured clinic	System is not web

Management System	management software. Suitable for automating the day-to-day operations of a general clinic.	based; hence the administration of the system will be cumbersome and the patients will not be able access the system from home. Cannot support the special requirements of mother and child care department. May not help reduce or eliminate the travelling and waiting of patients.
MemDB Clinic Management System	A simple clinic management system that can support a private clinic.	The system is standalone and can support only one user station. Will not reduce patient travelling or waiting time as it cannot be accessed by patients. No support for storing lab results and children's immunization schedules.

From the discussion and the summary provided above, it can be seen that most of the applications available in the market are for large hospitals and the appointment management module is rather an insignificant component of them. The special clinic management systems evaluated lack the facility of a web based system that can be accessed by healthcare professionals, healthcare providers' employees and patients. These two clinic management system will not help reduce the patient travelling or waiting as they only automate the manual operations of the clinics and does not add any special feature such as the capability to access and schedule appointments remotely or alerting facilities. Hence a clinical management system specially designed for gynecology and pediatrics department would help all stakeholders including healthcare service owners, doctors, nurses, management and patients immensely.

2.7   Summary

This chapter presented the literature survey carried out in order to identify the current research, products in the market and to identify the gap in the current systems. Initially the impact of Information and Communication Technology on human life in general and healthcare in particular was investigated briefly. Then the issue of Quality of Service (QoS) in healthcare and the effect of waiting time were investigated in depth. The probable impact of Internet on healthcare was studied thoroughly with special emphasis to the current situation, positives and negatives of using the Internet for healthcare. An in depth look at the appointment scheduling in clinics was taken with the aid of the published work. Finally the hospital

management systems and clinic management system software in the market were investigated with special reference to their strengths and weaknesses.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is more than just collection of method to perform a research; it is a systematic way to solve the research problem (Rajasekar et al., 2006). The research methods refer to the methods and technique used by the researcher in performing the research, for example data collection technique, and data processing techniques. For the purpose of designing and developing the prototype, the general research methodology proposed by Kuchler and Vaishnavi would be used (Kuechler & Vaishnavi, 2008). This methodology has been selected in this study primarily due to the reason that it has been modified several times taking the advances in technology into consideration. The most recent update for the methodology has been carried out in 2008 and is very suitable for projects that are mainly focused on system development rather than theoretical research. The system developed will be tested for usability through a test on the prototype.

Methodology proposed by Kuchler and Vaishnani consists of five major phases (Kuechler & Vaishnavi, 2008). They are namely;

- Awareness of Problem

- Suggestion

- Development

- Evaluation

- Conclusion

Figure 3.1 shows these five major phases.
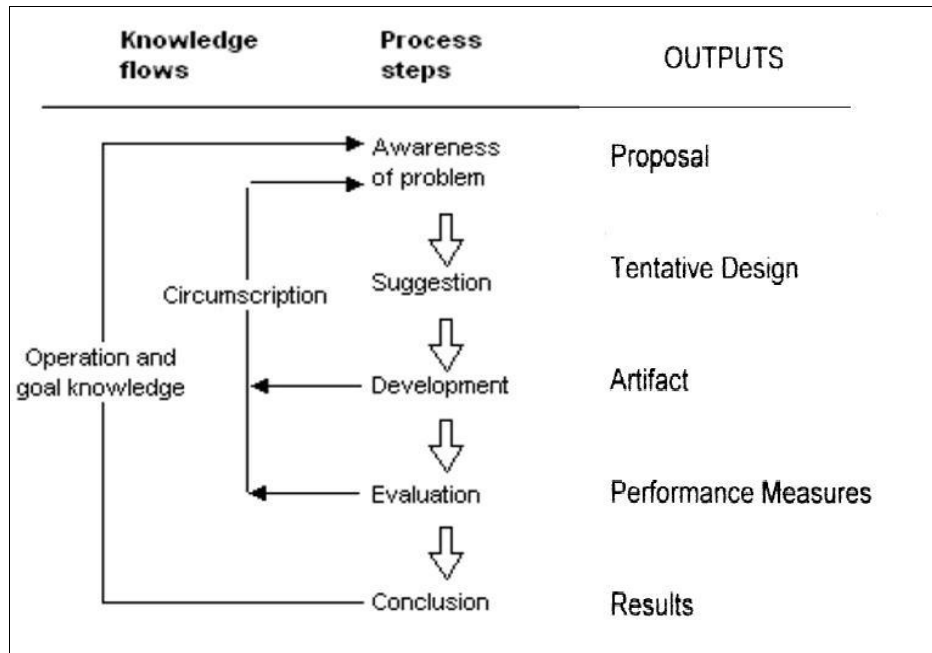
Figure 3.1: Major Phases in Design Cycle (Kuechler & Vaishnavi, 2008)

3.2   Research Design Methodology

3.2.1   Awareness of Problem

A problem needs to be understood properly prior to developing any solution. If the any solution development is attempted without proper knowledge of the problem itself, the solution proposed or developed will fall short of meeting its objectives. Thus requirement analysis is a very important step in any development effort. Requirement analysis is made up of two major activities, namely understanding or analysis of the problem and requirement specification. Understanding the problem

becomes a major task for large systems with many modules and features that require performing many different tasks. During this step, the main focus must be on what is to be performed rather than how it is to be performed. The analyst at this stage must possess a thorough knowledge of the problem domain and its context in order to carry out this operation successfully.

When the problem has been correctly identified and understood, the solution development would be much easier. Many different methods can be used to understand a problem.

There are many techniques help analyst to extract problems such as interview, discussion, and questionnaire.

In this project, the problem awareness process was carried out by conducting interviews with some clients (patients) and a staff member of the *Klinik Kesihatan Changlun.*

On April 4, 2011 at 2 PM, the researcher met one of staff members namely Ms. Shaebah Binti Ahmad a staff nurse at the clinic. She gave the basic information about the clinic including the physical and other resources, working hours and services offered by the clinic. She stated that the *klinik kesihatan changlun* has two departments namely, outpatient department and mother and child care department. In the mother and child care department has three rooms. Out of these three rooms, two rooms are used for mother and child care and the other room is used for family

planning. The clinic is staffed by one specialist, one general physician, seven staff nurses and six community nurses.

The clinic provides both anti natal and post natal care and childcare up to the age of six years. The main services provided includes immunization, physical assessment and growth assessment of children and tailing blood specimen, urine test, blood pressure, weight, height and physical examination of mothers. The clinic does not handle deliveries. The patients are transferred to the Alternative Birth Center for deliveries. Any other disease not connected to mother and child care is treated at the outpatient department.

According Ms. Shaebah, the clinic working hours are Sunday to Thursday from 8AM to 1PM and 2PM to 5PM. Friday and Saturday are off days. Patients have to come early before 8AM to obtain a queue number. A queue number obtained on any particular day is valid only for that day and if a patient misses the schedule he or she has to obtain a fresh queue number again. There is no facility to obtain a queue number beforehand. All the patients are registered at the clinic manually in a file. Each appointment is entered in two places, one in the department appointment file and the other one in the patients' card by the doctor. The patient's card is given to the patient and be brought every time she attends the clinic. Children's immunization schedules are maintained in a similar fashion in two cards one maintained in the department and the other one with the mother. Every detail about the child is entered in the cards.

Ms. Shaebah stated that coming early in the morning for obtaining a queue number is a problem for many patients. Sometimes even if they come very early they cannot obtain a queue number due to a large number of patients who had already arrived there before them. Most of the times, patients have to wait for a long time to meet the physician due to long queues. This is a big problem for many patients especially pregnant mothers as the waiting room facilities at the clinic is limited.

Manual maintenance of patient information is also cumbersome and problematic to both the clinic as well as the patients. Sometimes, the patients forget to bring the appointment or the immunization cards due to the hurriedness of them to come to the clinic in order to obtain a queue number or sometimes the patients totally forget their scheduled clinic dates. Missing appointment may affect the mother and the child very badly in case of pregnant mothers and missing an immunization schedule may affect a child later in his or her life. There is presently no way of reminding the patients about scheduled clinic or immunization dates. She opined that an automated system will reduce the administrative work load of the staff dramatically and improve the efficiency and quality of service of the clinic impressively.

Some of the patients were also interviewed on the same day after the interview of Ms. Ahmad. All the patients interviewed were of the opinion that the present manual system is not at all satisfactory. They mainly emphasized the need for an automated system that can be accessed from their homes in order to reserve a clinic slot and check their schedules. They also mentioned that an automatic reminder

system would help them tremendously as most of them are working mothers and due to the work load, there is a very high chance of missing schedules.

3.2.2   Suggestion

Problem awareness phase is immediately followed by the suggestion phase. Both the problem awareness and suggestion phases are closely linked together. The result of the suggestion phase is a tentative design of the application. During the suggestion phase, an in depth attention is paid to how to solve the problem identified in Phase 1. The creative skills and knowledge of the developer are considered vital for developing the best solution in terms of functionality and efficiency.

The main aim of this study is to develop a clinic management system for *Klinik Kesihatan Changlun* with the main functions of appointment management and follow-up facilities. The proposed system features will be discussed with a few selected set of users at the *Klinik Kesihatan Changlun* in order to verify the suggestion. The main tools were used at this stage are Use Case diagrams, sequence diagrams and ER diagrams. All of these was done by using Rational Rose 2002.

3.2.3   Development

During this phase, a prototype of the proposed system was developed. The prototype has all the functionalities envisaged in the final application but with limited scope. The prototype developed helped the evaluation of the system through user testing with the participation of real users. The involvement of the real

users helped to understand the shortcomings in the system and fix them fast compared to testing and fixing the final system. Prototype has been developed using ASP.Net 2008 with C# as the programming language also data base has been designed through SQL server 2008.

3.2.3.1 Prototype Development

A reduced system similar to the final product has been developed during this stage. This would be a complete working model having all the function satisfying the requirements identified in Phase 1. Prototyping system for the purpose of testing has certain definite advantages along with a few disadvantages. Table 3.1 lists the advantages and disadvantage of prototyping.

According to Laudon and Laudon, prototyping involves three deterministic steps (Laudon & Laudon, 2001). They are namely develop initial prototype, use the prototype and revise and enhance the prototype. These steps are shown in a graphical format in Figure 8. From this figure, it can be seen that the development of a prototype is an iterative process where the prototype is enhanced until a satisfactory working model is developed.
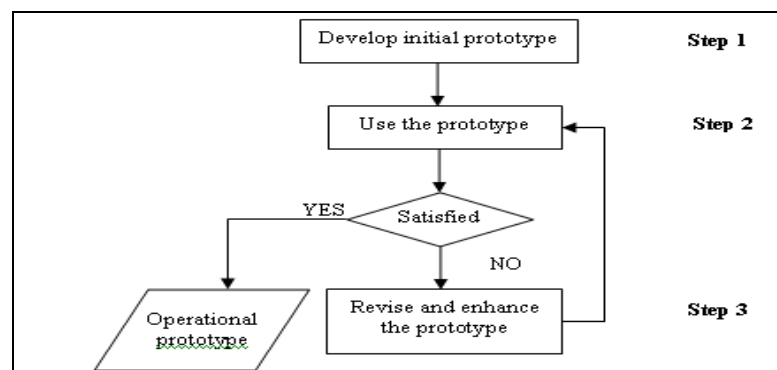

Figure 3.2: Main Steps in Prototyping (Laudon & Laudon, 2001)

Figure 3.2, shows that prototyping is essentially an iterative process going through a cycle of improvements until a satisfactory solution has been achieved. In Step 1 an initial prototype has been developed. This is mostly a crude version of the product needing definite improvements before it becomes a usable prototype. Steps 2 and 3 are two main components of the testing phase that involves testing and modification until the user is satisfied with the model. Final outcome of this exercise is the fully functional prototype.

3.2.4   Evaluation

Once a fully functional prototype has been developed, it has been tested for ease of use and usefulness. A set of real users were selected for carrying out the user testing. The main criteria for the selection of test users have been their prior experience with such systems and their knowledge in the application domain. At the end of the testing session, the users filled a detailed questionnaire based on their experience with the system. The questionnaire for testing the usability and user experience (USE) has been used. The number of test users would be limited to 40 considering the cost of carrying out this function in terms of time and money. SPSS program version 16 has been used to analyses the data was gathered from the questionnaires that filled by staff of *klinik kesihatan changlun*. The results of the test have been analyzed and presented in Chapter 5 of the thesis.

3.2.5   Conclusion

Conclusion is the final phase of the research and design methodology. The project was concluded with the development of documentation of the entire process along with the writing and defending the thesis. As part of the documentation effort, at

the end of the system analysis and design phase, user and system requirements document containing functional and non-functional requirements that have been developed. The end of the design phase resulted in a design document comprising UML, sequence and class diagrams. Finally user and administrative manuals developed to help the users and administrators. All these documents along with the program source code have been included in the final thesis submitted to the university as partial fulfillment of the degree of Master of Science.

3.3   Summary

This chapter has presented the methodology that has been used in this project, where the methodology was grouped into five phases starting with awareness of the problem phase and ending with conclusion phase.

CHAPTER 4

SYSTEM ANALYSIS AND DESIGN

4.1 Introduction

The design and development of the prototype developed for the purpose of testing has been presented in this chapter. A prototype has the same functionality as the final intended system but is a scaled down version. The development of **Web-Based Clinic System** (**WBCS**) process was carried out following all the steps discussed in Chapter 3. Chapter 3 listed the process of the system development in the three step process of designing, modeling and prototype development. The Unified Modeling Language (UML) was used to design and model the system. The UML design diagrams are discussed in detail in this chapter.

4.2   WBCS Requirements

Determining the requirements for an information system is actually the steps of gathering relevant and important information on what the system should be able to do according to the needs of the system's users (Atle, 2008). User requirements have been defined and organized under two categories, namely; functional requirements and non functional requirements.

4.2.1   WBCS Functional Requirements

Functional requirements identify the system components, attributes that are required to achieve the intended results (Bennett, 2002). The objective of determining the functional requirements are:

- to identify the user requirements

- to identify the other requirements known as non functional requirements

All the system components must be identified at the system requirement gathering stage itself (Dennis et al., 2005).Table 4.1 lists the functional requirements of the WBCS system.

Table 4.1: List of Functional Requirements

Requirement_ ID	Function Requirement	Priority
WBCS -01	**Register Patient**	**Mandatory**
	Patient and nurse can register patient information to get new Account	
WBCS -02	**Perform Login**	**Mandatory**
	Patient, doctor, nurse and admin can login to system to perform his/ her task	
WBCS -03	**Make appointment**	**Mandatory**
	Patient and nurse can make patient's appointment with doctor	
WBCS -04	**View Appointment**	**Mandatory**
	Patient can view his/her appointment	
WBCS -05	**View appointments list**	**Mandatory**
	Doctor , nurse and admin can view list of new appointments that booked online by patients	
WBCS -06	**Make Diagnosis**	**Mandatory**

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	Doctor can make diagnosis for patient	
WBCS -07	**Manage Department**	**Mandatory**
	Admin can add, delete and remove clinic department	
WBCS -08	**View Patient medical History**	**Mandatory**
	Doctor can view patient medical history	
WBCS -09	**Manage patient profile**	**Mandatory**
	Nurse can manage patient profile	
WBCS -10	**View clinic information**	**Mandatory**
	Admin, doctor, nurse and patient can view information about clinic.	

4.2.2   WBCS Non-Functional Requirements

In Software Engineering the role of the system's Non-Functional Requirements is to showing and clarifying a pragmatic and systematic approach to `developing quality into' software systems. Systems should put on view software the measuring quality attributes, such as security, accuracy, modifiability and performance.

The next coming table a WBCS non-functional requirmens will be listed.

Table 4.2: List of Non-Functional Requirements

Requirement ID	Requirement Description	Priority
WBCS _11	**Reliability Issues**	
	The availability of the system must be ensured to provide 24*7 service, with the processing of a minimum number of reservation within a given time period with zero errors.	Mandatory
WBCS _12	**Usability Issues**	

|	The system interface must be user friendly with the required functionalities.	Mandatory
WBCS_13	**Response Time / Speed**	
	The system response time must be optimum to provide a smooth user interaction. A slow response may make people frustrated and abandon the system.	Mandatory
WBCS _14	**Security Issues**	
	Private information of users must be protected. No unauthorized access to the system and user information should be allowed at any time.	Mandatory

4.3 WBCS Modeling and System Design

This section describes the design and modeling of the proposed system using UML tools. Barclay and Savage (2004) state that the UML diagrams provide developers of software systems to look at the systems developed from different perspectives and varying degrees of abstraction Use case diagrams, sequence diagrams and class diagrams are the commonly created diagrams when modeling systems.
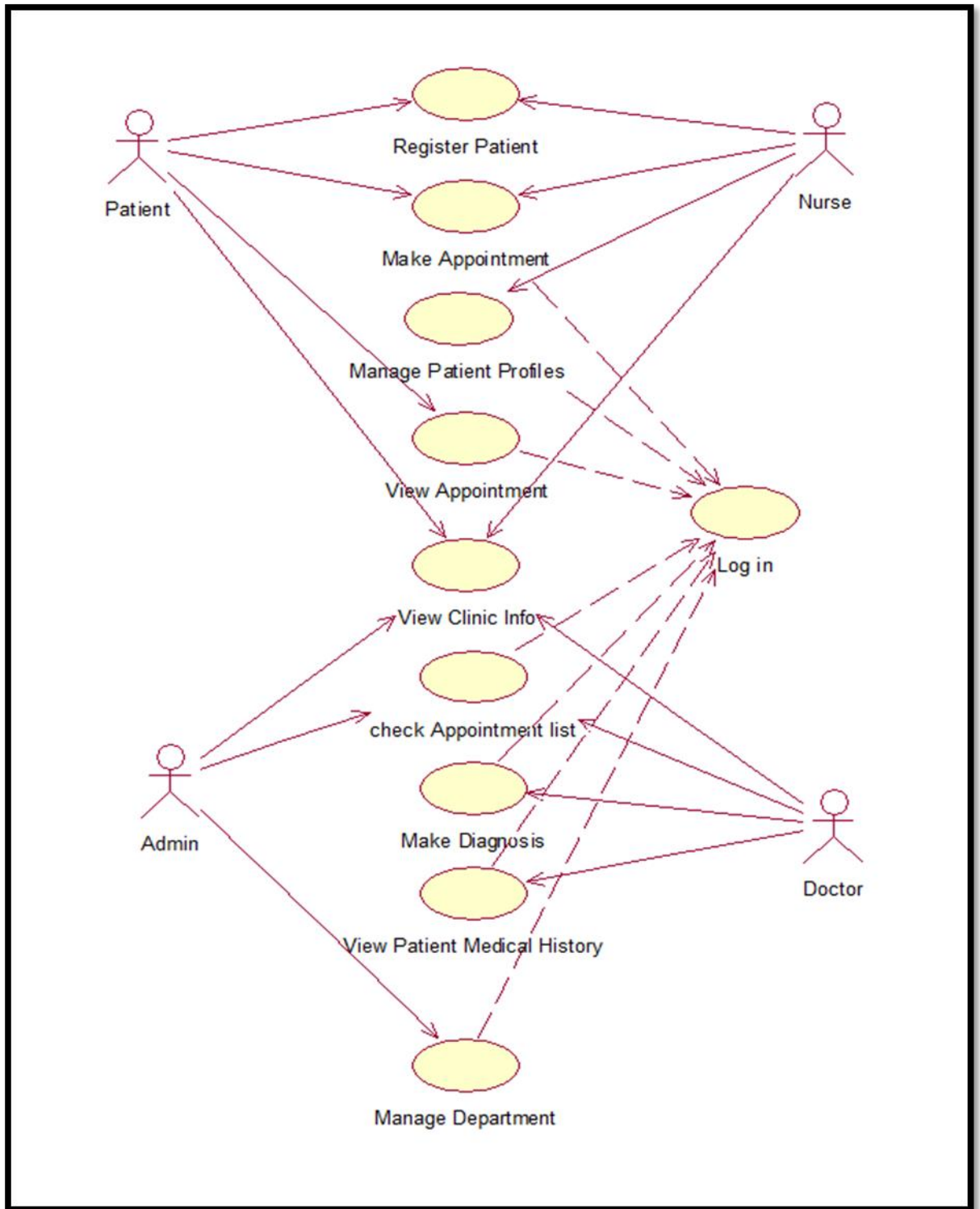
4.3.1 Use Case Diagram

A use case diagram provides a set of scenarios that describe the interaction between users and the system. It displays the relationship between the actors and use cases. Actors and use cases are the two main components of a use case diagram. Uses are used in almost every project as it helps to identify the requirements in the planning stage. Most of the use cases must be defined in the planning stage itself, but as the project is being implemented others can be defined (Martin & Kendal, 2000).

Figure 4.3 shows the symbols used in UML diagrams to represent actors and use cases. A user or a system which interacts with the proposed system is called the Actor and the Use Case is an action the Actor performs while interacting with the system to perform his intended task.
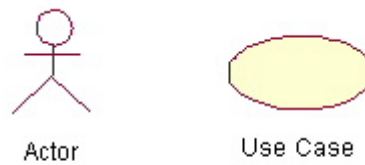
Figure 4.1: Symbols used to Represent Actors and Uses Cases in UML

The Figure 4.2 describe the WBCS use case diagram

Figure 4.2: WBCS Use Case Diagram

4.3.2 Use case specification

The WBCS use cases specifications are depicted in table 4.3 to table 4.7 respectively.

Table 4.3: Perform Log in Use Case Specification.

Use Case Name: **Perform Login**	ID: **WBCS _01**	Importance Level: **High**
Primary Actor: **User (Admin, Patient, Doctor, Nurse).**		
Short Description: This use case describes how user can log in function ensures that only authorized users gain access to the system databases. An authorized user is a user who has an account on the system. The systems' users should key-in a valid password and username to gain access to the system		
Trigger: user decides to login through key- in his/her username and password in the log in panel. Type: **External** / Temporal		

Major Inputs:		Major Outputs:	
Description	**Source**	**Description**	**Destination**
User username & password	User	Display User page	user
Login button	WBCS System		

Major Steps Performed	**Information for Steps**
1. User inserts his/her Username and Password through log in panel.	Username/password.
2. The user clicks login button.	Login button. Display user page.
3. The system shall verify and validate the entered information and Displays user page if it is correct.	

Table 4.4: Register Patient Use Case Specification.

Use Case Name: **Register Patient**	ID: **WBCS _02**	Importance Level: **High**
Primary Actor: **User (Patient , Nurse)**		
Short Description: This use case describes how Patient/Nurse registers new patient profile in the system.		
Trigger: User decides to register new patient.		
Type: **External** / Temporal		

Major Inputs:		Major Outputs:
Description **Source** Apply register link. WBCS System Name , Gender, date of birth, address, Patient information email, Marital status ,Phone , username, password Submit button. WBCS System		**Description** **Destination** Display patient form user

Major Steps Performed	**Information for Steps**
1. The user clicks on Register link	Register link.
2.The system will display the Patient form	Display Patient form
3. The user Fills up the patient form field (Name , Gender, date of birth, address, email, phone, username, password).	Name , Gender, date of birth, address, email, Marital status ,Phone , username, password
4. The user shall submit the application form by click on submit button.	Submit button.

Table 4.5: Make appointment Use Case Specification.

Use Case Name: **Make Appointment**	ID: **WBCS _03**	Importance Level: **High**
Primary Actor: **User (Patient , Nurse)**		

Short Description: This function allows user to make appointment through the WBCS.

Trigger: User decides to make appointment.
Type: **External** / Temporal

Major Inputs:		Major Outputs:	
Description	**Source**	**Description**	**Destination**
Appointment button	WBCS System	Appointment page	user
Doctor	WBCS System		
Visit date	WBCS System		
Time	WBCS System		
Submit button	WBCS System		

Major Steps Performed	**Information for Steps**
1. The user click on new Appointment button. 2. system display appointment page 3. The user choose the doctor , visit date and time. 4. The user press submit button.	Appointment button Appointment page. Doctor-visit date – time Submit button

Table 4.6: View Clinic Information Use Case Specification.

Use Case Name: **View Clinic Information**		ID: **WBCS _04**	Importance Level: **High**
Primary Actor: **User (Admin, Doctor, Patient , Nurse)**			
Short Description: This function allows user to view information about clinic through the WBCS.			
Trigger: User decides to view information about clinic. Type: **External** / Temporal			
Major Inputs:		**Major Outputs:**	
Description **Source**		**Description** **Destination**	
about button WBCS System		Clinic information user	
Major Steps Performed		**Information for Steps**	
1. The user clicks on button. 2. system display clinic information page		about button clinic information page	

Table 4.7: Manage Patient File Use Case Specification.

Use Case Name: **Manage Patient's profile**	ID: **WBCS _05**	Importance Level: **High**
Primary Actor: **Nurse**		

Short Description:
By this use case, the system allows the Nurse to managing patient profile , can view patient information / make search information / delete and update

Type: **External** / Temporal

Major Inputs:	**Major Outputs:**
Manage button Selected patient Select Function (Edit/Update/delete)	Patient list Page nurse Patient Profile nurse Updated patient file nurse Display successful message nurse

Major steps performed	**Information for Steps**
1. Press on manage button. 2. System will display patients' page 3. Nurse selects patent 4. System display patient's page 5. Nurse selects operation. 6. System display successful message	Manage button Display patients' page Selected patient Display patient's Profile. Selected operation Display successful message

4.3.3 Clinic Web Base System (WBCS) Sequence Diagrams

According to (Johan, 2004) the sequence diagrams display the time sequence of the objects participating in the interaction. This consists of the vertical dimension (time) and horizontal dimension (different objects).
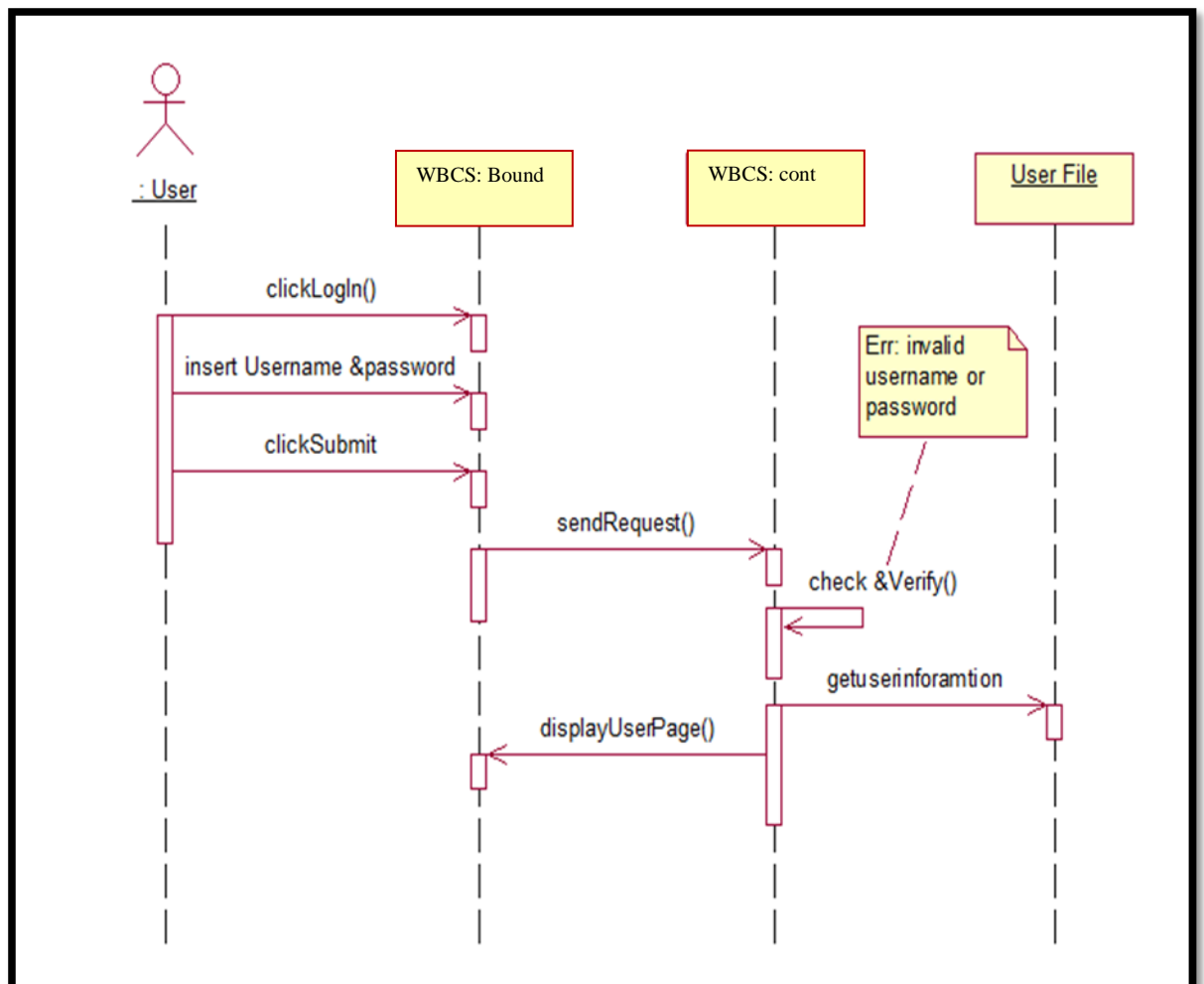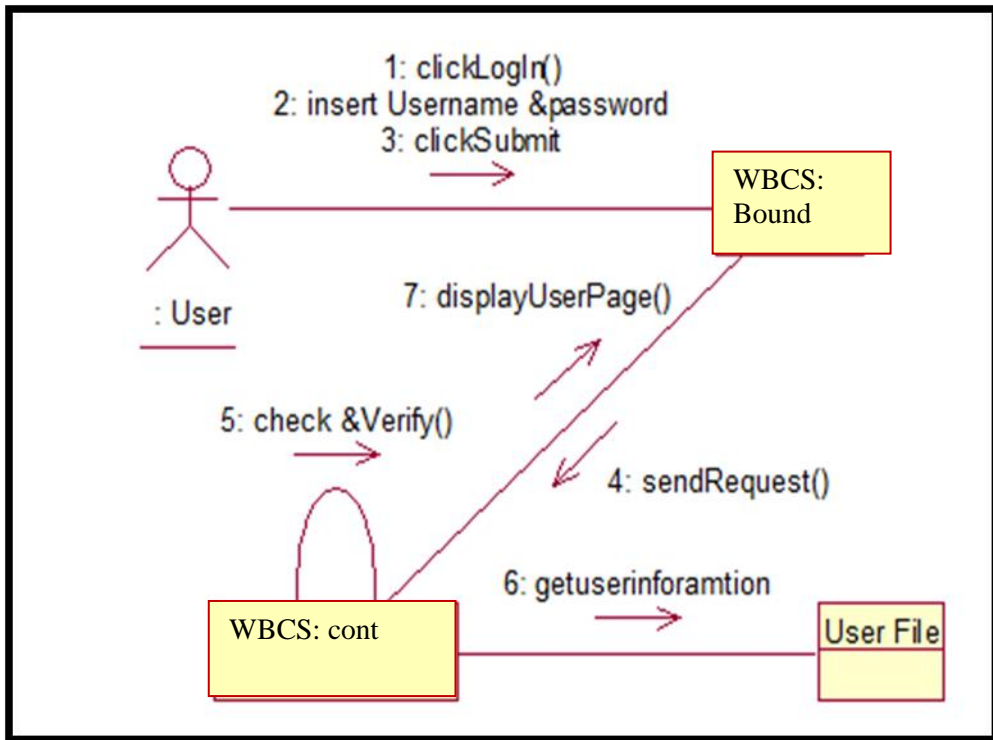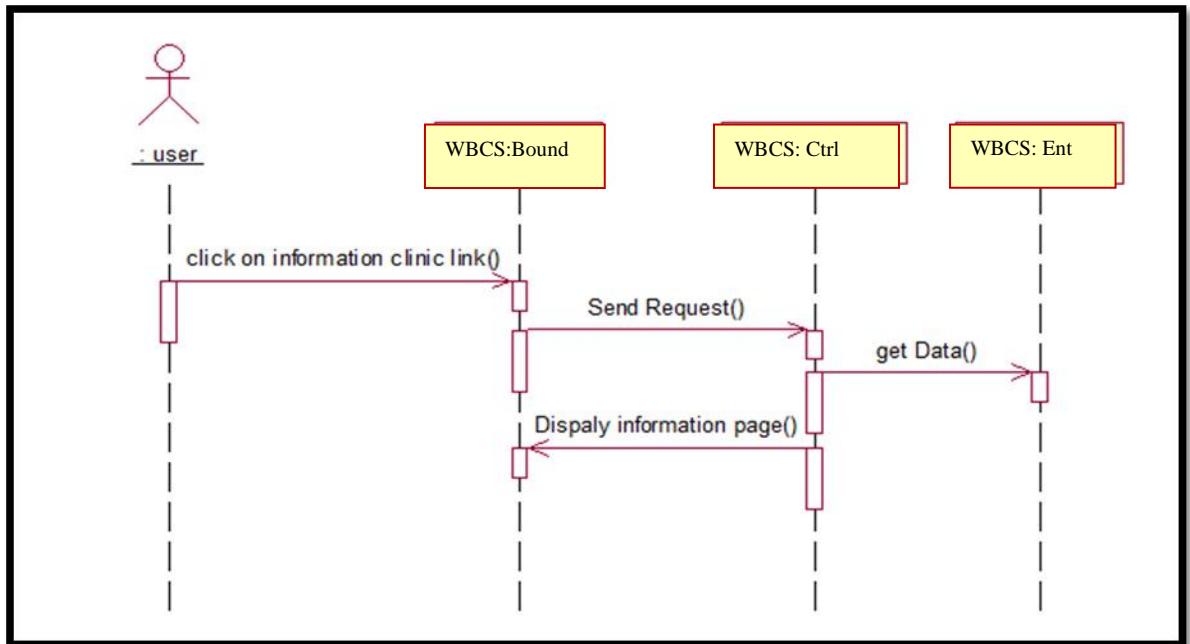

Figure 4.3: Log in Sequence Diagram

Figure 4.4: Log in Collaboration Diagram
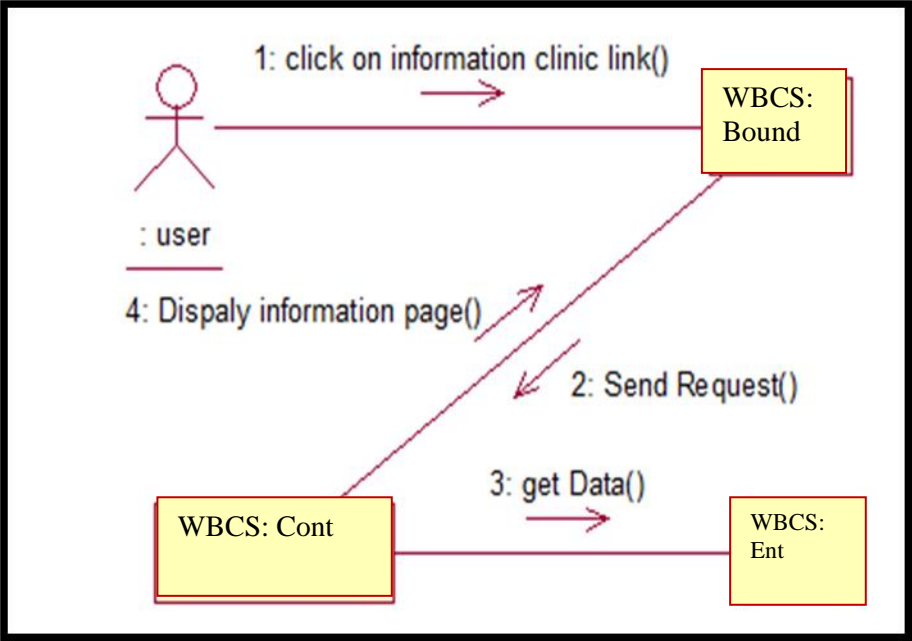

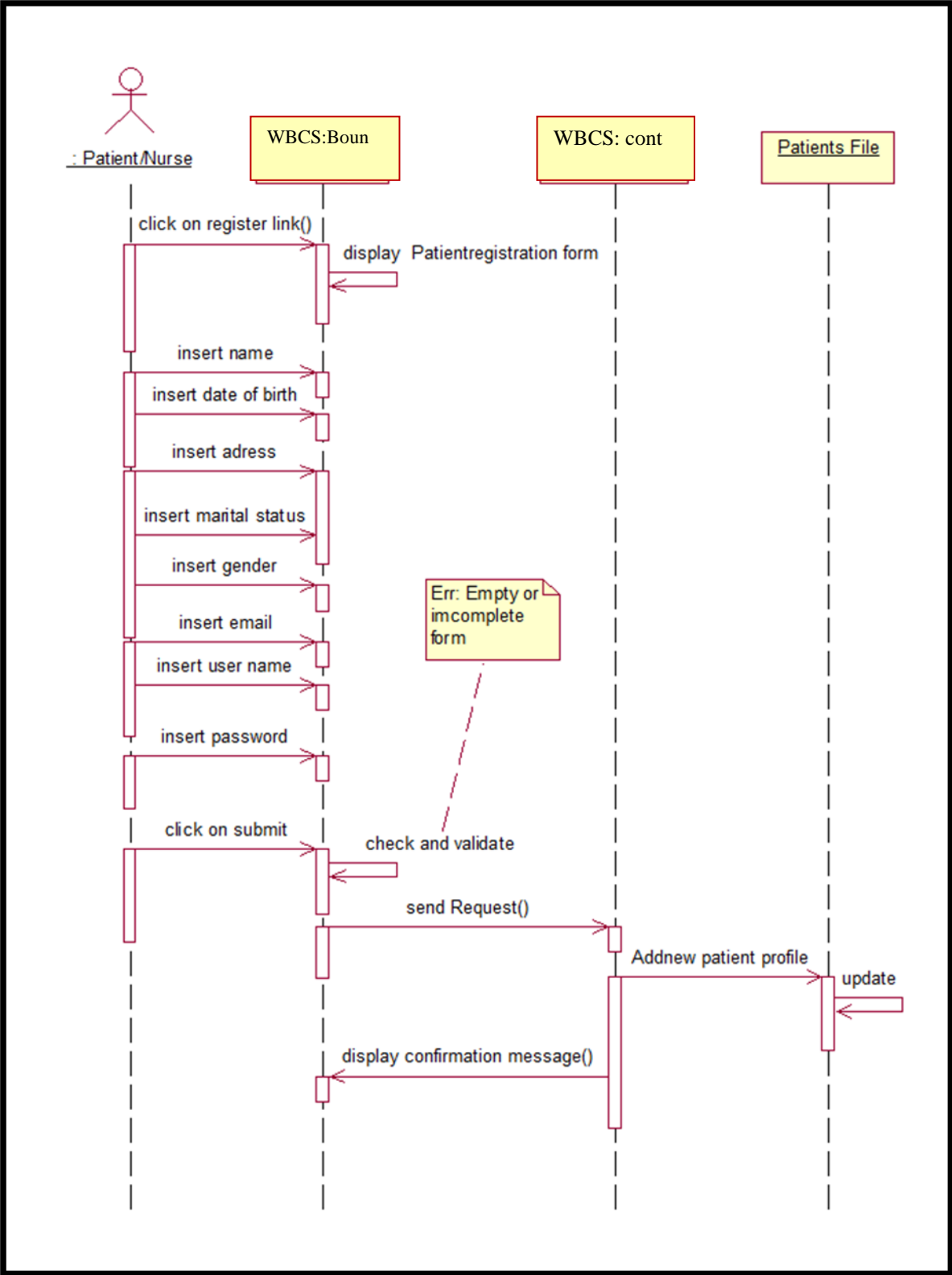**Figure 4.5**: View info clinic Sequence Diagram
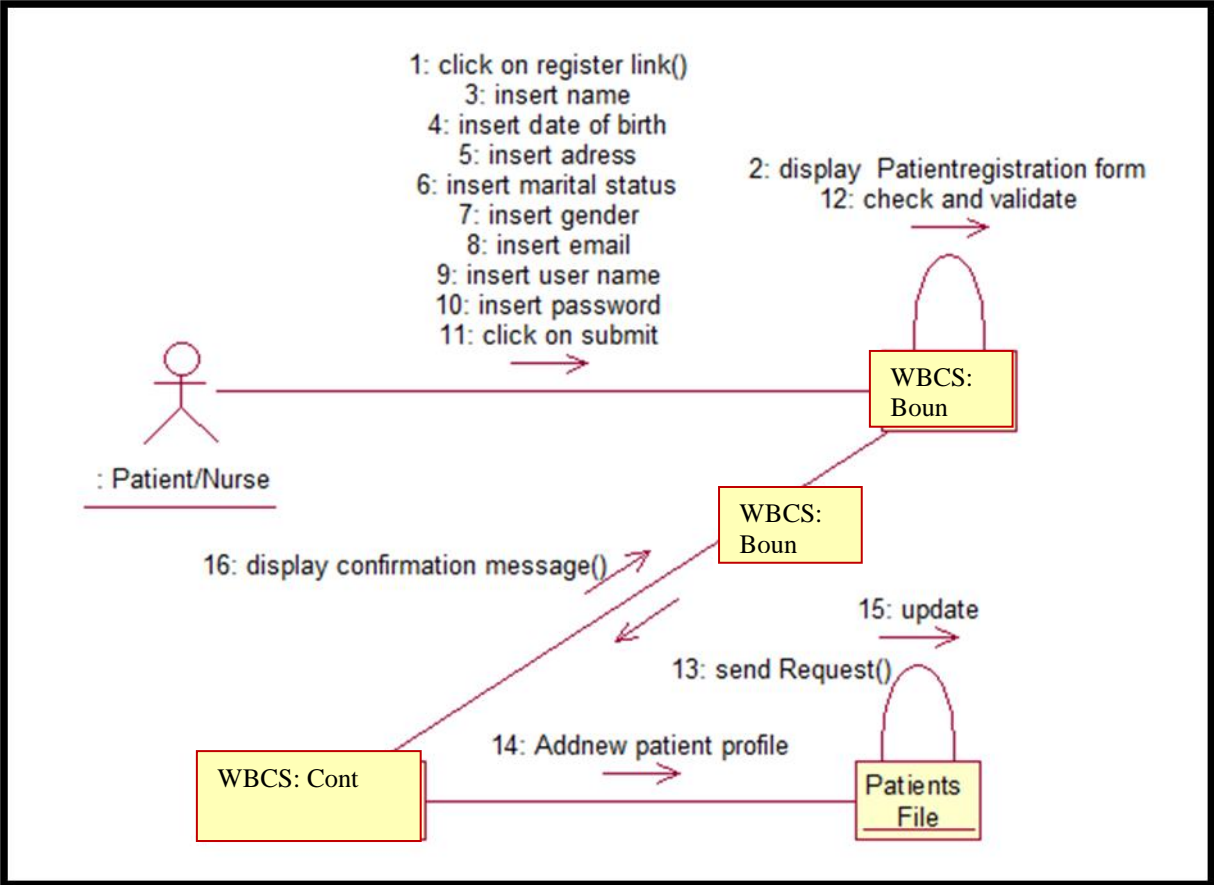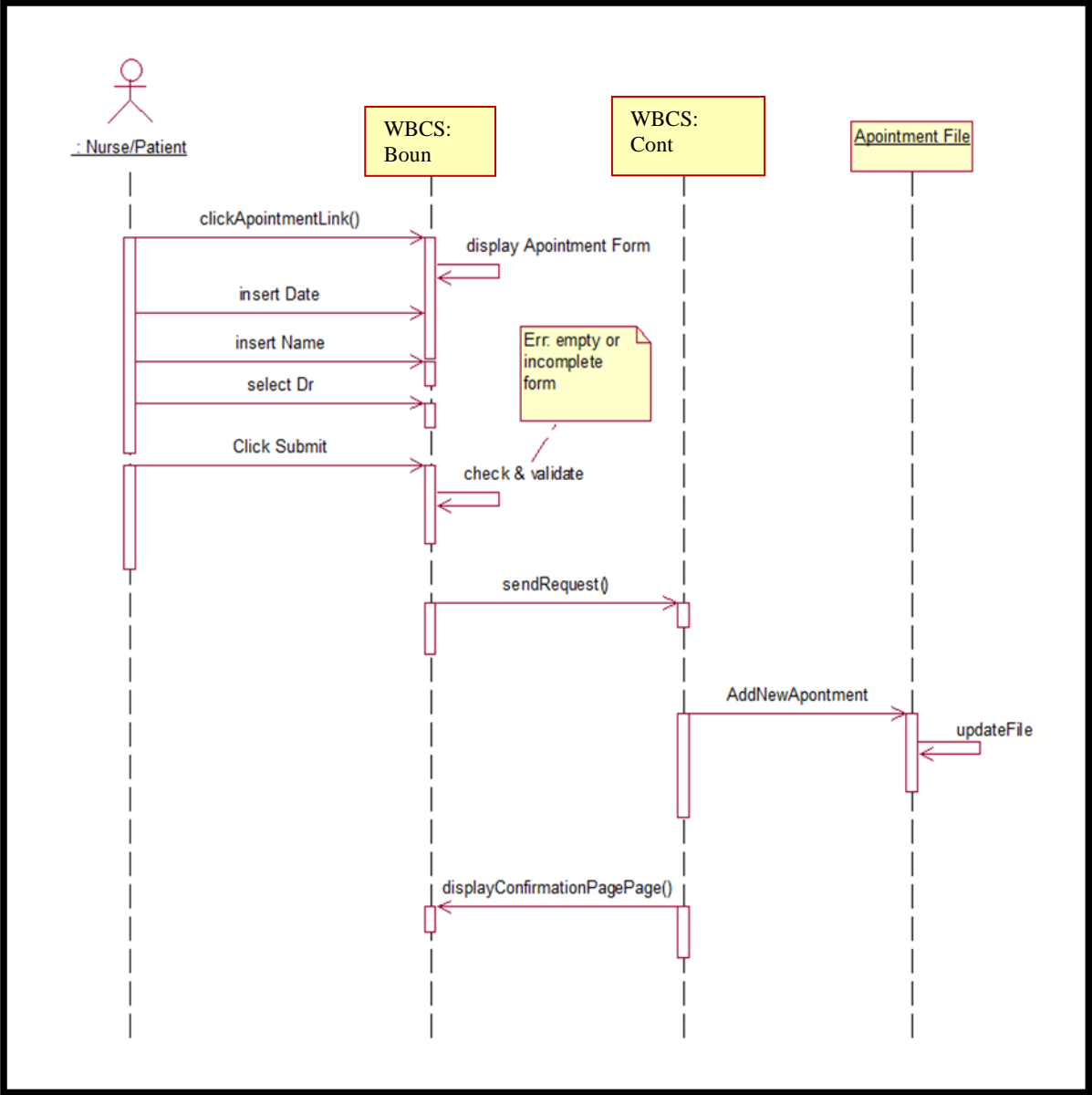
57

Figure 4.6: View info clinic Collaboration Diagram

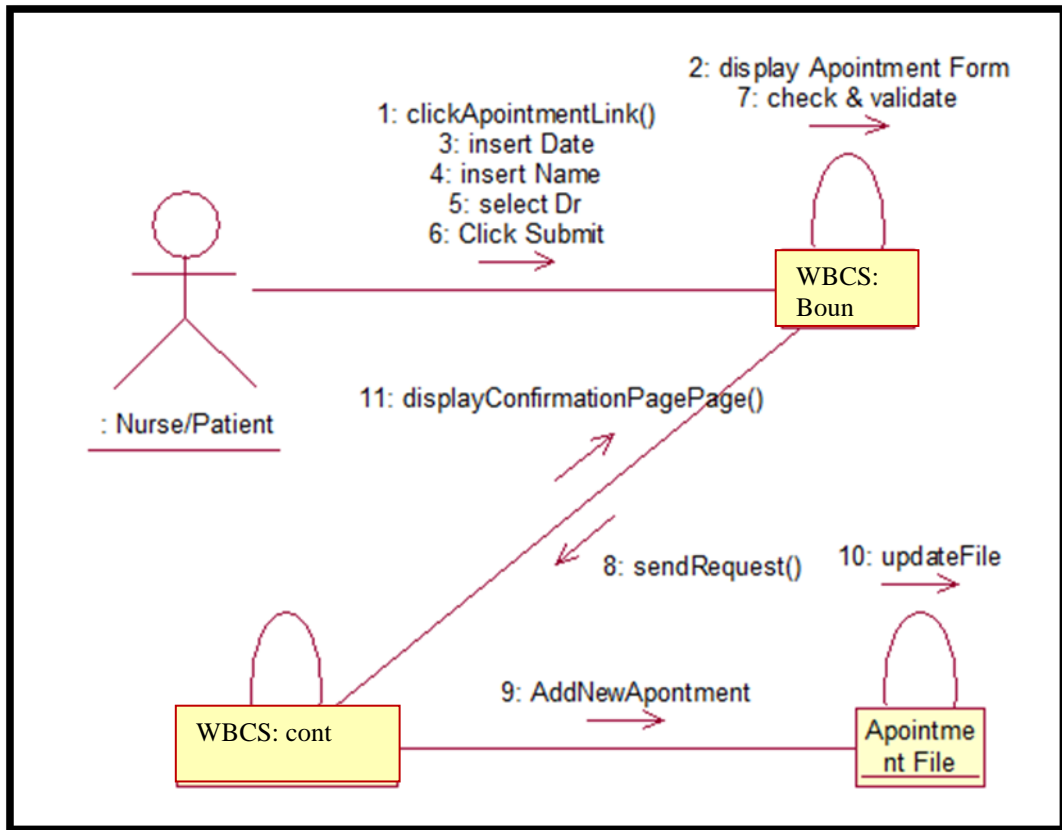**Figure 4.7**: New Patient Register Sequence Diagram

Figure 4.8: New Patient Register Collaboration Diagram

Figure 4.9: Make Appointment Sequence Diagram

Figure 4.10: Make Appointment Collaboration Diagram
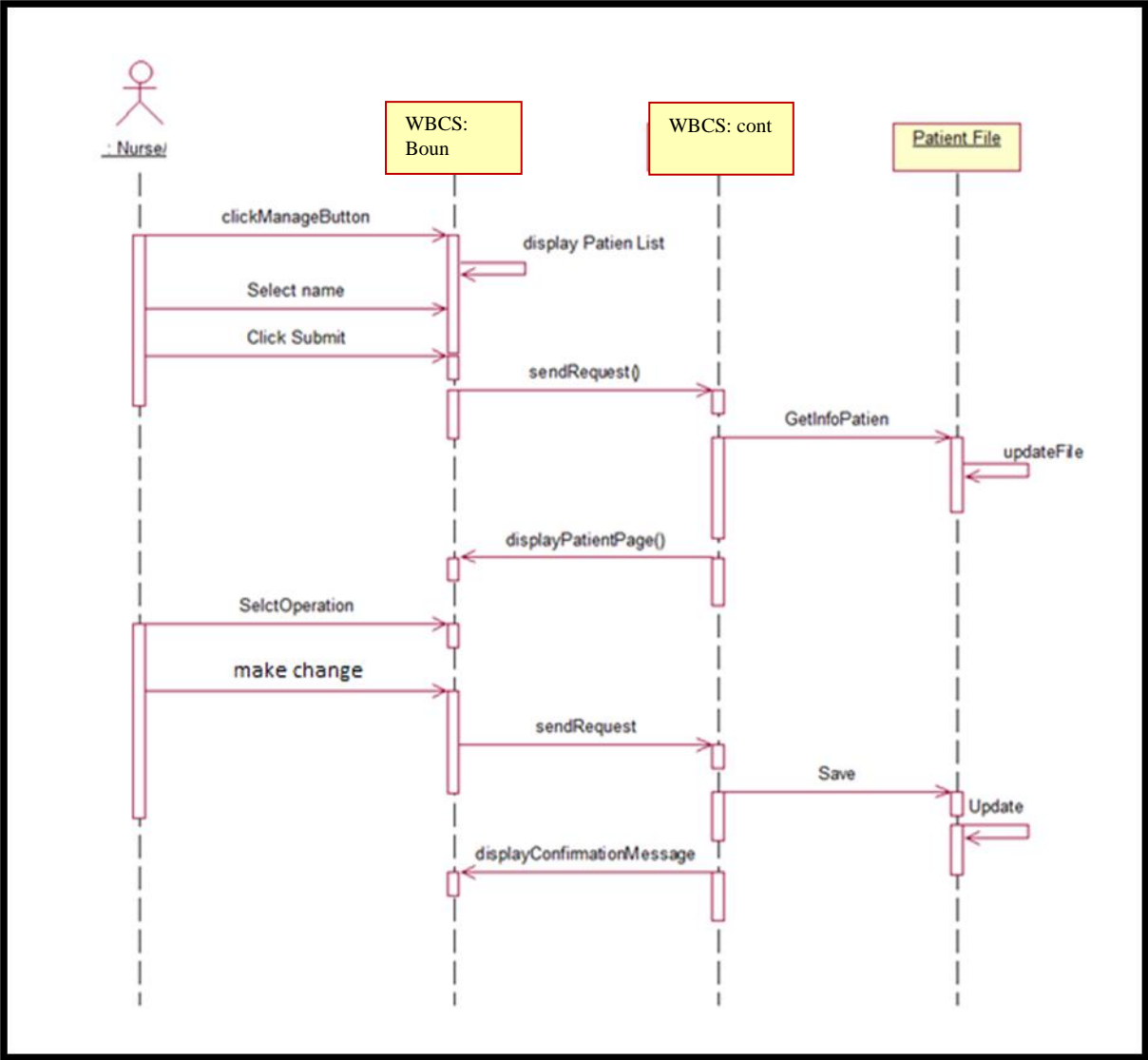
Figure 4.11: Manage Patient profile Sequence Diagram
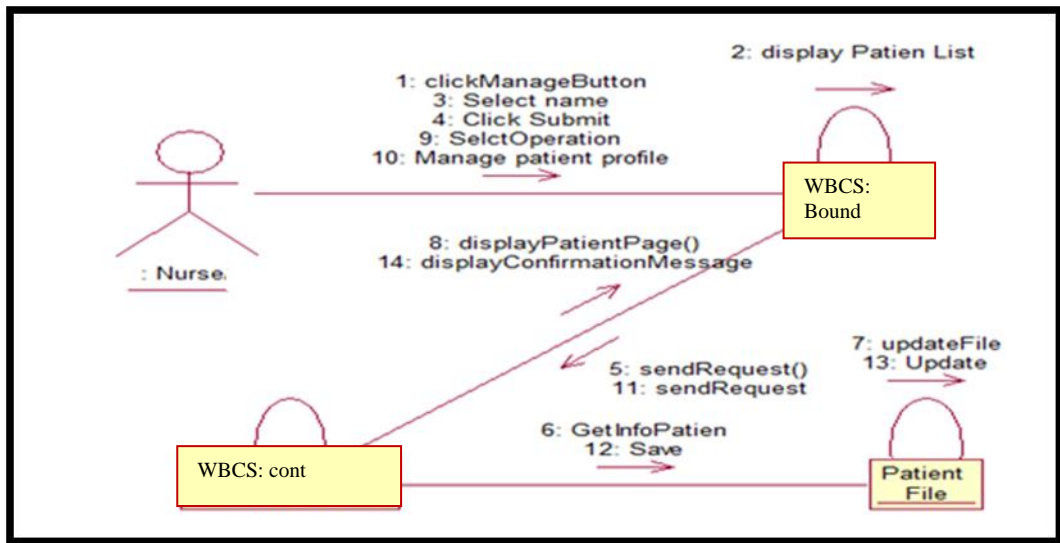
Figure 4.12: Manage Patient profile Collaboration Diagram

4.3.4 WBCS Class Diagram

Referring to Atle (2008), Class diagrams are the most common diagrams found in modeling object-oriented systems. A class diagram shows a set of classes, interfaces and collaborations and their relationships. Before drawing a class diagram consider the three different perspectives of the system the diagram will present; conceptual, specification, and implementation. It should not to focus on one perspective and it is better seeing how it all works together.
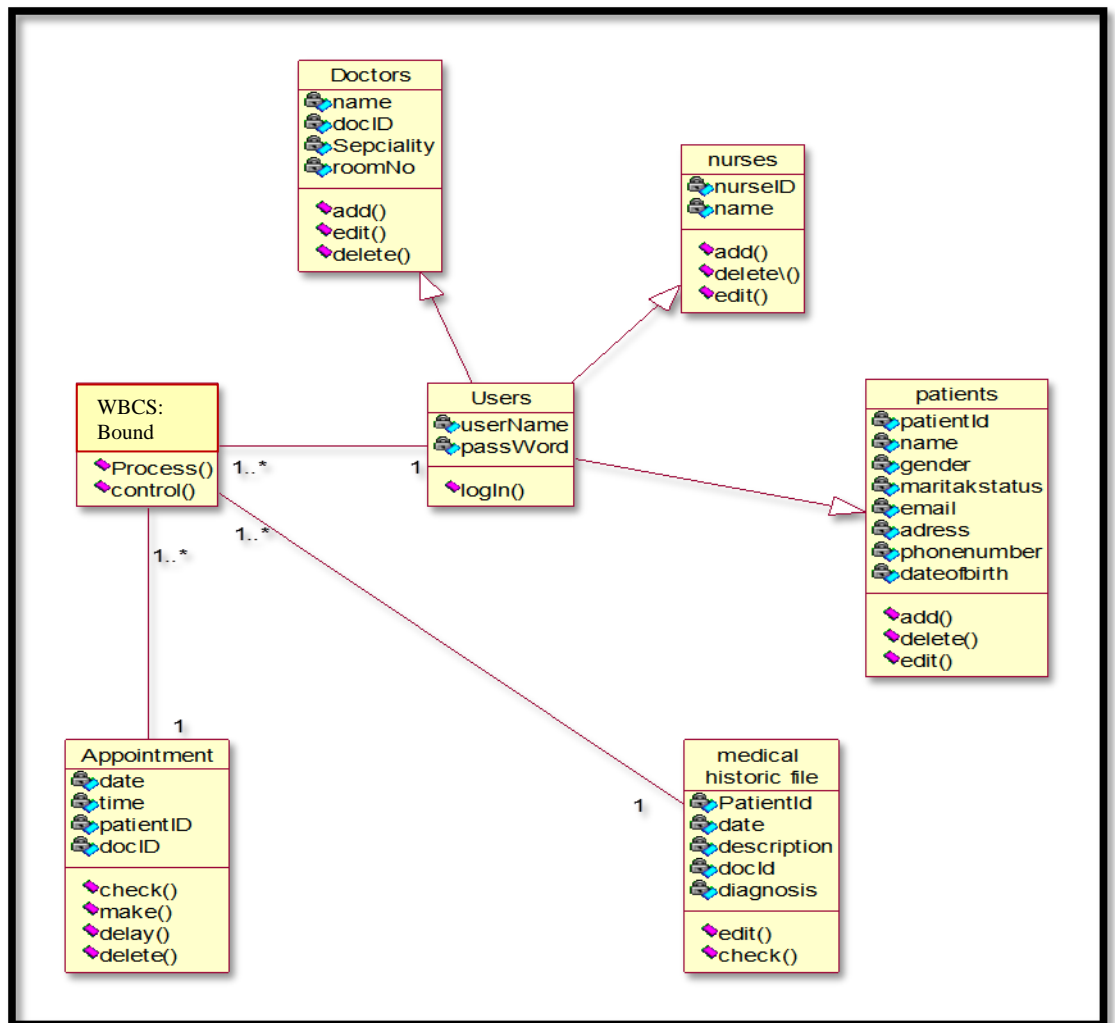
Figure 4.13: WBCS Class Diagram

4.4 Prototype Implementation

Prototype has been developed achieving all the requirements identified at the functional requirements stage. The design has been implemented using C# and ASP.NET. The backend data store was implemented using Microsoft SQL Server 2008. The following subsections discuss the details of the prototype application developed.

The Clinic Web based application front end has been developed using JavaScript and html. The aesthetics of the appearance of the user interface was given a prime attention to make the user experience as pleasant as possible. The following figures show a sample of user interfaces.

Home Page: Figure 4. 14shows the Home page interface of the WBCS. This is the first screen a user will be presented with when accessing the system. The systems' user will be required to enter a web address of the system in Mozilla browser and access the system.
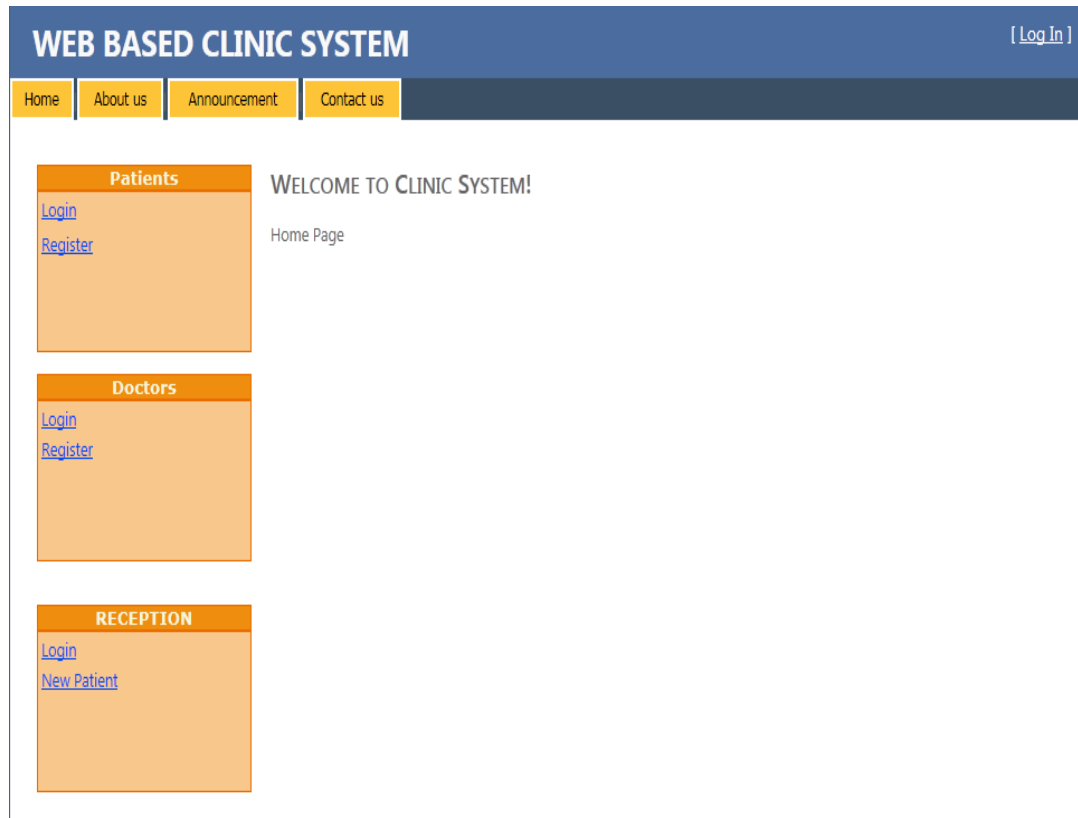
Figure 4.14: WBCS Home Page

View Clinic Information:

Figure 4.15 is accessed from the main screen of WBCS through view information link in the menu. The systems' users can view all kind of the announcement.

Figure4.15: View clinic information of WBCS

Register Page: The page presented by the Figure 4.16 can be accessed from the main screen through Register button in the box displayed in the first page (home page). This secreen shows the user's registration page and its required fields. For registering on the system a user required to enter the name , email, password and retype the password again, ended the register request via clicking on the register button as shown in the figure below.

Figure4.16: Register page in WBCS.

Log in page screen

Figure 4.16 shows the main log-in interface to the system. This is the second screen a user will be presented with when accessing the system. The user will be required to enter a valid username and password to log-in and access the system. For security purposes, the password entered by the user will be shown with dots, instead of plain text. Once a user enters the username password, they will be verified against the user information stored in the database. If successful, he would be allowed access to the other services of the system.

Figure4.17: WBCS Login Page.

Manage Patient Profile

Figure 4.18 shows the nurse functionality for managing the interesting place details such as adding, updating, deleting, and viewing the interesting required information, for the adding interesting details, admin require inserting the interesting patient information type that will be interesting to use it.

Figure 4.18: manage patient profile of WBCS

4.5 Summary

This chapter talks about the design, implementation and development of the system at the prototype level. The functional and non functional requirements of the system were initially defined and then the system modeling was carried out the Unified Modeling Language (UML). The sequence diagrams and the class diagrams were also presented in this chapter as design stage. The system was implemented using C# .ASP.NET and Microsoft SQL Server 2008. The snapshots of the user interfaces for different functionalities and operation were finally discussed.

CHAPTER 5

SYSTEM USABILITY TESTING

5.1 Introduction

The main aim of this chapter is to discuss the evaluation of the the Clinic Web Based System. The evaluation method carried out in this study was applied through design of the questionnaire and the analysis methods that used to involve the usability test of the system; this chapter explores the using of SPSS 16.0 to analyze the data that been given from the respondents.

5.2 System Usability Evaluation

The usability test with end users is considered one of the most fundamental methods in usability evaluation (Holzinger, 2005). The level of usefulness, operabilty and ease of use of a system are the recommended reasons for conducting usability tests (Neilson, 2006). In this study a system usability test was conducted through the adoption of quantitative method . This is achieved through the survey via the use of questionnaires given to the participants; to evaluate the system of the study; a questionnaire had been given to 40 candidates. Each of the participants had been taught to use the prototype software. The objective, description and functionalities had been informed to the respondents. The main objective to do that is to get the level of user agreement in terms of the usfellnes and the ease of use with the operability of the WBCS prototype.

5.3 The Instrument of the Survey

The User awareness on the ease of use and the usability of WBCS prototype was estimated using a testing session followed by a set of questionnaires The study's questionnaire was involved two sectionss, the first is "Section A" consists of the general information of the respondent while the second is "Section B" contains the Usefulness and Ease of Use variables, where several items are included under each variable.

A 5-point Likert scale was used to enumerate user preference. It is starting from "Strongly Disagree" (1) to Strongly Agree (5).

5.4 Data analysis Results

5.4.1 Demographic Data

Table 5. 1: Demographic Data.

	Percentage	Frequency (N=40)
Gender		
Female	**17.5%**	**07**
Male	**82.5%**	**33**
Age		
20-25 years	**5.0%**	**02**
26-35 years	**57.5%**	**23**
36-45 years	**35.0%**	**14**
above 45 years	**2.5%**	**01**
Level of Education		
Master Qualification	**90%**	**36**
Degree Qualification	**10%**	**04**
PhD Qualification	**00%**	**00**
Other	**00%**	**00**
Have you been used similar application before?		
No	**100%**	**40**
Yes	**00**	**00**

Table 5.1 gives the profile of the respondents, from these figures it can be seen that majority of the respondents are males making a share of 82.5 percentage. In the age group category, 26-35 year olds make the largest respondent group with a 57.5 percent followed by 36-45 year olds with a 14 percent. All the respondents have postgraduate university education out of which a 10 percent has undergone qualification at master's level. Out of all the respondents, 95 percent are working under educational sector. Figure 5.1 displays the same information in a graphical format.
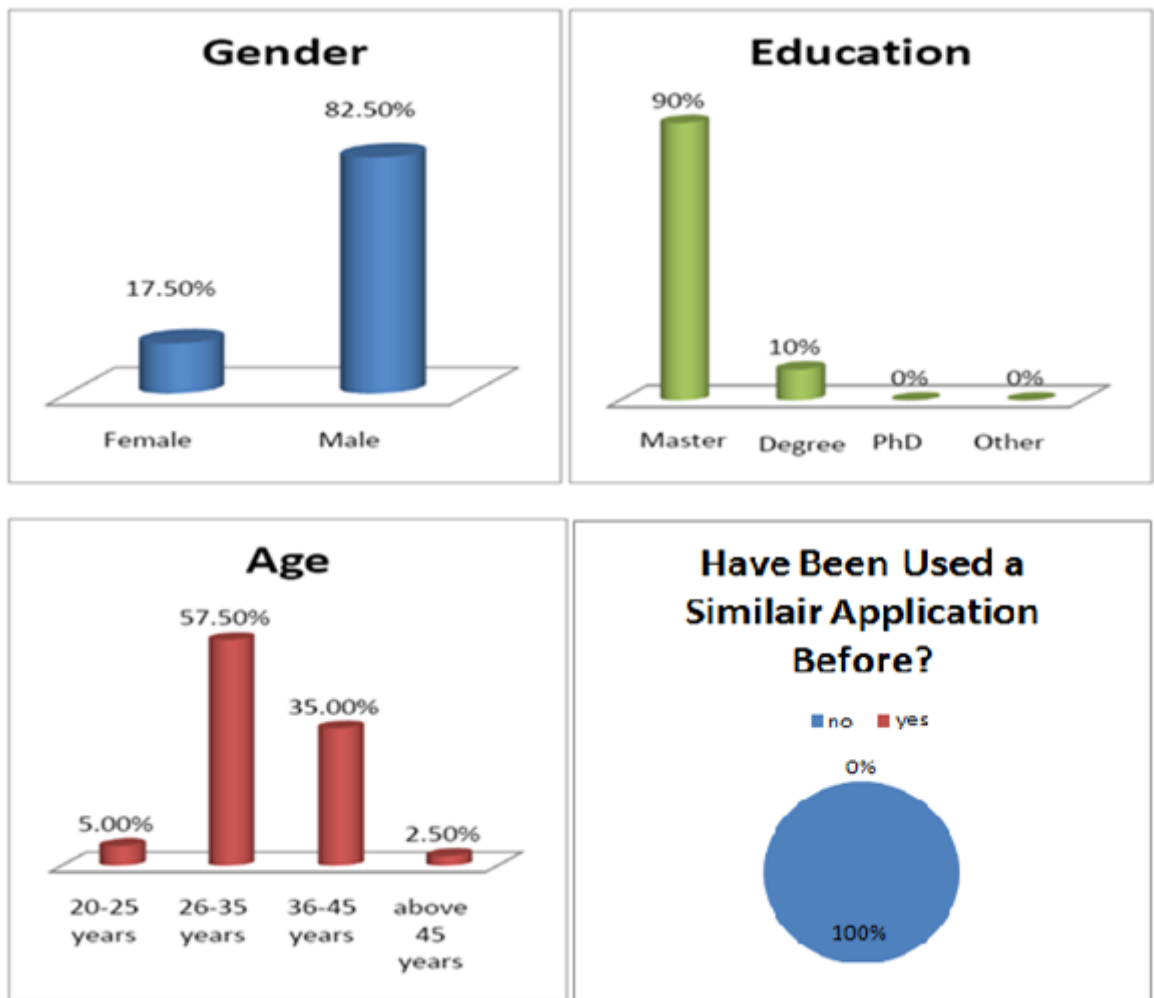
Figure5.1: Respondent Demographic.

5.4.2 Items Analysis

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

Table 5.2: Analysis of the Items

Items	1	2	3	4	5	Mean
The WBCSis useful.	0%	0%	0%	42.5%	57.5%	**4.5750**
When I use the WBCS, I save my time.	0%	0%	0%	47.5%	52.5%	**4.5250**
It saves my effort when I use it the WBCS.	0%	0%	0%	42.5%	57.5%	**4.5750**
The WBCS gives me more control over the activities in my life.	0%	0%	0%	35%	65%	**4.6500**
The WBCS makes the things I want to accomplish easier to get.	0%	0%	0%	32.5%	67.5%	**4.6750**
It does everything I would expect it to do.	0%	0%	0%	30%	70%	**4.7000**
WBCS is easy to use.	0%	0%	0%	52.5%	47.5%	**4.4750**
WBCSis flexible use.	0%	0%	0%	47.5%	52.5%	**4.5250**
WBCSis simple to use.	0%	0%	0%	55%	45%	**4.4500**
WBCSis user friendly.	0%	0%	0%	45%	55%	**4.5500**
WBCS requires the fewest steps possible to accomplish	0%	0%	0%	40%	60%	**4.6000**
I can use it without written instructions.	0%	0%	0%	32.5%	67.5%	**4.6750**

Table 5.2 lists the recapitulation of the responses of the user experience and their perception of the test usability of the WBCS system Prototype. The usability has been tested under two broad categories 'perceived usefulness' and 'perceived ease of use'. Several questions were asked about the usability under these two categories. From the results depicted in Table 5.2, it can be seen that the usability of the system is very high with an overall mean value more than 4.50. Hence it can be concluded

that most of the respondent are strongly agree and the usability of the system is very high in terms of usefulness and ease of use.

5.5 Summary

This chapter afforded the survey's data analysis carried out in this study. At the start an introduction to the test variables was given referring to the experience of the senior researchers in this field. The respondents' general information was presented before discussing the data collected and the interpretation of the items results. From the analysis it was found that the usability of the system was very high on both aspects namely, usefulness and ease of use.

CHAPTER 6

CONCLUSION

This chapter reviews the project's overall progress by giving a full view based on the research objectives. In addition, this chapter presents recommendations and limitations of this system.

6.1 Discussion

According to the problem statements and research objective, the research has heavily getting involved in developing requirements to complete the methodology that described in the third chapter and implemented successfully through managing the requirements. In order to make requirements more understandable the requirements have been modeled by using the UML diagrams such as use case diagram, use case specification and sequence diagram.

The prototype was evaluated and the results confirm that it is useful for patients and it is capable to help them to make their needs easy, direct and successful regardless of location and time.

6.2 Recommendations and limitations

Clinic Web Based System (WBCS) prototype was developed to help patient, doctor and clinic staff via this developed system. The project has been designed by keeping in view various requirements of a Medical Institute/Hospital so that the workload can

be decreased. This project helps in management of Hospital for adding and keeping the records of patients i.e. all the relevant information about the patients. This project plays a very important part in handling the attendance process. This project solves many problems like management of patients & preparing reports by graphical interface. However, there are some problems and limitations in implementing this system. Such as;

- Web based prototype has been tested using a local server with test data only. The proper system needs to be tested using real data.

- The limited time to do more in depth research and study is another challenge to gather the complete information and understanding for this study area. Better result will be achieved if the project period is lengthened.

6.3 Conclusion

In conclusion; all the activities that should be completed in this Project have been complete successfully What can be concluded here is the use of information technology is the back bone of the any organization, It is hoped that the findings of this study will encourage health sector companies to incorporate WBCS into the existing clinic services in order to improve and enhance the Clinic and hospitals' services so that it is available to users at any place and any time.

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APPENDIX

QUESTIONNAIRE

Clinic Web Based System

System Prototype Evaluation

This questionnaire is divided into two sections (Section A, and B). Section A: addressing respondent general information; Section B measuring the Perceive of Usefulness and the Perceive of Ease of Use of WBCS. Respondent are required to answer all the questions in order to complete the session.

Yours truly

Ahmad

Master of ICT

College of Arts and Sciences (CAS)

Universiti Utara Malaysia (UUM)

SECTION A: RESPONDENT GENERAL INFORMATION

This segment is about your background information. Please fill up the blanks and mark

[√] where appropriate.

1. Gender: [ ] Male   [ ] Female

2. Age: 20-25[ ]   26-35[ ]   36-45 [ ]   Above 45 [ ] .

3. Educational Level: Degree Qualification [ ]   Master Qualification [ ]   other [ ]

4. Do you use a similar application before   [ ] Yes   [ ] No

SECTION B

For the next segments, please tick or shade the answer to the following questions using the scale.

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

Items	1	2	3	4	5
1. The WBCS is useful.					
2. When I use the WBCS, I save my time.					
3. It saves my effort when I use it the WBCS.					
4. The WBCS gives me more control over the activities in my life.					
5. The WBCS makes the things I want to accomplish easier to get.					
6. It does everything I would expect it to do.					
7. WBCS is easy to use.					
8. WBCS is flexible use.					
9. WBCS is simple to use.					
10. WBCS is user friendly.					
11. WBCS requires the fewest steps possible to accomplish					
12. I can use it without written instructions.					

Thank you