Web Based Clinical System for UTP Panels

by

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CERTIFICATION OF APPROVAL

Web Based Clinical System for UTP Panels

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A project dissertation submitted to the
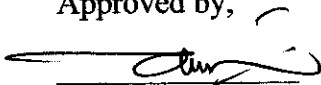
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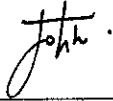(BUSINESS INFORMATION SYSTEMS)

Approved by,

(Aliza Sarlan)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2009

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

JOHN EMMANUEL EDMUND A/L EDMUND

ABSTRACT

Health institutions like clinics and hospitals can improve in their efficiency through implementation of an information system where tedious paper work can be avoided and vital information regarding patients can be retrieved immediately between different clinics. Malaysian Clinics are yet to fully discover the advantages of implementing information systems in helping and supporting the business process and daily operations.

Therefore, this project aims at conducting research on common business processes among UTP panel clinics, to develop a web-based clinical information sharing system for UTP panels and to conduct research on distributed system issues & development for the system. This helps towards early and fast diagnosis and gives possible treatment plans for patients and a networking between clinics.

There are, however, a few problems or drawbacks. As business processes are done manually by clinics which increase the tendency for errors, lack of data sharing between clinics regarding the same patient has hindered the research as there is no reference of medical records from previous clinics or hospitals regarding patients when they seek medical treatment in a different clinic.

Various techniques were involved in requirement gathering namely research, interview, observation and questionnaire. The Prototyping model approach which consists of building an experimental system rapidly was used for the systems development. The implementation of Web Based Clinical System for UTP panels can ensure reduced tendencies for errors, save time and space for recording & storing when dealing with patient's information and medical records and at the same time increases the patients' convenience.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Health issues are something which every individual face in their life one day or another. Health institutions are set up to accommodate these health issues. Health institutions consist of clinics and hospitals. Clinics are defined as a medical establishment run by several specialists working and sharing the same facilities which is devoted to the diagnosis and care of outpatients by Wikipedia [1].

Clinics need information systems now more than ever before to help in the decision making, control and management processes to give doctors and clinical staff the advantage in the medical field. Clinical information systems are becoming increasingly important nowadays. It can help towards early and fast diagnosis and possible treatment plans for patients. Hence reducing time needed to process patient's information.

Clinics are improving on their medical equipments, facilities as well as efficiency in their daily operations and business processes. Clinics are progressing forward as time goes by and more people prefer to go to clinics rather than hospitals. There are a few reasons which are identified. Firstly, clinics are conveniently located and easily available to patients. For example, the nearest hospital to UTP is about a 20 minute drive away but the nearest clinic is just within walking distance.

People prefer to go to clinics rather than hospitals if they are just having minor health problem. For example, would you go all the way to hospital and go through all those complicated procedures just to consult the doctor and get some flu medicine?

Furthermore, government hospitals are big and are divided into various departments to deal with different conditions. It is a very time consuming and tedious process to go to the hospital unless it is a serious problem. The hassle of waiting and being given the proper care and attention as needed by each patient in a hospital would not be as efficient as compared to clinics. Some hospitals have too many outpatients to attend to and may result in insufficient doctors and nurses catering to the patients needs.

Contrary to hospitals, clinics are smaller yet they are able to cater to a variety of illnesses and emergencies in short duration and faster. The convenience and availability of clinics are the main reasons why people prefer to visit clinics rather than hospitals. The small size, convenience and availability of clinics make them more versatile compared to hospitals.

As mentioned, clinics are improving in their efficiency. But how is this accomplished? Well, this is done through the implementation of an information system. Information system is a system of persons, data records and activities that process the data and information in an organization, and it includes the organization's manual and automated processes.

1.2 PROBLEM STATEMENT

Many clinics around Malaysia are yet to discover the advantages of implementing information systems in helping and supporting the business process and daily operations in clinics. Nowadays there is growing demand in the healthcare industry to automate their business processes and daily operations. Furthermore with the improvements in technologies, these demands achievable which couldn't be dreamt possible few years back.

There are few drawbacks to the current way the daily business processes are done which will be identified here. Firstly most of these business processes are done manually by clinics and without the usage of a computerized or automated system. Many clinics are

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still recording patients information on paper [2] what more the doctors in recording the patient's medical records like symptoms, diagnosis and treatments. The manual processes are very messy and bring about tremendous hassle to the doctors and clinical staff and not to mention inefficient in recording patient's information, medical background etc [2]. This increases tendency for errors when doctors and clinical staffs manually deal with patient's information. Wrongly writing down the patients treatment, difficulty in reading the doctor's hand writing and so on are examples of the problem identified.

Besides that there is no systematic approach to storing patient's personal details, information, medical background and so on which are recorded on papers and stored in files for future references [2]. An automated system is vital in order to improve the business processes. Unavailability of patients information, illegibility, disorganization of massive amount of patients information, and lack of privacy are some of the important limitations of a manual business process in other words paper based or without an automated system for the business process [2].

The third problem identified is the lack of data sharing between clinics regarding the patient's information, medical background etc. There is no reference of medical records from previous clinics, hospitals or even doctors regarding patients when seeking medical treatment in a different clinic. This makes it hard for patients when visiting a new clinic. The patients would have to explain and describe their previous medical records, symptoms, medications etc which leads to the fourth problem statement.

Patients find it difficult to describe to the doctors about their previous medical records like symptoms, diagnosis, treatment and medication given by the prior doctors. Doctors cannot rely solely on patients to provide their medical history. Some patients are not well versed to be able to describe their medical history, symptoms, medication etc. In addition the same patients will have to go through the hassle of registering their personal details again for different clinics. Data sharing among clinics are becoming increasingly important for the benefit of doctors and not to mention patients as well.

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In short, it is an alternative to paper works and doctors can trace back information on particular patient easily too. Just one click and all the information will be displayed on the screen. Besides, information system makes easier for clinics to communicate among each other. If one patient is being transferred from one clinic to another, with information system, it will be made easier for the other hospital to retrieve information on that particular patient.

1.3 OBJECTIVES OF STUDY

This project has few objectives which are listed as below:
1. To conduct research study on common business processes among UTP panel clinics
2. To develop a web-based clinical system for UTP panels
3. To conduct research on distributed system issues & development for the system

1.4 SCOPE AND OTHER AREA OF STUDY

The project will concentrate on UTP panel clinics which can be categorized as small or medium sized clinics. There is quite a number of UTP Panel clinics scattered around Perak and the scope is narrowed down further to focus on UTP Panels in the Ipoh vicinity.

CHAPTER 2
LITERATURE REVIEW

2.1 CLINICS

Clinics are defined as a medical establishment run by several specialists working and sharing the same facilities which is devoted to the diagnosis and care of outpatients by Wikipedia [1].There are many types of clinics ranging from children clinics to eye specialist which has various sizes from small, medium to large.

2.2 BUSINESS PROCESS

A business process is "a logically related set of tasks performed to achieve a defined business outcome [3]. The authors view a business process as a set of coordinated activities, enacted by human or software agents that exchange knowledge resources to achieve business objectives [3]. Businesses engaged in shared inter-organizational business processes need to share important information and knowledge to increase the other company's knowledge [3]. This statement by the author also relates to the topic of this project where clinics will need to share patient's information with other business, in this case other clinics to increase both parties' information and knowledge base.

There are few benefits in implementing a shared business process as stated by the authors. First of all, it includes reduced total inventory costs and secondly, enhanced operational efficiency through coordination of allocated resources, activities, and roles in a value chain [3].

Unavailability of patients information, illegibility, disorganization of massive amount of patients information, and lack of privacy are some of the important limitations of a manual business process in other words paper based business process [2]. Business processes can be done manually by having to do paper work or it can be done automatically by having a computerized information system for example Health Information System (HIS), Clinical Decision Support System (DSS) etc.

2.3 INFORMATION SYSTEM

Information systems (IS) have a major role to intra and inter organizational by ensuring the collection, storage, sharing and the integrity of the data within the organization [4]. The authors also defined federated information systems (FIS) which represent a set of autonomous systems, which share their data and are organized to cooperate through a federator. The federator is a centralized system, with a model of control, which is responsible of the communication between various sites [4]. The article also explains the capability of the FIS in terms of data sharing information system and how the federator serves as the system which organizes the sharing capabilities of the data [4]. Computer based systems helps healthcare providers use information to make better decisions have been developed and implemented [2].

2.4 HEALTH INFORMATION SYSTEM (HIS)

The author discussed that the success of healthcare depends critically on the collection, analysis and seamless exchange of clinical, billing, and utilization information or knowledge within and across the above organizational boundaries [5]. The author expresses the importance of HIS to the success of healthcare. Based on this journal, a significant IT challenge in the clinical practice is to integrate several disparate, standalone, information repositories into a single logical repository [5]. This integration of several standalone repositories is suggested to create a single point of access by user.

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The authors discusses on the E-Health system. E-health improves the relationship between patients and doctors and provides online education for both patient and physician through online resources, and sharing information especially for remote patients' [6]. Moreover, e-health also improves efficiencies, reduces cost and improves the quality of health service delivery [6].

The authors define computer-based application as a system which helps the user to make better decisions [2]. By the word better here meaning improved quality of care and reduced cost without compromising the quality [2].

2.5 WEB BASED CONCEPT

Modern Internet technology has collapsed geographical boundaries for global information sharing. The authors discussed that a Web-based messaging is a better way for communication compared to standard e-mail applications because the message can be automatically categorized and routed to the appropriate staffs [6]. Besides that, functions like electronic delivery for laboratory results, appointments, online referral, prescription renewal, and billing can be created, implemented and used easily as long as the users are connected to the Internet with web-based application [6].

The authors discussed on the first web-based system to combine patient management, patient accounting and communication tools into an all-in-one solution [7]. This initial explanation of this system by the author relates to the development of the project. The web-based system can provide easy access to the user using Internet/Intranet and operating system independent [7]. This explanation here proves the capability to develop the web-based system by using the distributed database concepts.

The system supports a centralized control data on the server and provides information sharing and distributed data management through the network structure. GP-Soft can be installed on any platform system and is supported by a back-end database system [7]. This GP-Soft is a best example of how the web based clinical system for UTP panel will

be developed. But the web site will be created by using the distributed database concept which is different from the GP- Soft system developed by the authors. Figure 2.1 below shows the proposed GP-Soft system architecture.
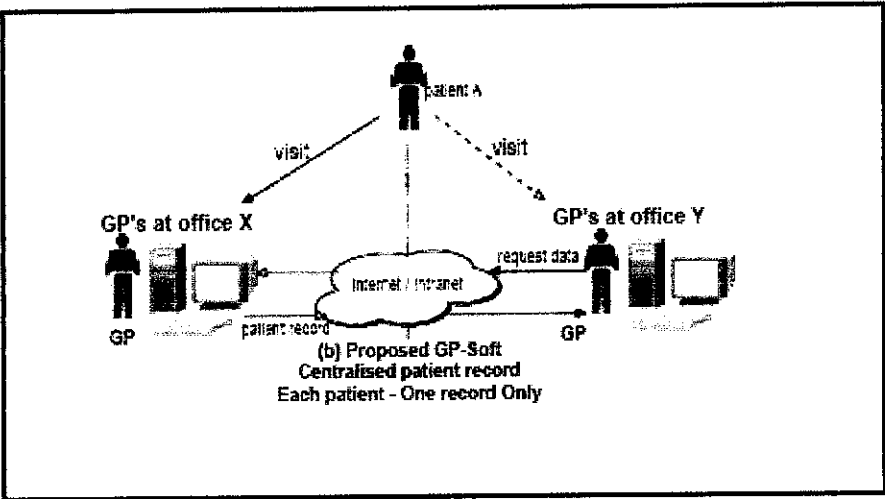
Figure 2.1: Proposed GP-Soft System Architecture

According to the authors, a key challenge for independent databases that are distributed over the Internet is to provide mechanisms for interoperability to facilitate resource discovery, access, distributed processing and integration [8]. The author discusses the challenges that may arise when creating a distributed system over the internet.

Interoperability is also an issue in order to provide mechanisms for distributed database over the internet. The author also discussed on improved interoperability of Web-based information systems and increased automation in information processing were the original motivations for the development of the Semantic Web. The Semantic Web brings, in particular, challenges to the integration of independent heterogeneous distributed databases over the Internet [8].

2.6 DISTRIBUTED DATABASE CONCEPT

Advances in distributed service-oriented computing and Internet technology have formed a strong technology push for outsourcing and information sharing among business and in this project among it refers to clinics. According to the authors, distributed database stores logically related data in two or more physically independent sites connected through a network or internet [9].

The authors have written a journal regarding A Three-Level Architecture for Distributed Web Information Systems. The authors argued that in case of database distribution, it will obtain a further separation between a global database level and an operational level, which will become available locally at each node of a network [10]. The authors added that by using to exploit the well known approach of two-stack machines to realize this operational level. The major addition is to extend the two-stack machines in such a way that distribution, generalized remote procedure calls, parallelism and communication are supported [10].

The author emphasizes the need for large-scale data sharing between autonomous and possibly heterogeneous decentralized systems on the Web gave rise to the concept of Peer to Peer database systems in the journal Distributed Databases and Peer to Peer Databases: Past and Present [11]. The author discussed the pass and present type of databases in terms of data sharing with peer to peer method [11].

The author also discussed on the integration of workstations in a distributed environment enables a more efficient function distribution in which application programs run on workstations, called applications servers, while database functions are handled by dedicated computers, called database servers [4]. This federator concept which is stated by the author can be used in development of the project by using the distributed concept.

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The authors discussed that enterprises and organizations have great interest in sharing their data and extracting interesting knowledge. Data sharing in the health sector is also becoming increasingly important [12]. For instance, many insurance companies collect data on disease incidents, seriousness of the disease, and patient background and there is great interest in sharing their data through a data aggregation service [12]. With the technological advancement today, organizations are leveraging to share data and this is also applicable to clinics. Clinics are beginning to realize the importance of information to their clinics and even hospitals. A distributed data sharing mechanism across private databases would greatly facilitate such data aggregation outsourcing services as stated by the author [12].

Ideally, the authors wish to share certain statistical data and extract the knowledge from the private databases without revealing any additional information of each individual database apart from the aggregate result that is permitted [12]. In the article, the authors describe two scenarios for outsourcing data aggregation services and present a set of decentralized peer-to-peer protocols for supporting data sharing across multiple private databases while minimizing the data disclosure among individual parties [12].This finding and research by the authors can be used or implemented for this project.

In a nutshell these projects are all about data sharing between clinics but there are only permitted to share certain information regarding certain issues. For example the payment made between patients and those clinics does need to be shared across to other clinics sharing the system and certain information which the patients and doctors agree upon will be made disclosed for other clinics to view.

2.6.1 Data Replication

The authors in the journal discuss Update propagation strategies to improve freshness in lazy master replicated databases discuss that the concept of Lazy replication has been used as an alternative solution in several types of applications such as on-line financial transactions and telecommunication

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systems. In this case, mutual consistency is relaxed and the concept of freshness is used to measure the deviation between replica copies [13]. This article proves the usage of lazy replication in other systems. Ester and Eric explains the usage of freshness in the measure of calculation and determining the replicated data. Besides that Ester and Eric states that data replication and freshness is when it is updated to a primary copy can be propagated towards a slave node as soon as they are detected at the master node without waiting for the commitment of the update transaction [13]. Now with explanation from the article data can be replicated or copied without waiting for the user to update the data.

2.6.2 Fragmentation

The authors discussed on one of the concepts of distributed database which is fragmentation [9]. The database can be divided into fragments of horizontally or vertically which can be allocated to different computer or servers on the network. This concept here elaborates how the data from one location of the clinic can be fragmented and replicated to the server without interfering with the clinic's private data.

2.6.3 Data Aggregation

Enterprises and organizations have great interest in sharing their data and extracting interesting knowledge [12]. Data sharing in the health sector is also becoming increasingly important in today technology advancement world [12]. Take insurance companies as an example where they collect data on disease incidents, seriousness of the disease, and patient background and there is great interest in sharing their data through a data aggregation service [12].

2.7 INFORMATION TECHNOLOGY IMPLEMENTION ISSUES

Effectiveness and efficiency of Health Care Information Systems (HIS) will become one of the main challenges in health care [14]. According to the World Health Organization (WHO, 2006), momentous enhancements are being made in healthcare due to information and communication technologies (ICT) [14]. ICT's support clinical care, patient education, facilitates scientific advancement of the field, and improves the work flow of various functions in the healthcare [14]. Applying strong theoretical perspectives into existing and emerging electronic practices of HIS will facilitate the opening of the black box of technology and what circumstances theory can guide the implementation, use and acceptance of ICTs in the health care context [14].

The major issue that was identified from the article is the security issue. The communications among users in healthcare through the Internet or Intranet involve sensitive information either through wired or wireless media [14]. These requirements like authentication of user and patients of the system and also confidentiality of not disclosing sensitive information are important in order to protect patient's privacy during and after the communication whereby the data must be kept safe [14].

CHAPTER 3

METHODOLOGY

3.1 REQUIREMENT GATHERING

The initial step before system development is requirement gathering. Requirement gathering is the process of gathering various information which is use to outline the development of the system. There are few techniques used in this requirement gathering process.

First is the research technique. This technique involves searching many mediums for gathering necessary information regarding the system requirement and development. Mediums mentioned include the Internet, journals, research papers, conferences papers, articles, magazines etc.

Next is the interview technique. Interviews are the process of gathering information from the users on a face to face basis. The questions are more of an open ended question where the end user is required to give more in-depth explanation about certain issues. Interviews have been held with the end user of the system which is the doctors, clinical staff and patients. The system's requirements, constraints and goals are established by consultation with system end users. Interview sessions have been done for at least 6 clinics under the scope of this project which is UTP panels in Ipoh. The interviews have been done personally and separately for all the system end users starting with the doctors of the clinics then to the clinical staff and lastly, the patients themselves.

Besides that, there is also the observation technique. Observations have been done more widely than the interviews. Observation involves watching the system end users

perform the daily task and business processes in that environment. Moreover, observations are used to gather information which couldn't be captured by just having interviews. Furthermore, the observation includes the gathering of information about the current business processes in the clinics which are for example the patient registration, diagnosis, treatment, medicine dispensary process etc. The steps, procedures and time for each business processes are observed, recorded and analyzed to find ways for improvement.

Lastly is the questionnaire technique. This technique have been used to gather information from user about the current system and business processes but it is done in a more precise way and on paper rather then general, open ended questions which require explanations. The questions are targeted to require the end user to rate the functionality of the previous system or even ask the user to answer a simple yes or no to the question provided.

3.2 SYSTEM DEVELOPMENT

In the system development, a specific methodology is required in guiding the overall process flow. The methodology that has been used for the system development is the prototyping model approach. This prototyping methodology has been chosen because prototyping consists of building an experimental system rapidly and is inexpensive for the end users to evaluate and give feedback [15]. Other than that, prototyping has the advantage of being able to follow the end users requirements when creating the system. With that stated, the steps required to build the system by using the prototype methodology has be repeated over and over again until the system meets the end users final requirement. Figure 3.1 shows the prototyping methodology.

This method is also suitable because the phases involved move from sequence to another sequence and it performs analysis, designing, testing and implementing phase concurrently and all these three phases has been repeated until the final system is complete as shown in figure 3.1.

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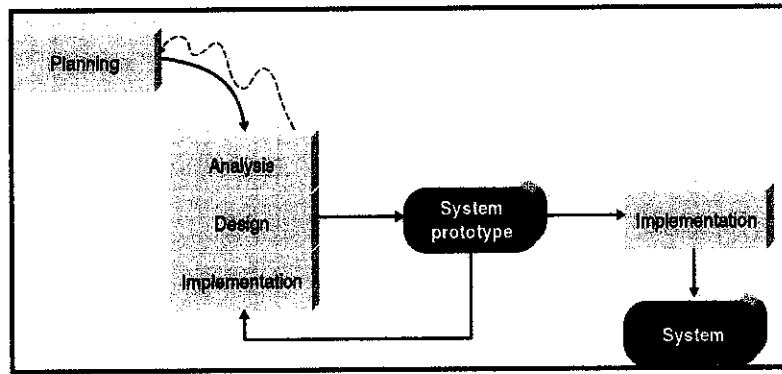
Figure 3.1: Prototype Methodology

In the planning phase, all the activities has been planned according to a timeline from research, interviews, observation to analysis of this information to the development of a prototype to implementation of the system. The tasks and its timeline are recorded in the Gantt chart which is shown in Figure 3.2 in Appendix A.

The analysis phase follows after the planning phase which gathers and analyses the requirements from the requirement gathering techniques mention in section 3.1 above. The information and requirements which are gathered has been analyzed and used in the next phase to create the prototype system. This phase will also define the scope and limitation of the system. All the elements of the system and business processes have been identified. After identifying, the analysis phase has put the elements together to make up a modeling method for the system which are:

- Activity Diagram
- Use Case Diagram
- UML Class Diagram
- Sequence Diagram

The next phase is the design phase. In this phase the architecture and user interface has been designed. The user interface has been designed to meet the end users requirements. The architectural design is the process of designing the database, the server, the connections the platform and identifying the software and tools which has been used in

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the development of the system. A prototype has been created in this phase. A quick and dirty prototype has been created from the initial minimum user requirement.

Lastly is the implementation phase where the initial prototype has been completed and tested by the end user. The users were encouraged to work with the system to determine how well the prototype meets their needs and suggest and give feedback for improving the prototype. If the prototype system meets the users' needs, the prototype is fully implemented in the end user environment. But if the prototype system does not meet the user requirements, the prototype is changed, revised and refined according to the user suggestions and feedbacks. After the prototype is revised the process returns to the cycle again from analysis to re-designing the prototype system as shown in Figure 3.1.

3.3 GANTT CHART

Please refer to Figure 3.2 in Appendix A to view the Gantt chart.

3.4 TOOLS AND SOFTWARE USED

Tools	Usage
Microsoft Office Visio	Create Gantt Charts and Modeling Diagrams.
Microsoft Visual Basic.net	Create the Web Based Clinical System
MySQL	Database management system
Microsoft Information Internet Server (IIS)	Web server

Table 3.1: Tools and Software Used

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 DATA GATHERING & ANALYSIS

This chapter discussed the data gathered and findings of the research that has been done for the project. The findings were based on the activities that has been done like the interview sessions, questionnaires and observations from UTP panel clinics around the vicinity of Perak.

Clinics	Observation	Questionnaire	Interview
Klinik Raghu			
Klinik Dr. Najiha			
Klinik Dr. Zakaria dan Rakan	✓	✓	✓
Kumpulan Perubatan Ar-Ridzuan	✓	✓	
Klinik Safri & Hamimah	✓	✓	✓
Perak Medical Centre	✓	✓	
Poliklinik Permai	✓	✓	
Poliklinik Dr. Azhar & Rakan - Rakan	✓	✓	

Table 4.1: List of small and medium size UTP panel clinics in Perak

Table 4.1 is an extraction from Table 4.2 in Appendix B. Table 4.2 shows the full list of UTP panel clinics with the size and location of each clinic. Table 4.1 represented an

extraction from Table 4.2 of clinics which fell in the scope of this project. Table 4.1 also showed how these clinics responded to the requirement gathering process. The next session was divided to interview sessions, questionnaires and lastly observations.

4.1.1 Interview Sessions

Based on the Table 4.1, there were only 2 clinics which I was able to interview which are Klinik Safri & Hamimah and Klinik Dr. Zakaria dan Rakan. The interview questions were attached in Appendix C for reference.

Firstly was the interview session for Klinik Dr. Zakaria dan Rakan. The response received from the doctors and nurses were very good. The doctor was willing to be interviewed. The interview session took an extimate hour to complete.

The clinics business process were all done manually, there is no computerized system for any of the business processes. There was however a computer with internet connection for the doctor's personal usage only. The doctor stated that the reason for not having any automated system is because manual systems are simpler and easier.

The clinics has an average of 30-40 patients on a daily basis. Since there were no automated system in place at this clinics, the patient registration and diagnosis and treatment business process were done manually. The doctor did not agree on implementing an automated system at the clinic but recomended that there is a system to display where the patients file is kept. The doctor also disagreed on an automated system for diagnosis and treatment. He felt that manually writing patients diagnosis and treatments are much easier.

The doctor stated that he did not agree to sharing patients information, he said that it is unprofessional for the a doctor to share the patient's information. Every

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doctors has their own opinion on this, some may agree while others disagrees. Most important issue about sharing patients information was the permission of the patients themselves.

Klinik Safri & Hamimah was where the second interview session took place. This interview session hade a total opposite answers from the previous clinic. The interview was conducted with Dr. Safri. This clinic is one of the 5 branches of Klinik Safri & Hamimah. The interview session took 2 hours to complete. Dr. Safri was very responsive and coorperative for the interview session.

Clinic Safri emphasized on the patient diagnosis and treatment as the most crucial business process because was is a service industry and with this must have good public relations. Most of their daily business processes were done manually except the patients registration. The patients registration business process were a semi automated system. The patients IC and name are stored in a computer. The patient's information was stored manually in a file and the location if this file is saved in the computer. The nurses then retrieved the whereabouts of where patients file was based on their IC number and name.

There was an internet connection at the clinic in order to cater to ING panel patients. The clinics had an online system which enabled them to trace patients who were insured medically for example ING. The clinic has about 25-40 patients on a daily basis.

Currently the diagnosis and treatment business process was done manually. The doctor wrote the diagnosis and treatments on a paper and stored the paper for future usage. Dr. Safri however, strongly agreed with the notion of implementing an automated system in his clinics. He strongly agreed because of a few reasons. Firstly was that the hassle of manually writing patients details and information could be dramatically reduced. Another reason is that when a situation where a patient works here and stay another place. So there is no need

for telephone calls between the two different doctors regarding patient's previous diagnosis and treatments. The third reason is that the patients don't need to struggle to explain to the doctor on their diagnosis which most patients are unable to explain. The doctor is just able to retrieve from the system the patients relevant information, diagnosis etc only with the permission and approval of the patients.

Dr. Safri added that a follow up system could be done which was similar to a scheduling appointment system. The system notified the nurse or doctor to inform the patients if there were any appointments or necessary check up. This can help to build good rapport with the patients. Patients needed constant reminding on their appointments.

Regarding data sharing between clinics, Dr. Safri had the total opposite opinion from the previous clinic. He strongly agreed on data sharing between clinics but this could only happen with the approval of patients first. He stated there was nothing to hide regarding patient diagnosis and treatment and on that matter any medical information regarding certain patients.

4.1.2 Questionnaires

From Table 4.1, 9 questionnaires were gathered back from the 6 clinics. The data from the questionnaires were tabulated and translated into meaningful graphs. From the data that was gathered 5 out of the 6 clinics have at least 1 automated system in place at their clinics.

Figure 4.1 shows the comparison of automated systems currently used with potentially implemented and used. There was an increase in the potential number of automated system preferred by doctors and nurses when compared to the current automated system available. The most required automated system that all of the clinics agree is the patient registration system, followed by the

medicine dispensary and inventory. The reason was that these systems were used most regularly on a daily basis. This system could help clinical staffs and doctors register patients more efficiently as well as dispense medicine and keep track of the medicine inventory. Please refer to Appendix D for the questionnaire.
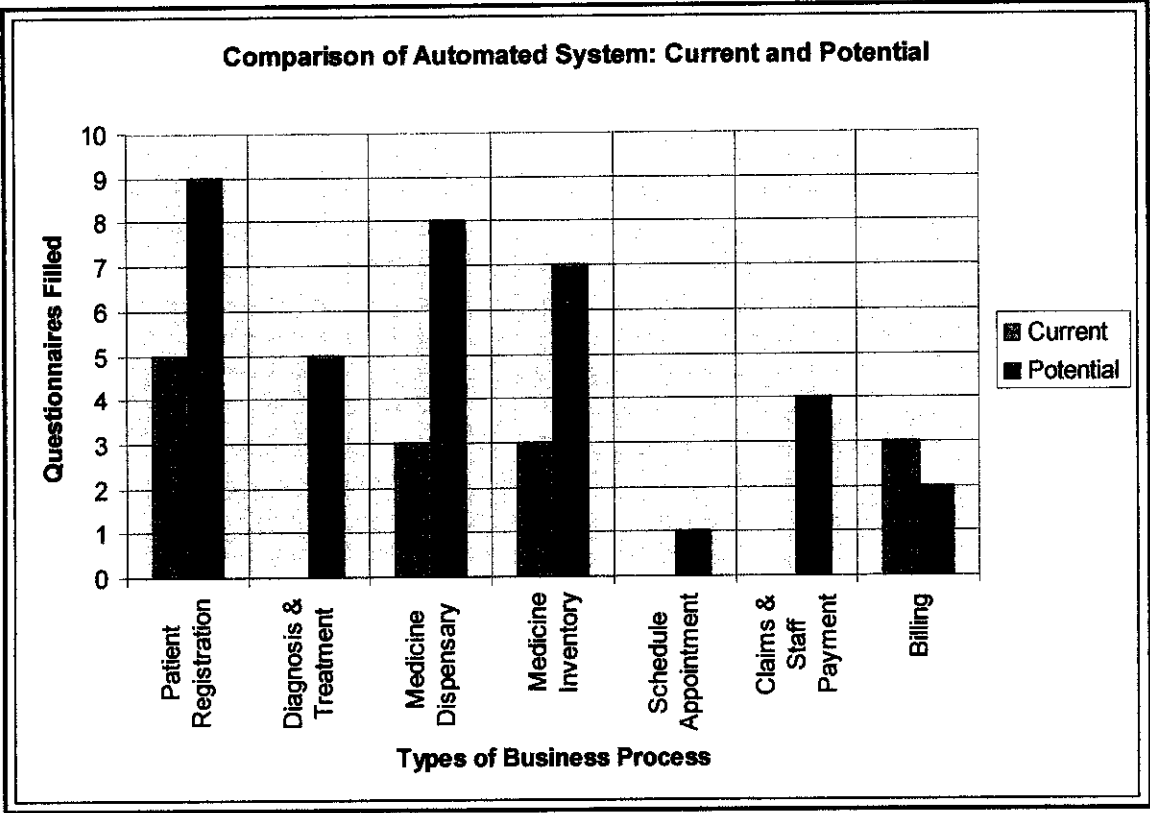
Figure 4.1: Comparison of Automated Systems

Regarding the diagnosis and treatment business process, currently there are no automated diagnosis and treatment business process in most of the UTP panel clinics. The doctor records the patient's diagnosis and treatment on papers and kept the records in a file and stored in racks. There is a high increase for the implementation of an automated diagnosis and treatment business process when compared between the currently used and potentially used business processes.

There are potentials to implement an automated system for the diagnosis & treatment business process. An automated system for the diagnosis and treatment business process has brought about benefits. The benefits are reduced tendency for errors, saved time and space for recording & storing patient information and medical records and lastly increased patient convenience.

4.1.3 Observations

This section is about my personal observation when gathering information from the listed UTP panel clinics in Table 4.1. All of the clinics had 1 doctor on duty at all times with few nurses assisting. Some of the clinics had a substitute doctor to stand in for them. The data and information about patients are all stored in files. Most of them were organized by IC numbers of their patients. Each clinic had their own way to organize the patient's data. From what I could notice, it took quite some time to retrieve the patient data and information.

4.2 RESULTS AND DISCUSSION

This section refers to the system analysis of the current and proposed web based clinical system. Modeling methods for the system are discussed in this section. The business processes are illustrated in the modeling diagrams which consist of the current and proposed activity diagram, use case diagram, class diagram and sequence diagram of the web based clinical system for UTP panels. Each modeling diagram explicitly provides a graphical representation to model the web based clinical system from analysis through implementation.

4.2.1 Present Activity Diagram

Figure 4.2 shows the present stages of how the business processes are carried out on a daily basis. All of the stages showed above are done manually by the clinical staffs. There are no computerized systems in place to help in simplifying

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the identified business processes. The only computerized system which was identified in the research phase covers the medicine inventory business process. There are no computerized systems for the patient registration and diagnosis and treatment business processes in most of the UTP panel clinics.
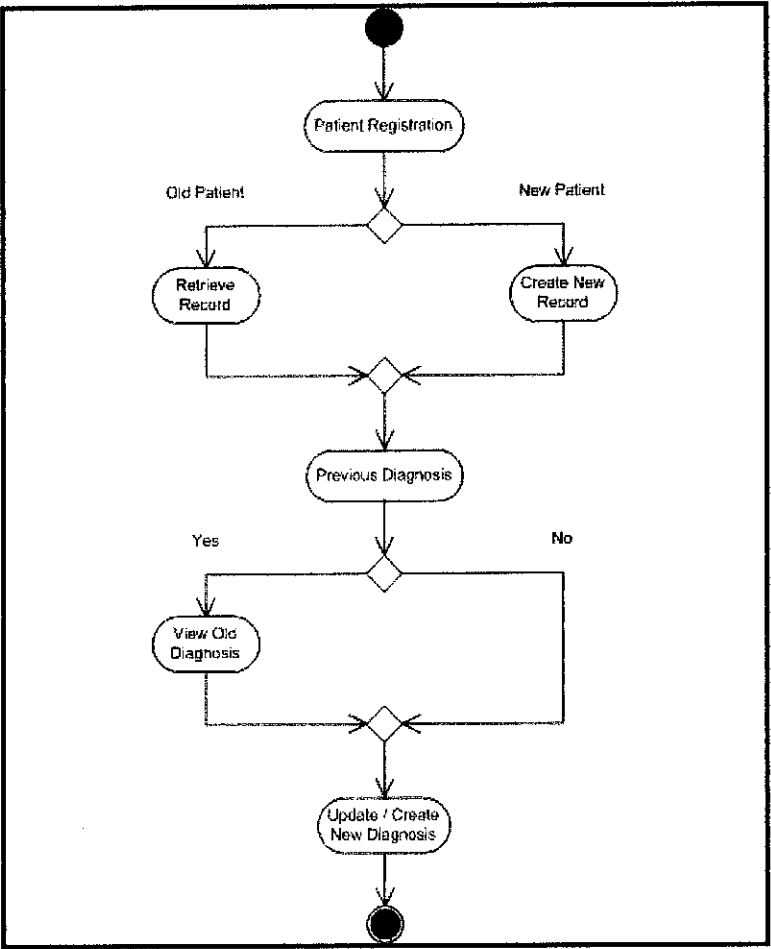

Figure 4.2: Activity Diagram for the **present** Web Based Clinical System

With that being stated the patient's details, symptoms, diagnosis, treatments etc are all recorded and kept in files. This method here posses a difficulty when retrieving details regarding a patient in addition to that it consumes time as well as storage spaces.

Each time a patient comes in the nurses have to search for the patient's file manually among the thousands that have accumulated across the years. The problem of miss labeling and losing the patients details is common for some clinics like finding a needle in a hay stack. After retrieving the patient's details, they are registered before consulting with the doctor. The doctor then views and updates the patient's information regarding their symptoms, diagnosis, treatments etc if necessary.

An issue arises when a patient's details stored at another clinic. Bear in mind that the clinics that are being referred to are UTP panels and patients are UTP staffs. For example if the patient's illness is a continuous condition and the previous diagnosis is vital for the current doctor to know about. The doctor has to ask the other clinic for this patient's prior particulars. This is quite troublesome plus not knowing what other problems may arise for instances the doctors are unable to provide the needed information, the files are misplaced or may be even unable to contact the doctors.

The doctor then has to base his (her) diagnosis and treatments based on the patient's explanation of their symptoms, previous diagnosis, treatments and medicine taken. This may go well if the patient is well aware of his previous information but not many are able to recall this kind of vital information. Some may not know how to explain their symptom properly or even give a good explanation about their prior diagnosis, medicine taken etc. This issue here is being addressed by the proposed system.

The prototype is built to accommodate the clinics to save and retrieve the patients' information easily and effectively. This prototype also includes retrieving the patient's previous medical records from any UTP panel clinics previously visited by the patients from the remote database. This here has eliminated the hassle and pain of paperwork and also saves as well as minimizes the storage spaces for files in clinics.

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Patient registration are also made simple with the web based clinical system where the patients are now able to just provide their IC number to register and the clinical staffs and doctors will be able to view the patients details. The patients have to provide their authorization key to the doctor in order to allow the doctor to view their previous medical records like symptoms, diagnosis and treatments.

4.2.2 Proposed Activity Diagram

Figure 4.3 gives a picture of the Proposed Web Based Clinical System. The activity diagram is divided into two categories. These two categories are performed by the same user but with different roles which is firstly as an UTP staff and secondly as a patient who is visiting the clinic. The reason being is that, before being able to provide authorization to the doctors who can view their previous medical records, UTP Staffs has to register their authorization account. This authorization registration is not part of the Web Based Clinical System rather it is part of another system. So with that stated, the authorization registration is the first step that each UTP Staff needs to perform in order to allow the doctors to view their previous medical records from other clinics from the remote database.

The right side of figure 4.3 represents UTP staffs as patients. Patient registration is the first business process which the patients have to go through when visiting the panel clinics. The patients can either be an old or new patient visiting the clinic. If the patient is an UTP staff, the nurses will retrieve the patient's personal details from the remote database (located at UTP) provided that the patient gives their IC number. The patient's personal details like name, address, phone number, email etc will be displayed in the system. Then the nurses will be able to edit this detail if there are any incorrect or outdated information. The retrieved personal details can be saved in the local database at the clinic whether the patient is a new patient or an old patient updating their personal details.

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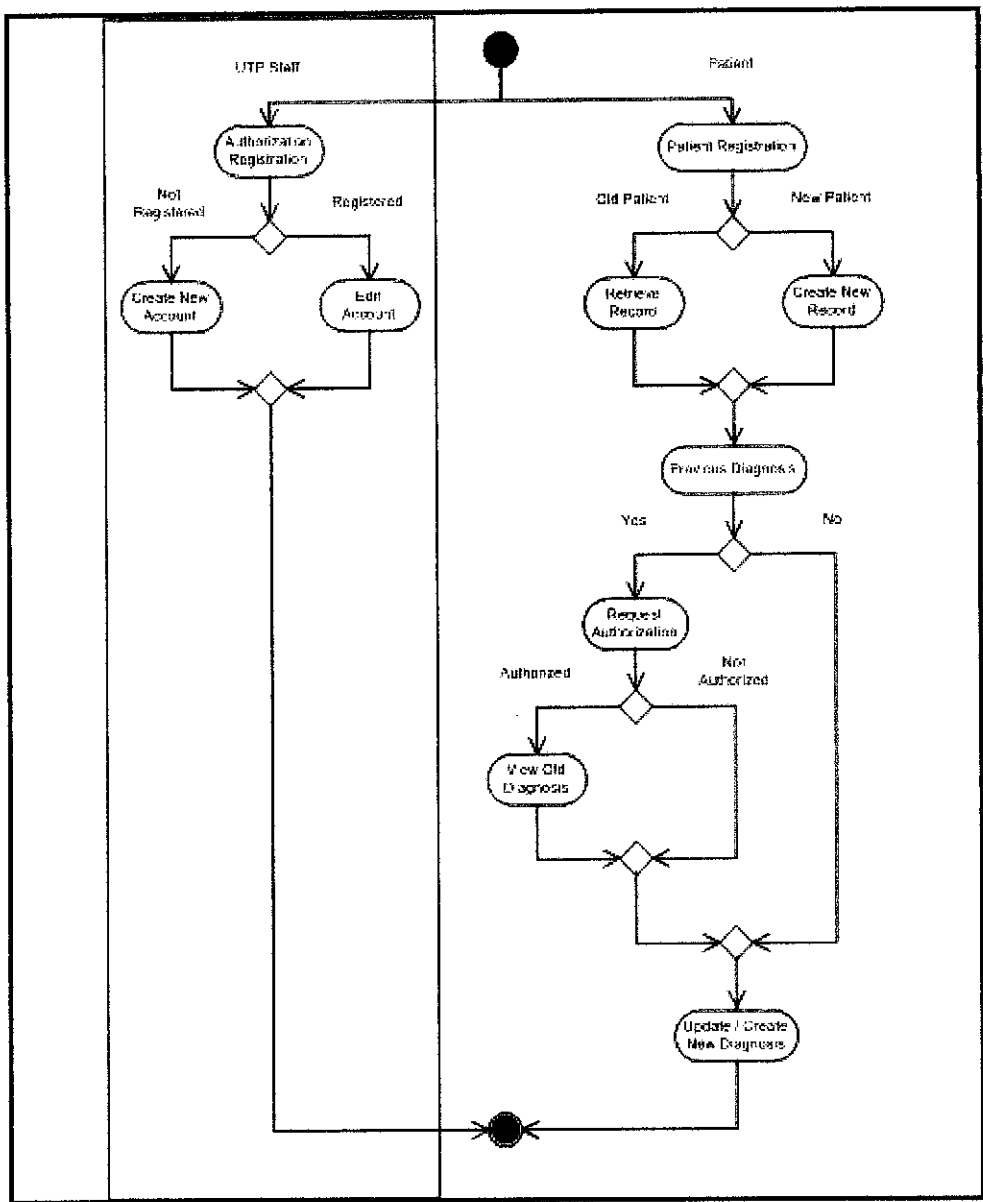
Figure 4.3: Activity Diagram for the **proposed** Web Based Clinical System

Next after the registration process, the patient will consult with the doctor. The doctor will determine whether the patient's previous medical record is needed or not for the doctor to diagnose and provide treatment to the patient. This decision by the doctor is the representation of the "previous diagnosis" step in the proposed activity diagram in figure 4.3. If the doctor decides that the previous diagnosis is not needed then the doctor proceeds to create new diagnosis which also represents the last step in the activity diagram. In create new diagnosis, the

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doctor will record the patient's symptoms, diagnosis and treatment into the system which is then saved in the remote and local database for future reference if needed.

The doctor will request for authorization from the patient to view the patient's previous medical records which is shown in the activity diagram as "request authorization". Once authorized by the system (a valid patient authorization) then the doctor will be able to view the previous medical records and proceed by either creating a new medical record for the patient based on the previous medical records retrieved.

Figure 4.3 Patient Information Transfer between UTP Panel Clinics and UTP
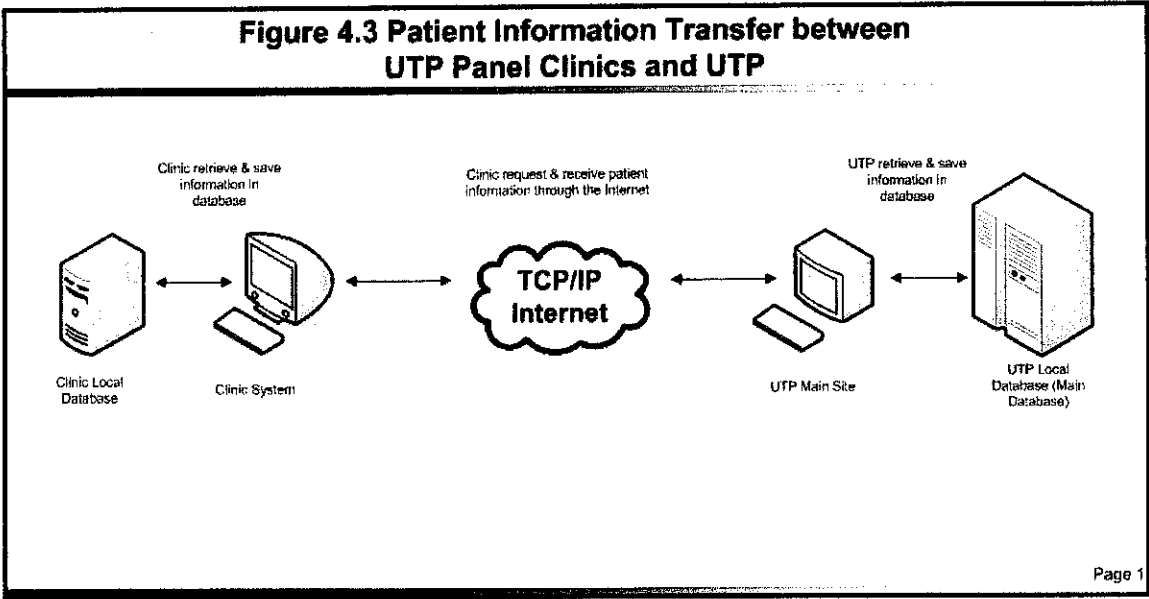
Figure 4.4: Patient Information Transfer between UTP Panel Clinics and UTP

Figure 4.4 gives a picture of how the patient's information is transfer over the internet. The users of the system are the clinical staffs and doctors at the clinic. The Web Based Clinical System will store information on both the local and remote database which is situated in UTP. Figure 4.8 in the system architecture gives a better representation of how the client-server architecture is used in the Web Based Clinical System for UTP panels.

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4.2.3 Use Case Diagram

Figure 4.5: Use Case Diagram for the proposed Web Based Clinical System

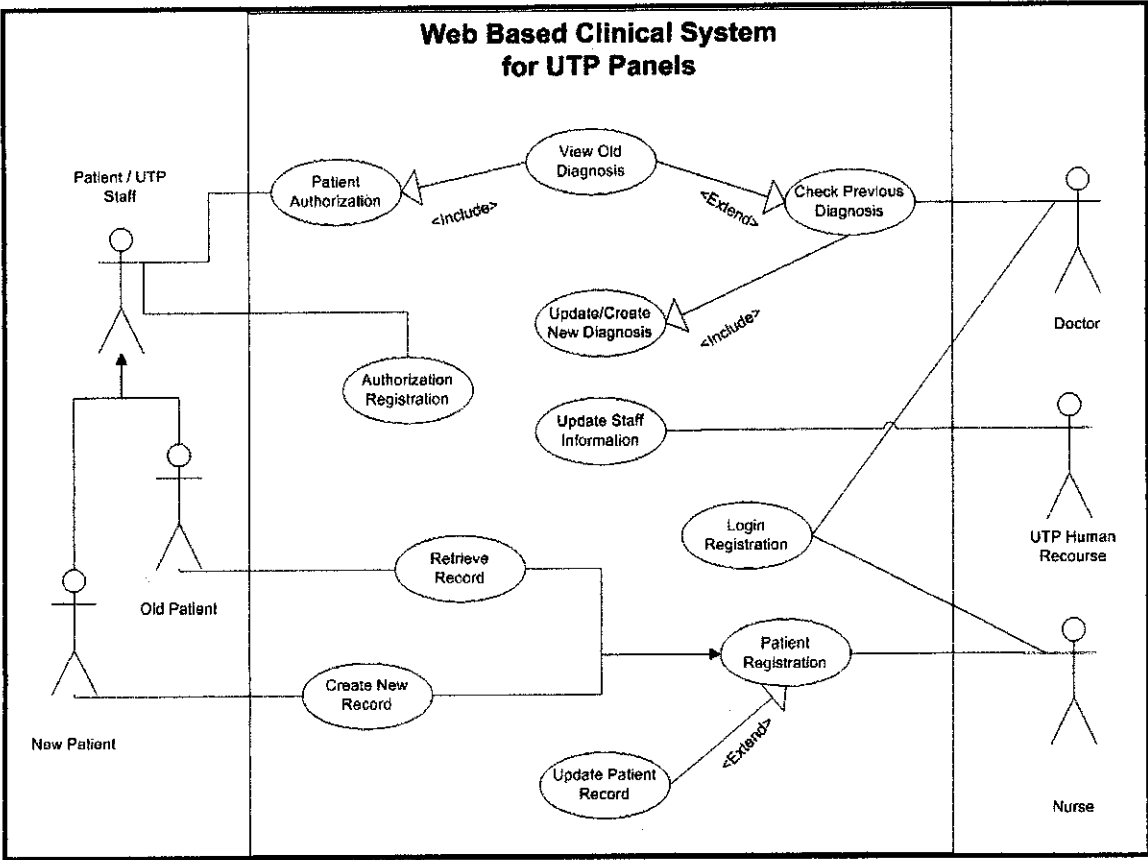| Actors	Roles	
Nurse	1. Patient Registration	<Uses>: Retrieve patient's records.
		<Uses>: Create new patient's records.
		<Extend>: Update patient's records.
	2. Login Registration	Create new username & password which grant clinical staff access to the system.
Patient	3. Authorization Registration	Create an account by registering a username & password. Grant doctors the access to the patient's previous records.
	4. Patient Authorization	Allow doctors to access the patient's records with the patient's approval only. Patients will provide username & password. Patients approve the doctor's to view their old diagnosis etc.
	5. Patient Registration	Patient details are recorded. New patients are required to create new records. Old patients' records are retrieved and can be updated.
Doctor	6. Login Registration	Create new username & password. Grant clinical staff access to the system.
	7. Check Previous Diagnosis	<Uses>: Doctors check the patient's previous diagnosis for better understanding of the patient's condition.
		<Include>: Doctor updates the patients diagnosis etc from the previous diagnosis. Doctors are able to create new diagnosis etc if there is no relation to the previous ones.
		<Extends>: Doctors are able to view patient's old diagnosis etc with authorization from the patient first.
UTP Human Resource	8. Update Staff Information	UTP HR updates the staff's personal details. This personal detail is retrieved by clinics when patient registration takes place.

Table 4.3: Roles of Actors for the proposed Web Based Clinical System

4.2.4 Class Diagram
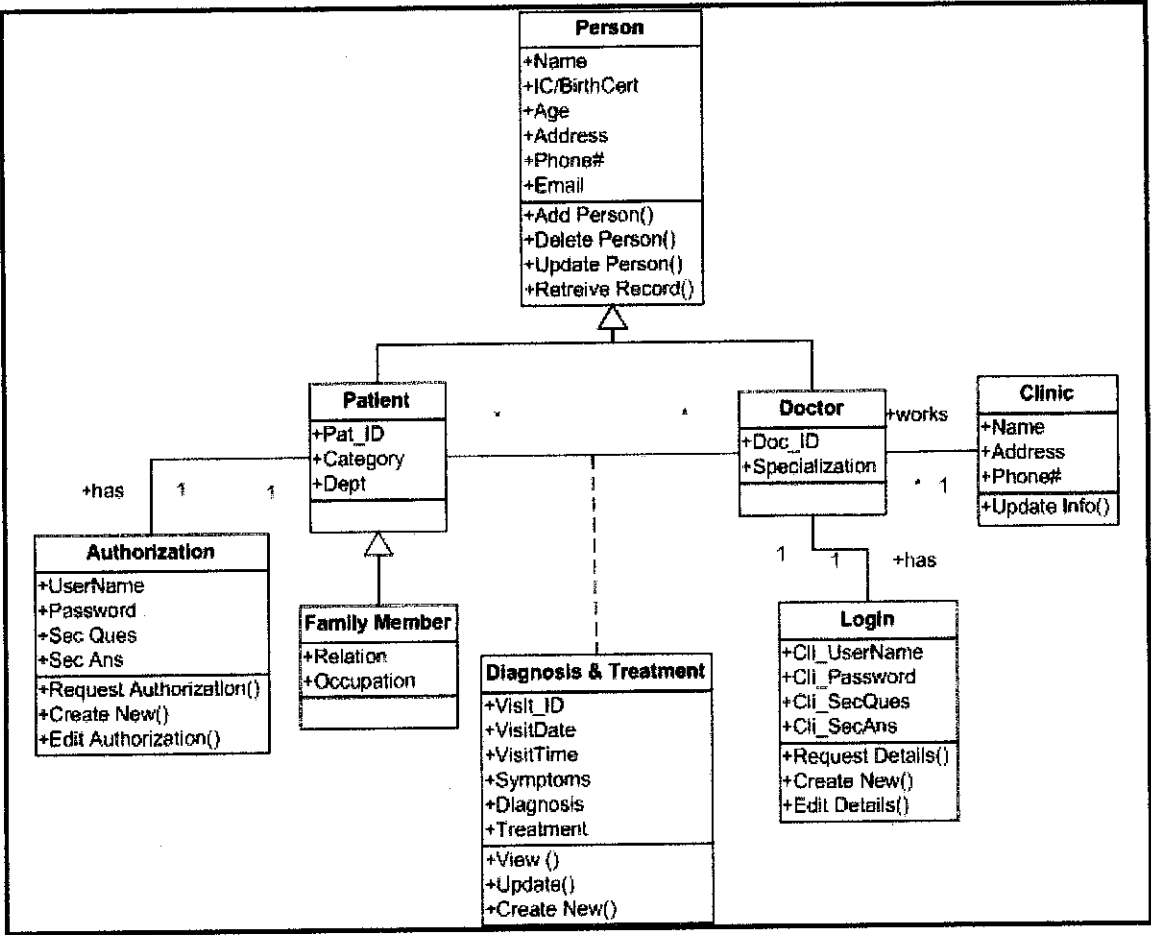
Figure 4.6: Class Diagram for the proposed Web Based Clinical System

Figure 4.6 represents the Web Based Clinical System class diagram. There are a total of 9 objects in the class diagram. Each object has attributes and methods. The database in figure 4.6 represents the Clinical System Database situated in UTP.

Person is the generalization of Patient and Doctor. Person attributes consist of name, IC (birth cert), age, address, phone no and email. There are 4 methods identified for the Person object which are add, delete and update person and retrieve record. The user can add, delete and update person (patient or doctor)

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details in the Person object. The user can also retrieve the person's record. These 4 methods are inherited by the Patient, Doctor and Family Member objects. There are few attributes which are unique from Patient, Doctor and Family Member. Patient has patient ID (which is UTP staff ID), category and dept. In addition, Family Member object has relation and occupation attributes. Meanwhile the Doctor object attributes consists of doctor ID and specialization.

Next is the Authorization object which consist of username, password and secret question attributes. There are 3 methods for the Authorization object which are request authorization, create new and edit authorization. The authorization table is only created in the remote database which stores all UTP staff authorization details.

The Login object has 3 attributes and 3 methods. Clinic username, clinic password and clinic secret question represent the attributes. Meanwhile the methods are the same as the Authorization object which consist of request details, create new and edit details. The Login table is only created in the local database of every UTP panel clinic whose uses the system.

Next is the Clinic object where the clinic details are stored. The attributes consist of name, address and phone no. besides that there is only one method for this object which is update info method. This method allows the user to add, delete and update information regarding the user's clinic.

The Diagnosis & Treatment object is a representation of a many-to-many relationship between Patient and Doctor objects where one or many patients has one or many doctors and via versa. This object has 6 attributes which are visit date, visit time, symptoms, diagnosis, treatment and treatment cost. There are 4 methods belonging to this object which are view, update, and create new. The view method allows user to view the patients record in other words the user will be able to retrieve the patients previous medical record. Next is the update

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method which allows the user to add on to the previous medical record. Create new on the other hand enables the user to create new records (consist of symptoms, diagnosis and treatment) on the patients.

4.2.5 Sequence Diagram
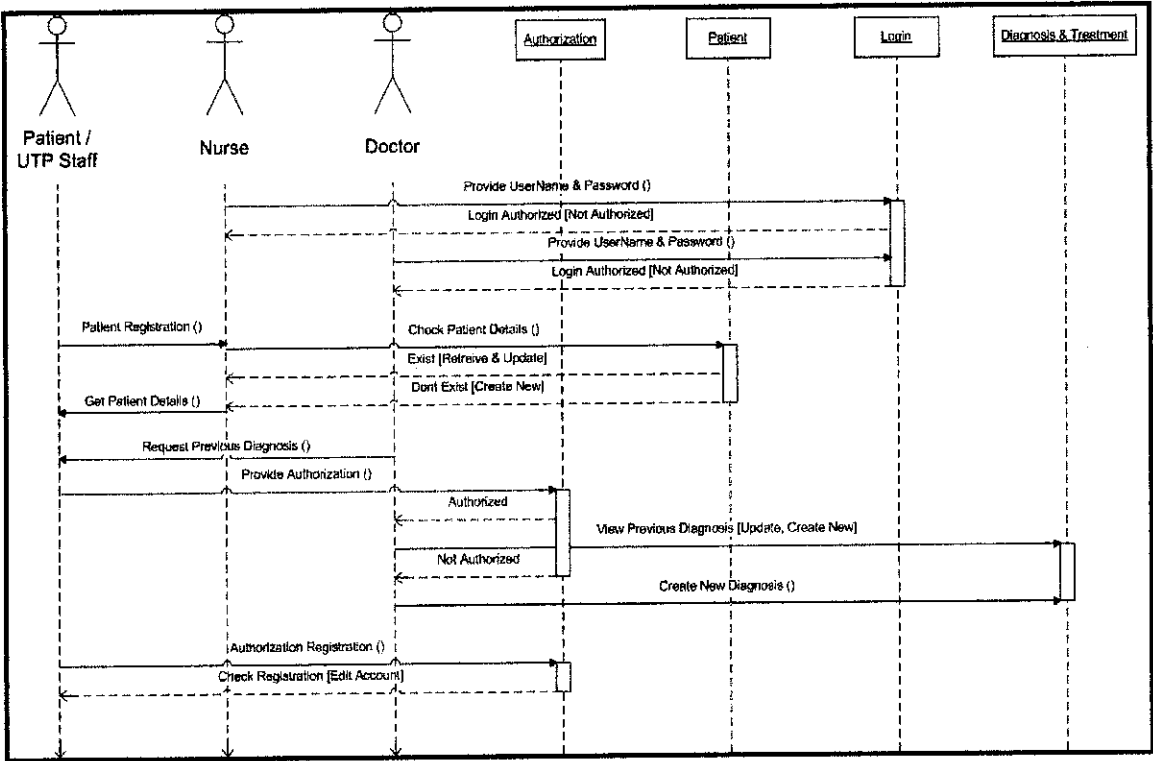
Figure 4.7: Sequence Diagram for the proposed Web Based Clinical System

Figure 4.7 gives an illustration of how the system interacts between the users and the database. The actors are representations of users from the use case diagram shown in figure 4.5 and the objects are representations of tables from the class diagram in figure 4.6.

Firstly the login process which involves the nurse, doctor and the Login table. The user (clinical staff and doctors) provides the username and password to

access the system. If the login is verified then the user is granted access to the system. If not authorized then the user are not given access to the system.

Secondly is the patient registration process which involves patient, nurse and the Patient table. The patient registers with the nurse by providing their IC number and the nurse checks in the system. The system communicates with the Patient table to retrieve the patient's details if there are any. If the patient's details exist then the details are retrieved and the details can be updated if needed.

Next is the request previous diagnosis process which involves the doctor, patient, the Authorization table and the Diagnosis & Treatment table. The doctor requests to view the patient's previous medical record which requires the patient to provide the doctor with their authorization. If authorized the doctor is able to view the patient's previous medical records and the doctor can either update the previous medical record or the doctor can create new record. If the doctor is not authorized then he can straight away proceed by creating a new medical record for the patient.

The authorization registration involves the UTP staff and the Authorization table. Before being able to provide the doctors with the authorization, the UTP staff needs to register and create an authorization account. This account will be used when they visit the clinics and the doctor will be able to view the previous medical record with the correct authorization of the patient.

4.3 SYSTEM ARCHITECTURE

Figure 4.8 is a conceptual design which defines the structure of the web based clinical system. Client-server architecture is used to represent the structure of the system. The patient's details and information are transferred from the remote database to the clinic over the internet. Similarly, the clinic saves the patients details and information to the remote and also the local database through the use of the internet.

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Patients' latest information and medical records are updated to the remote database for future usage. Clinics also save the patients information and medical records to the local database. The reason is to keep a back up copy of the patient's information and medical records, just in case if the remote database can't be access to due certain error or if the patient is no longer an UTP staff. The patient's information and medical records can still be access through the local database.
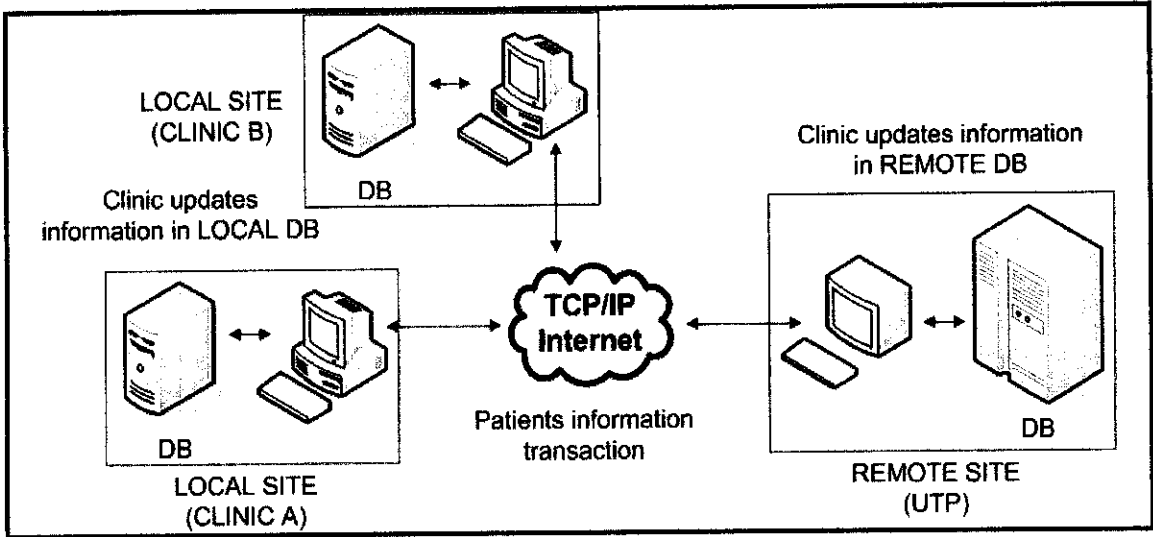
Figure 4.8: Web Based Clinical System Client-Server Architecture

A database is created at the clinic's location which is labeled the local database in figure 4.8. This database is created for each UTP panel clinics which means every panel has an identical local database. More clinics can be added to the network without any major changes to the structure or the system architecture. The remote database stores all the medical records of all the UTP staffs and allows clinics to access this information and save it to the local database with the authorization of the patients. Without the patient's authorization, the clinics aren't able to retrieve the previous medical records.

4.4 DISTRIBUTED SYSTEMS ISSUES & IMPLEMENTATION

This section suggests the issues that arise when designing a distributed database system or distributed system. Although distributed systems are to be found everywhere, their design is simple yet there are many issues which need to be consider when developing a distributed system [16]. Following are the issues identified in the development of the Web Based Clinical System for UTP Panels.

4.4.1 Security

Many of the information that is made available and maintained in distributed systems have high intrinsic value to their users. The security of this information is vital. Security for information resources has two components: Confidentiality which is protection against disclosure to unauthorized individuals and second Integrity which is protection against alteration or corruption [16].

Security risks are associated with allowing free access to all of the information in an intranet or network. A firewall can be used to form a barrier, restricting the traffic that can enter and leave but this does not deal with ensuring the appropriate use of information and resources by users within the network.

The web based clinical system has adopted the client-server architecture. In this architecture the clients send request to access data managed by a server which involves sending information in messages over the internet or network. The issue is to send sensitive information in a message over a network in a secure manner. The security is not just a matter of hiding the contents of the message but it also involves knowing for sure the identity of the user on whose behalf the message was sent and received.

In the case of the web based clinical system, there are two processes implemented in the system to address the security issue. Firstly is the system

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login process which involves the doctors and clinical staffs. The system login process makes sure that only authorized personal like doctors and clinical staffs are allow using the system. As shown in figure 4.8 in the system prototype section.

Besides that, the patient authorization process which involves only UTP staff patients is implemented to protect against any disclosure to unauthorized access of the patients information, medical background etc. The patient authorization process also protects and keeps the patient's privacy and avoids anyone (in this case any doctors) from viewing the patient's medical records without the patient's authorization or consent. As shown in figure 4.11 in the system prototype section. The doctor will need to get the patients authorization before being able to view their previous medical background etc.

4.4.2 Transparency

Transparency is defined as the concealment from the user and the application programmer of the separation of components in a distributed system, so that the system is perceived as a whole rather than as a collection of independent components [16]. There are many types of transparency and few of those are covered in this section as distributed systems issues. The aim is to make certain parts of distribution invisible so that the only concern would be the design of the application.

First is the Network transparency which enables local and remote resources to be accessed using identical operations and without knowledge of their physical or network location [16]. The web based clinical system uses both local and remote databases to save and retrieve data. The local database stores the patient's detail and information who visits the clinic doesn't matter whether the patients are UTP staff or not. Meanwhile the remote database stores only UTP staff patients detail and information from all other clinics.

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Replication transparency enables multiple instances of information or resources to be used to increase reliability and performance without the knowledge of the replicas by users [16]. As mention earlier, the patient's (UTP staff) details and information are saved in two separate databases which are the local and remote database every time a transaction is saved. The details and information are replicated to two different databases. When retrieving details or information, the system retrieves from the remote database first and if there are any errors (database or connection errors), the system will retrieve from the local database as a backup.

Lastly is the Scaling transparency which allows the system or application to expand in scale without change to the system structure or the application algorithms [16]. The system allows for more clinics to be added in the network without any extra configuration needed. The only configuration required would be to rename the connection to the database to suit the local site which is at the clinic's computer. Any clinics which are UTP panels can be added to and use the Web Based Clinical System to retrieve and save UTP staff details, information, medical background etc.

Transparency hides and renders anonymous the resources that are not of direct relevance to the task in hand from users.

4.4.3 Heterogeneity

The internet allows users to access and run applications over a heterogeneous collection of computers and networks. Heterogeneity is defined as variety and difference which applies to networks, computer hardware, operating systems, programming languages etc [16].

The web based clinical system can be access and utilized from any facility that has internet connection. The internet communication protocols mask (in other words hides) the difference in networks which addresses the heterogeneity issue.

4.4.4 Openness

The openness of a computer system is the characteristic that determines whether the system can be extended and re-implemented in various ways [16]. The openness of distributed systems is determined primarily by the degree to which new resource sharing services can be added and be made available for the use by variety of client programs [16].

The web based clinical system can be extended by the addition of clinics and databases to the system network as well as re-implemented by using a different programming language to create the system. The system is created by using Visual Basic .NET (which is also known as ASP .NET) programming language and can also be re-created by using many other programming languages as well which addresses the openness issue.

The internet enables users throughout the world to access its services wherever it may be located and whenever it is used. Information and resource sharing is the main incentive for developing and implementing distributed systems.

4.5 SYSTEM PROTOTYPE

The end product of this project is Web Based Clinical System for UTP Panels prototype. The scope of this prototype has been defined earlier in the result and discussion section. Some snapshots and brief explanations of the prototype are provided below.

4.5.1 Main Login

This is the main page which everyone would see when they access the system thru the web. There are 2 tasks that the user can perform on this main login page.
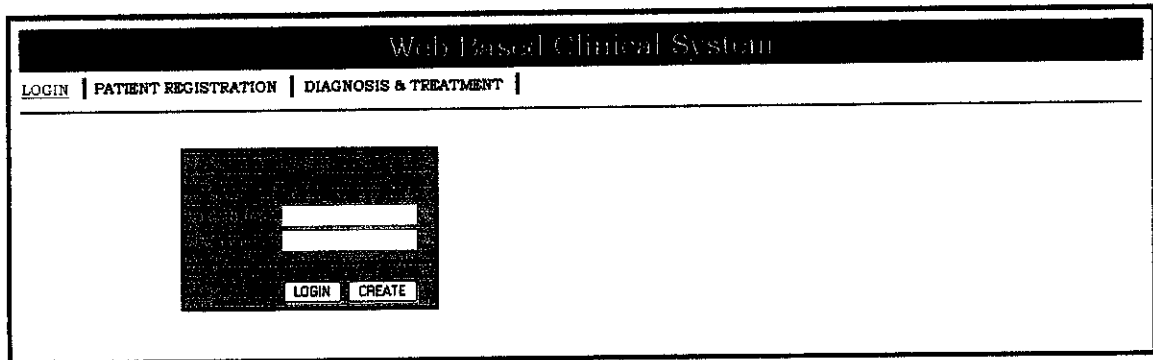

Figure 4.9: Main Login for the proposed Web Based Clinical System

1. Login - Clinical staff enters their username and password to access the system. Without the username and password they are unable to access the system. The username and password are verified with the data in the Login table to ensure reliability of the system. The Login table is part of the local database located at the clinic. Only the clinical staffs and doctors situated at that specific clinic are able to view and edit the table.

2. Create – New clinical staffs or doctors are able to create a new account by providing a username, password, secret question and answer and email address

4.5.2 Choose Patient

This page only appears after the clinical staffs or doctors have successfully logged in. This page provides the users with two options which are choosing either UTP staff or other patients. Each button will bring the user to an

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appropriate page. Each page is created to suit the type of patient. In this case there are 2 types of patients which are UTP staffs or not.

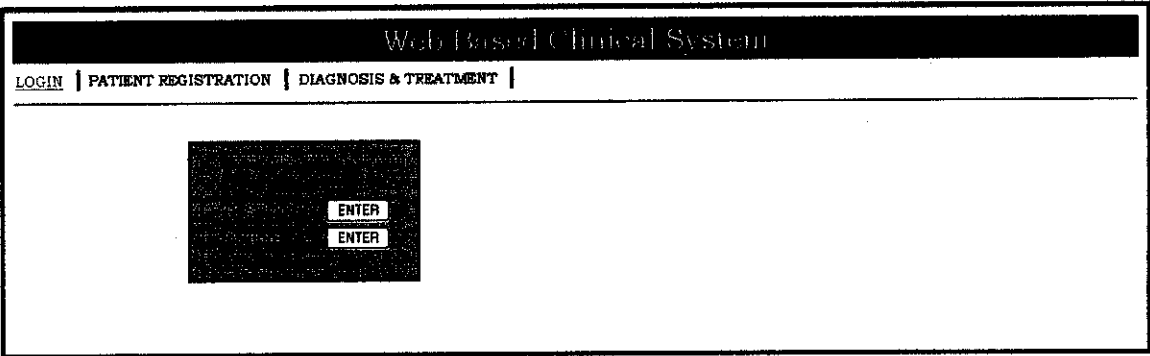

Figure 4.10: Choose Patient for the proposed Web Based Clinical System

4.5.3 Patient Registration

Figure 4.10 represents the patient registration page which appears after choose patient page. This page shows the patients personal details which consist of the patient's name, IC, UTP staff ID, age, address, phone no, email address, category and department. This page also displays the patient's family member's details as well.

There are also crumbs at the top of the page to allow the user to navigate from one page to another. There are 3 crumbs which are Login, Patient Registration and Diagnosis & Treatment. By clicking any of these crumbs, the user will be able to proceed to that page. There are 3 tasks which the user can perform on this patient registration page.

1. Retrieve - This enables the clinical staffs to retrieve the patient's personal details from the Person, Patient and Family Member tables which are part of the remote database located at UTP. The patients just need to provide the clinical staffs with their IC number.

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After entering their IC number, the clinical staff will be able to view their personal details as well as their family member's details. These personal details are provided and added into the database by the UTP HR and can be edited by the UTP HR or staffs themselves at UTP.

Figure 4.11: Patient Registration for the proposed Web Based Clinical System

2. Edit - This allows the clinical staffs to edit any personal details which are incorrect or out dated. For example there are changes in the patient's phone no and address and this correction are not made with UTP HR before visiting the clinic. The clinical staff will be able to edit this piece of information when the patient visits the clinic.

3. Save - The changes are saved in the local database. The patient's personal details and information which was retrieved earlier are saved to the local database if the patient is a new patient. Otherwise, only the updated personal details are saved in the local database as well in the remote database.

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4.5.4 Diagnosis & Treatment

Figure 4.12 gives a preview of the diagnosis and treatment page. This page consists of the patient's name, IC, previous and new medical records like symptoms, diagnosis and treatment. This page also displays the doctor's name and ID who is in charge for that day or for that diagnosis of the patient. There are 3 tasks which the user can perform which are retrieve, create and save.

Figure 4.12: Diagnosis & Treatment for the proposed Web Based Clinical System

1. Retrieve - This will allow the doctors to retrieve previous medical records like the patient's symptoms, diagnosis and treatments from the remote database. The UTP staff authorization process enables the patient to input their username and password and click retrieve. Without the correct username or password, the doctor will not be able to view the patient's previous medical record. This process is done in order to keep the patient's privacy and will avoid from anyone (any doctors for that matter) viewing the patient's medical record without their authorization.

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If the remote database is unable to provide the doctors with the previous medical records due to certain errors, the system will retrieve the patient's information from the local database.

2. Create - This function allows the doctors to create new symptoms, diagnosis and treatments for the patient when the previous medical records are needed or not. The doctor will be able to add on the previous medical record as well. The doctors can't edit the previous record but only view and add to it.

3. Save - The newly added medical records like symptoms, diagnosis and treatment are saved to two separate databases. The records are saved to the remote and local database. This process is an implementation of the data replication concept where data is saved and replicated to two different databases. The local as well as the remote database has the updated medical records for that particular patient.

4.6 SYSTEM TESTING

There are 3 types of testing [15] used for the Web Based Clinical System.

1. Unit Testing - Test each component of the prototype to find whether it works properly and free from faults and errors. This testing is done by the developer of the system by testing each main component of the prototype.

2. Integration Testing – Test the defects in the system interface as well interaction between integrated components until the system works as a whole.

3. Acceptance Testing - Test the acceptance of the system by the users.

4.6.1 Unit Testing

Unit testing requires testing of each component to examine whether it works properly as individually or multiple components. If it does not work, the testing has identified the errors and defects of the component tested. This unit testing involves component testing (test each web page) and database testing.

1. Login - The Login page is tested to assure that only authorized personal which consist of clinical staffs and doctors are able to enter and use the system.

2. Choose Patient - This page is tested to see if the selected button brings the user to the desired page. The selection process is show in Figure 4.10 in the System Prototype section.

3. Patient Registration - This page has 3 functions which are retrieve, edit and save. The retrieve functionality is used most because this function retrieves the patient's personal details from the remote database to the system where the clinical staff is able to edit and save this retrieved personal details. As mention, the retrieve function retrieves from the remote database and if the remote database can't be accessed the system will retrieve the personal details from the local database.

   For now, there are no errors that can be found for this function specified. The user was able to retrieve more than one patient's personal details after each detail has been displayed. The clinical staffs were also able to edit and save the patients personal details without any problem. The system retrieves the personal detail which was already inserted by the UTP HR into the remote database.

4. Diagnosis & Treatment - This page consist of 3 functionality as well which are retrieve the patient's previous medical records (patient authorization),

create new medical record and third saving the data. The most critical functionality would be the retrieve patient's previous medical record. This functionality involves the patients to provide the doctor with their authorization. Without the correct authorization, the doctor will not be able to view the patient's previous medical records. This UTP staff authorization is shown in Figure 4.12. This patient authorization has been tested many times with the patients who are UTP students and few lecturers.

There were certain issues which arise when testing the patient authorization functionality which was what if the patient didn't remember their username or password? Or what if the patient has not register and created an account with UTP HR? These issues can be overcome and are mention in the recommendation section 5.2. But for the system functionality, the system was able to retrieve the patient's medical records and arrange it into a table and can be viewed by the doctor.

Create new medical record function didn't have any errors as well. The doctors were able to insert the patient's symptoms, diagnosis and treatment into the according boxes without any problems. Next was to use the save function after inserting the patient's medical records, this function work properly but there might be some errors in the future if the database can't be accessed or if the internet connection wasn't available. The saving of information to the remote database would not take place. On the other hand the saving of this information to the local database would take place since it doesn't require an internet connection to connect to the database.

5. Database - The database was tested separately without inserting and retrieving data by using the system. This was done to ensure that data which was inserted manually to the database could be retrieved by the system. Many errors were encounter when inserting the data into the database

without using the system. This error was rectified by changing the constraints which limit the functionality of the database.

The reason for this testing is to ensure that UTP HR is able to insert all the UTP staffs personal details like name, staff ID, IC number, address, phone numbers, email address, department, category etc into the database without any errors.

4.6.2 Integration Testing

After testing every components individually in the unit testing, integration testing was done to test all the components as one whole integrated system. There are three user requirements and expectations which were addressed in the integration testing of the system. The expectations that were addressed are the system user interface, system user navigation and system functionality. The users of the systems which consist of clinical staffs and doctors as well as participants have tested the system with respect to the three requirements and expectations mention earlier.

Based on the testing and experience contributed from users and participants, they conclude that the system is straight forward, easy and simple. The users and participants find that the navigation of the system as strategic and conveniently placed. There are crumbs at the top of the web page which makes it easy for the user to navigate through the system from one page to another with ease and it is not confusing to be used by the users of the system. The system functionality meets most of the user's requirements and expectations which has been explained in the unit testing section. The patient registration and diagnosis & treatment pages fulfills 80% of the user's requirement with the necessary patient's information and medical records being displayed and saved to the database.

4.6.3 Acceptance Testing

In acceptance testing, the clinical staffs and doctors were required to participate in the system testing. The purpose of this testing is to check if the system meets the users expectations. The system was tested with two clinics. The clinical staff and doctors who tested the system gave good feedback as well as commented on constraints in the system. The constraint that was identified by the users was regarding the patient's medical records. The system didn't provide enough columns for the user to input addition information like patient's allergies, medicine taken, date, time etc.

Figure 4.13: Initial design of the Diagnosis & Treatment for the proposed Web Based Clinical System

Another drawback in the design of the system is that only one of previous medical records are retrieved from the remote database to the system. The doctors aren't able to view all the previous medical records and see this as a limitation of the system. The limitations of the prototype have been addressed

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and changes to meet the end user requirement have been fulfilled. A table like column has been added to the diagnosis & treatment section to overcome the limitation stated by the doctors.

The acceptance testing detected many faults, errors, drawback and limitation to the system that were not detectable using the previous two test methods, unit testing and integration testing. The reason being is that the end users were more involved in the testing of the system as a whole rather than testing part and pieces of the system individually (refers to unit testing).

Figure 4.13 shows the initial design of the diagnosis & treatment page which had few limitations and has been redesign which is Figure 4.12 in the system prototype section earlier. The initial design was too simple and didn't include the doctor's details, date and time of visit and others which were vital to the medical records.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This chapter discusses the conclusion of the project and provides recommendations that could be further studied and implemented in the future.

5.1 CONCLUSION

As discussed in the result and discussion chapter, from the requirement gathering methods, the information and finding has been tabulated in tables and graphs. The common business process among UTP panel clinics has been analyzed according to the scope of the project. As identified in the result and discussion section there is potential to implement an automated system for the diagnosis and treatment business process as well as the patient registration.

The implementation of Web Based Clinical System for UTP panels can ensure reduced tendencies for errors when dealing with patient's information and medical records. At the same time, the system is able to save time and space for recording & storing patient information and medical records. Last but not least the system will most definitely increase the patients' convenience.

In order to solve the problem statement, the best way will be to implement a system for all the UTP panel clinics to access. The system can't be a standalone system; it would defeat the purpose of data sharing among clinics. The best way to reach this purpose will be to develop a web based system where the UTP panel clinics will be able to communicate and share relevant information of patients. Developing a web based

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system comes with many, many information technology issues and loop holes but the disadvantages don't over weigh the benefits of using the system.

The methodology part involves two major parts which consist of requirements gathering and secondly system development. Requirements gathering consist of research, interviews, observation and questionnaires. The prototype methodology is used because consists of building an experimental system rapidly and is inexpensive for the end users to evaluate and give feedback.

5.2 RECOMMENDATION

This project has more room for improvement. First of all would be regarding the patient authorization function. Currently the proposed system would be requesting the user for identification and also password to be inserted into the system to verify the patient. The patient will have to remember his user name and also his password. This would sometimes be a hassle and difficulty for patients to remember. The future enhancement from this current way of getting patients authorization would be to implement thumb recognition, a RFID or magnetic card to allow patients to verify their access.

Secondly is to allow clinics to communicate between each other straight away rather than retrieving information from the remote database only at all times. Many more issues which needs to be addressed when it comes to this kind of network communication to be implemented. This concept here would help data transfer and sharing between clinics if the remote database is not available.

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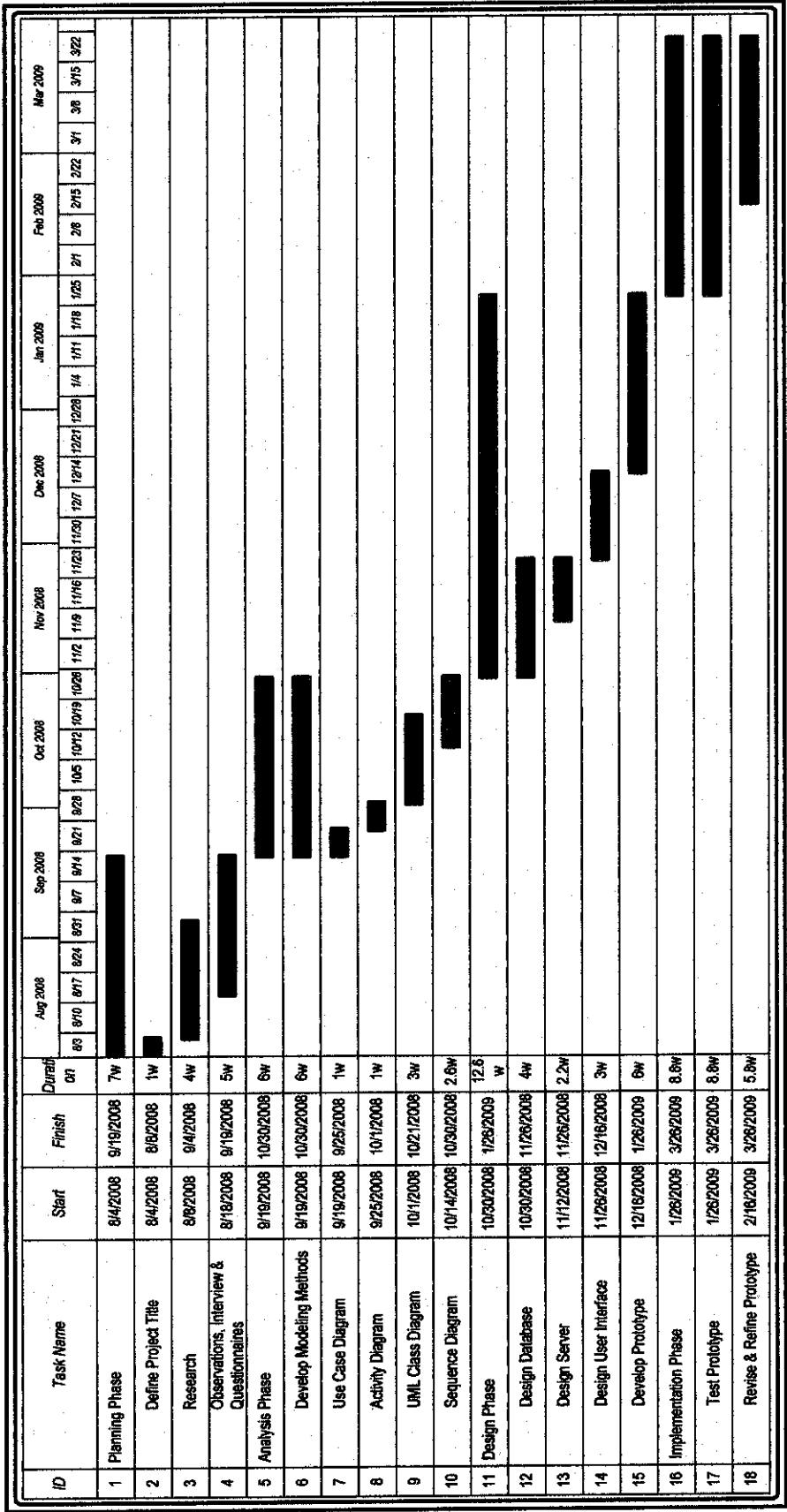
ID	Task Name	Start	Finish	Duration
1	Planning Phase	8/4/2008	9/19/2008	7w
2	Define Project Title	8/4/2008	8/8/2008	1w
3	Research	8/8/2008	9/4/2008	4w
4	Observations, Interview & Questionnaires	8/18/2008	9/19/2008	5w
5	Analysis Phase	9/19/2008	10/30/2008	6w
6	Develop Modeling Methods	9/19/2008	10/30/2008	6w
7	Use Case Diagram	9/19/2008	9/25/2008	1w
8	Activity Diagram	9/25/2008	10/1/2008	1w
9	UML Class Diagram	10/1/2008	10/21/2008	3w
10	Sequence Diagram	10/14/2008	10/30/2008	2.6w
11	Design Phase	10/30/2008	1/26/2009	12.6w
12	Design Database	10/30/2008	11/26/2008	4w
13	Design Server	11/12/2008	11/26/2008	2.2w
14	Design User Interface	11/26/2008	12/16/2008	3w
15	Develop Prototype	12/16/2008	1/26/2009	6w
16	Implementation Phase	1/26/2009	3/26/2009	8.6w
17	Test Prototype	1/26/2009	3/26/2009	8.8w
18	Revise & Refine Prototype	2/16/2009	3/26/2009	5.8w

Figure 3.2: Gantt Chart

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APPENDIX B

No	Clinics	Size	Location	Scope	Respond	Observation	Questionnaires	Intreview
1	SELANGOR MEDICAL CENTRE	Large	Selangor	X				
2	GLENEAGLES INTAN MEDICAL CENTRE	Large	Kuala Lumpur	X				
3	KLINIK KANAK-KANAK YEE & KLINIK LEE	Large	Perak	X				
4	IPOH SPECIALIST HOSPITAL	Large	Perak	X				
5	HOSPITAL FATIMAH	Large	Perak	X				
6	HOSPITAL PANTAI PUTRI	Large	Perak	X				
7	SUBANG JAYA MEDICAL CENTRE	Small & Medium	Selangor	X				
8	HOSPITAL PUSRAWI SDN BHD	Large	Kuala Lumpur	X				
9	KLINIK RAGHU	Small & Medium	Perak		Closed			
10	KLINIK DR. NAJIHA	Small & Medium	Perak		Bad			
11	KLINIK DR. ZAKARIA DAN RAKAN	Small & Medium	Perak		Very Good	Y	Y	Y
12	KUMPULAN PERUBATAN AR-RIDZUAN	Small & Medium	Perak		Good	Y	Y	
13	KLINIK SAFRI & HAMIMAH SDN BHD	Small & Medium	Perak		Very Good	Y	Y	Y
14	PERAK MEDICAL CENTRE SDN BHD	Small & Medium	Perak		Good	Y	Y	
15	POLIKLINIK PERMAI	Small & Medium	Perak		Good	Y	Y	
16	POLIKLINIK DR. AZHAR & RAKAN-RAKAN	Small & Medium	Perak		Good	Y	Y	

Table 4.2: List of small and medium sized UTP panel clinics around Malaysia.

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APPENDIX C

Interview Questions

1. What is the business processes (daily activities) involved in your clinic?

2. Which of these daily activities are considered most crucial? Why?

3. How does your clinic go about doing these daily activities? Manually or Using a system?

4. Do you have any automated system for any of the daily activities? Why?

5. Do you have a computer and also internet connection in your clinic?

6. How many patients visit in a day?

7. How is the patient registration done currently?

8. How is the diagnosis and treatment done currently?

9. What is your opinion on implementing an automated system for any of the daily activities?

10. What about implementing an automated system for the diagnosis & treatment and patient registration activities?

11. How do you feel about sharing the same patient's information with another UTP panel clinic? In particular the diagnosis & treatment and also patient registration activities.

12. Is it important for you to know about any information about other doctor's diagnosis to the patient and any medications that have been given to those patients? Why? In case the patient is seeing the doctor due to prolong illness.

APPENDIX D

Questionnaire

Section A: DETAILS ABOUT YOURSELF

Please tick or write your answer in the appropriate box

1. Gender:

☐ Male   ☐ Female

2. Age: _____ years

3. Position:

☐ Doctor   ☐ Nurse   ☐ Clerk   ☐ Others

Section B: DETAILS ABOUT THE CLINIC

1. Does the clinic use an automated system in any of the daily activities (business processes)?

☐ Yes   ☐ No   If no proceed to question 3

2. Which of these daily activities in your clinic are currently using an automated system?

☐ Patient Registration   ☐ Diagnosis & Treatment   ☐ Medicine Dispensary   ☐ Medicine Inventory

☐ Schedule Appointment   ☐ Claims and Staff Payment   ☐ Others

Others please specify: _____

3. Which of these daily activities would benefit by implementing an automated system in your clinic?

	Patient Registration		Diagnosis & Treatment		Medicine Dispensary		Medicine Inventory
	Schedule Appointment		Claims and Staff Payment		Others		

Others please specify: _____

4. How many patients visit your clinic on a daily basis?

☐ 1-30   ☐ 31-60   ☐ 61-90   ☐ More then 90

5. Do you agree to share certain information regarding the same patients with another clinic?

☐ Yes   ☐ No

6. How long do you keep your patients data?

☐ Less then 1 year   ☐ 1 – 5 years   ☐ 5 – 10 years   ☐ More then 10 years

Thank you for your effort and co-operation in completing this questionnaire.